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Abstract

Income per capita in Spain relative to that of other advanced EU countries held stable at around 90% from 2000 to 2016. Stagnant labour productivity is at the root of this lack of convergence. This paper examines these developments from a sectoral perspective based on recently released EU KLEMS data. Our main findings are as follows: i) Spain has lower productivity levels vis-à-vis other EU countries in most sectors, with only 4 out of 23 sectors exhibiting higher productivity in Spain: accommodation and food services, agriculture, electricity and gas supply, and information and communication services; moreover, the allocation of employment towards low-productivity sectors accounts for half of the aggregate Spain-EU productivity gap in levels; ii) turning to the changes in the 2000-2016 period, the overall lack of convergence is driven by a divergence in productivity relative to EU countries, especially within services sectors; iii) while both ICT (Information and Communication Technology) and non-ICT capital in Spain converged towards European levels, Total Factor Productivity (TFP) divergence in most sectors explains the lack of convergence in labour productivity. Finally, we explore one potential explanation for this pattern: the TFP divergence and ICT capital convergence can be rationalised in the presence of complementarities between ICT-capital and labour force skills. Indeed, our industry-country regression analysis suggests that the dismal performance of Spanish TFP might be related to the significant deficit in the population's skills as proxied by PIAAC-OECD scores.

Keywords: labour productivity, Total Factor Productivity, productivity gap, labour force skills.

JEL classification: D24, C23.

Resumen

Entre 2000 y 2016, la renta per cápita en España permaneció estable y representó en torno al 90 % en relación con otros países avanzados de la Unión Europea (UE). Esta falta de convergencia se debe en gran medida al estancamiento de la productividad laboral en España. Este documento analiza este hecho desde una perspectiva sectorial, empleando los datos recientemente publicados por EU KLEMS. Se observa que España presenta unos niveles de productividad más bajos en comparación con otros países de la UE en la mayoría de los sectores: solo 4 de los 23 sectores analizados muestran un mayor nivel de productividad. Además, la asignación de empleo a sectores de baja productividad representa la mitad de la brecha de productividad agregada entre España y la UE. En cuanto a los cambios del período 2000-2016, la falta de convergencia se debe a una divergencia en los niveles de productividad en relación con los países de la UE, especialmente en el sector servicios. Finalmente, mientras que el capital tecnológico (TIC) y el no tecnológico convergían hacia los niveles europeos, el bajo crecimiento de la productividad total de factores (PTF) en la mayoría de los sectores explica la falta de convergencia en la productividad laboral. Una posible explicación a la divergencia de la PTF y la convergencia del capital tecnológico podría ser la presencia de complementariedades entre el capital tecnológico y las habilidades de la fuerza laboral. De hecho, el análisis sectorial y por país realizado sugiere que el bajo crecimiento de la PTF española podría estar relacionado con un déficit significativo de las habilidades de la población, como indican los resultados obtenidos en el PIAAC-OCDE.

Palabras clave: productividad laboral, productividad total de los factores, *gap* de productividad, habilidades de la fuerza laboral.

Códigos JEL: D24, C23.

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1 Introduction

The ratio of Spanish GDP per capita to that of other EU countries stood at 90% in 2000. Surprisingly enough, this figure remained unchanged in 2016 in spite of the cyclical fluctuations. In this article, we explore the industry developments behind this lack of convergence since the year 2000. The remainder of this introduction offers details of the different sections and findings of the paper, which should allow the reader to grasp the essence of our contribution.

Section 2 describes the datasets at the industry-country level that allow us to analyse the productivity gap between Spain and other European countries from a sectoral perspective. More specifically, we study the labour productivity gap by industry, looking at both levels and changes between 2000 and 2016. On the one hand, Eurostat data permit analysis of the levels in selected years provided appropriate purchasing power parity adjustments are used. On the other, data taken from the EU KLEMS database enable the evolution over time of the labour productivity gap by sector to be dissected in terms of its input contributions (labour composition, ICT capital and non-ICT capital) along with the contribution of total factor productivity.

Section 3 describes aggregate Spanish GDP per capita vis-à-vis other European countries. According to the latest data published by Eurostat for 2018, GDP per capita in PPP stood at €28,113 in Spain, against €30,963 per person on average in the European Union. These figures mean a ratio of around 90%, very close to that of the year 2000 in spite of the cyclical fluctuations that increased the ratio during the boom but dampened it during the crisis years. The decomposition of GDP per capita into GDP per hour worked (labour productivity), average hours per worker and the employment rate allows us to conclude that the dismal performance of Spanish labour productivity is largely responsible for the persistent gap in GDP per capita. This is so because the lower employment rate in Spain is offset by the higher average hours per employee worked, meaning that Spanish hours per capita are broadly in line with other European countries in both 2000 and 2016.

Section 4 turns to the detailed industry-level anatomy of the labour productivity gap between Spain and other advanced European countries. Section 4.1 focuses on PPP-adjusted levels and concludes that most sectors in both industry and services exhibit negative productivity gaps. Indeed, there are only 4 out of 23[1] sectors in which Spain has higher productivity levels with respect to other countries over the whole period, namely, accommodation and food services, agriculture, electricity and gas supply, and, to a lesser extent, information and communication services. We also calculate the sector-specific contributions to the overall productivity gap and find that the contribution of services to the overall negative gap is significantly larger than that of manufacturing. The professional services sector stands out as that with the highest negative contribution to the overall productivity gap (4.6 pp out of –9.3 pp in 2016). Our levels decomposition analysis also

1 Without taking into account coke and refined petroleum products, which are very volatile and subject to price fluctuations that are difficult to account for by means of PPP adjustments.

suggests that around half of the productivity gap in 2016 can be explained by the allocation of employment towards low-productivity activities, i.e. low-productivity sectors exhibit relatively high employment shares vis-à-vis other European countries.

Section 4.2 analyses the evolution over time of the contributions to the productivity gap discussed in section 4.1. The overall lack of convergence between Spain and other countries from 2000 to 2016 is due to a deterioration in the contribution from manufacturing and construction that is partly offset by improvements in the contribution of the services sector. Interestingly, the improvement in the contribution of services is only the result of a greater tertiarisation of employment in Spain despite the across-the-board divergence in productivities vis-à-vis EU12 in virtually all services subsectors.[2] In contrast, we observe a different pattern for the manufacturing sector: a very modest improvement in relative productivities with respect to EU12 countries that is offset by a fall in the relative employment shares of most manufacturing subsectors. All in all, the divergence of whole-economy productivity is due, mainly, to a deterioration in relative labour productivities in services.

Section 4.3 analyses the lack of convergence in Spanish productivity vis-à-vis other European countries in terms of input contributions and TFP by sector. Recently released EU KLEMS data provide useful information to calculate the contributions to labour productivity growth of labour composition, ICT capital, non-ICT capital and TFP. Significantly, all three inputs contributed positively to closing the productivity gap: investment in both ICT and non-ICT capital was higher in Spain, and the composition of the labour force in terms of education, for instance, improved more in Spain than in the other EU12 countries. In contrast, the convergence in terms of inputs used was more than offset by a strong divergence in terms of TFP, meaning that the overall (negative) productivity gap widened slightly. These patterns are common to most sectors in both manufacturing and services.

Section 5 sheds some light on the TFP divergence puzzle. Schivardi and Schmitz (2019) show that the dismal performance of TFP in Southern European countries with respect to Germany is mostly due to inefficient management practices hampering the benefits of the IT revolution. In this connection, we find evidence in favour of an alternative but related hypothesis: in order to benefit from the IT revolution, what is needed is not only efficient management practices but also a trained labour force to complement ICT capital investments. However, according to PIAAC scores (Programme for the International Assessment of Adult Competencies), Spanish adults would be less prepared than their European counterparts to exploiting such complementarities even for a given level of formal educational attainment. Indeed, our regression evidence at the country-industry level suggests that investments in ICT capital result in significantly higher TFP gains when the country's population has higher PIAAC scores. Our back-of-the-envelope counterfactuals suggest that if the Spanish scores in PIAAC had moved from the current 5th percentile to the level of Finland (95th percentile), labour productivity growth would have doubled, leading to a relatively strong convergence of 5 pp over the whole 2000-2016 period.

2 The rise of services (and the fall in manufacturing) over this period might be related to the belated structural transformation of the Spanish economy with respect to other advanced European countries [see González-Díez and Moral-Benito (2019)].

2 Datasets at the industry-country level

In this section we describe the labour productivity data from Eurostat and summarise the growth accounting decomposition provided by EU KLEMS. We find that the measures of labour productivity growth from Eurostat and EU KLEMS coincide since they are both rooted in statistics from the National Accounts.

2.1 Data from Eurostat and PPP adjustment

Estimating productivity levels by industry are fraught with many measurement difficulties. By definition, a measure of productivity needs to put a volume measure of output in proportion to a volume measure of inputs. In our sectoral analysis, labour productivity is computed as value added per hour worked in each sector. In an international context, to make volume comparisons, value added is required to be converted into a common unit that takes into account the direct price differentials among countries, therefore current value added is converted into purchasing power parities (PPPs).[3] Under these "current PPPs" conversions, comparisons between countries within a specific year are straightforward as volumes are measured with the same price structure. However, inter-temporal comparisons requires eliminating the effect of inflation over time. Then, to combine spatial and temporal comparisons, we decided to replicate the relative movements of value added growth in volumes in each country by fixing a "base" year and extrapolating[4] PPPs over time,[5] and thus obtain "constant PPPs".[6]

The main difference between "current PPPs" and "constant PPPs" is that the former capture changes in volume as well as changes in relative prices while "constant PPPs" only capture volume changes. Even if the volumes of goods and services remain identical over time, a productivity comparison based on "current PPPs" may change over time if prices and price structures shift.[7] Following the recommendation of the OECD [Schreyer and Koechlin (2002)], we use "constant PPPs" choosing 2010 as the base year in line with the used statistics from National Accounts. Furthermore, given that data on PPPs are not available at sectoral level, we use economy-wide PPPs with 2010 as the base year assuming the global economy price structure in all industries of that year in each country.

2.2 Growth accounting data from EU KLEMS

The EU KLEMS database is designed for the analysis of growth patterns of advanced economies, and especially, the evolution of productivity growth and its determinants [O´Mahony and Timmer (2009)]. Labour productivity growth can be decomposed into

3 PPPs refer to the ratio of prices in national currencies of the same good and service in different countries.

4 Extrapolation can be done by applying the relative rates of inflation observed in different countries to the base year PPPs.

5 The main drawback with other approaches that use a fixed base is the assumption that price structures do not change over time. Another consequence of fixing price structures at a base year is that results depend on the choice of the base year.

6 Using "constant PPPs" produces the same result than applying volume growth rates of added value to the comparative added value levels of the base year, i.e., current added value in PPPs.

7 This factor comes into play when some countries are large producers and exporters of products with marked price changes.

contributions of capital intensity (also called capital deepening), labour quality and TFP. Capital intensity is measured as the amount of real capital in relation to labour. It is calculated as capital services derived from the stock of physical assets and intellectual property assets, divided by hours worked. Labour quality is captured through the labour composition that measures the effect of shifts in the age, education and gender composition of the workforce on the efficiency of hours worked.

The dataset provides industry-level growth accounting data for 28 countries and 4 aggregates (EU12, EU20, EU11 and EU19).[8] One of its key advantages is the ability to quantify separately the impact of ICT and non-ICT assets. EU KLEMS breaks down labour productivity growth estimated as value added per hour growth into: 1) TFP growth; 2) the contribution of ICT capital [split into tangible information and communication (ICT) and three types of intangible capital: software and databases, R&D and other innovative property products]; 3) the contribution of non-ICT capital (buildings and construction, machinery, transport equipment and cultivated assets); 4) the contribution of labour quality. It is worth highlighting that EU KLEMS information is based on growth rates but does not allow comparing productivity levels. The interested reader is referred to Annex 1 for more formal details on the EU KLEMS methodology and assumptions.

2.3 Sample coverage and definition of European benchmark

In order to compare the performance of the Spanish labour productivity over time with other European countries, choosing a European benchmark is crucial but is not exempt of difficulties. A common approach is to compare the country under study with the best performers or leading countries. As we need consistency between the analysis using data from Eurostat and EU KLEMS, the same benchmark needs to be selected. However, the EU KLEMS dataset does not allow building aggregates for the growth accounting exercise and we are thus constrained by their computed aggregates. In the latest 2019 released data, two country aggregates are computed from 2000 onwards: EU12[9] and EU11, which is EU12 without the United Kingdom. EU12 is then used as our benchmark which includes the following countries: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Italy, Netherlands, Spain, Sweden and United Kingdom. In this sample the best performers in terms of labour productivity levels are included: Belgium, Netherlands, Germany, Denmark, Finland and France. Moreover, the availability of the EU KLEMS information from 2000 to 2016 also determines the time period considered in our analysis.

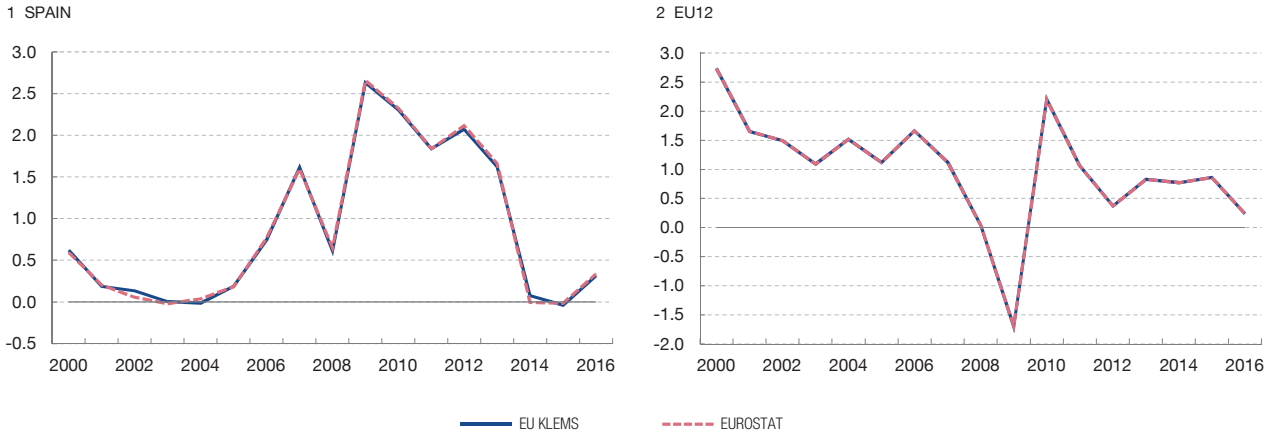
Turning to the industry classification, we consider 23 industries based on NACE-Rev 2, including 11 sub-categories in the manufacturing sector and 8 sub-categories in services. We decided to exclude from our analysis the real estate sector because its value added per hour worked is distorted by the inclusion of imputed rents of owner-occupied dwellings. The reasons are that owner occupied dwellings are typically not regarded as productive

8 EU12 is the aggregate used in this study. See section 2.3.

9 EU20 is also provided but only with data from 2009 onwards. We decided not to use it given the short time span.

Chart 1

REAL GROWTH VALUE ADDED PER HOUR WORKED. COMPARISONS EUROSTAT WITH EU KLEMS DATA



SOURCES: Eurostat and EU KLEMS.

capital, and also, they are produced without any additional measured of hours worked artificially inflating the estimates of labour productivity in the real estate sector.

Finally, we check that productivity growth series from Eurostat and EU KLEMS are comparable. Chart 1 provides the productivity growth rates from Eurostat and EU KLEMS and they both coincide over time. Therefore, the analyses provided in the different sections of this study are based on comparable data series, which is reassuring since both series are rooted in statistics from the National Accounts.

3 The lack of convergence in standards of living

GDP per capita is the most commonly used proxy of standards of living across countries. A simple accounting decomposition allows identifying the sources of its evolution in terms of labour productivity, hours worked and the employment rate. In particular, real GDP per capita can be broken down as follows:

$$\frac{\text{Real GDP}}{\text{Population}} = \frac{\text{Real GDP}}{\text{Hours}} \cdot \frac{\text{Hours}}{\text{Employment}} \cdot \frac{\text{Employment}}{\text{Population}} \qquad [1]$$

The first term of the right hand in the equation [1] consists of the contribution of labour productivity. The second and third terms focus on the role of labour markets measured in terms of hours per worker in an economy and the contribution of the employment rate heavily influenced by demographics. Note that the main object of interest throughout the paper is the so-called gaps, defined as the ratio of each component of equation [1] in Spain to that of EU12.

Income per capita in Spain relative to that of other advanced EU countries remained broadly unchanged from 2000 to 2016. In fact, in both 2000 and 2016 Spain shows a gap in terms of both GDP per capita and labour productivity close to 0.9 relative to our EU12 benchmark (see Charts 2.1 and 2.2). The employment rate gap follows a highly procyclical pattern, though the ratio against EU12 is slightly lower in 2016 than in 2000. Lastly, the gap in hours worked per worker has remained broadly unchanged over the whole period with a ratio vis-à-vis EU12 above 1 indicating that in Spain hours worked per worker are higher than those of EU12 countries.

During the first years following the introduction of the common currency Spain started a steady income convergence towards several advanced European economies (see Chart 2.1). However, during the years of recession, the marked deterioration of the economy prompted a clear brake in convergence, moving away from the EU12 GDP per capita. Since the economic recovery that started in 2014, in spite of registering a sustained economic growth above the European average, the Spanish economy has not reached a full convergence with its European peers. All in all, the Spanish economy has not improved its relative position towards EU12 in terms of GDP per capita between 2000 and 2016.

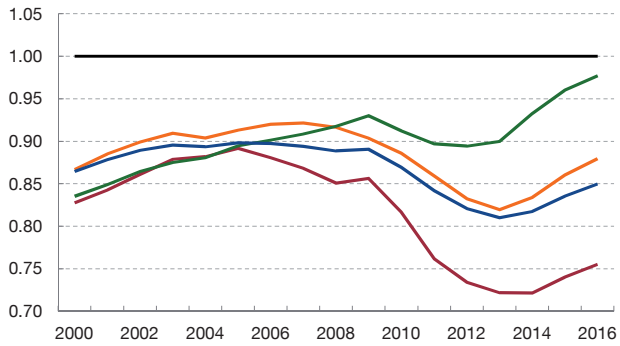
As shown in Chart 2, cyclical fluctuations in the GDP per capita gap are mainly driven by the employment rate,[10] with substantially higher job creation dynamics in Spain during the expansion and stronger job destruction rates during the recession. The labour productivity gap also presents a mild cyclical pattern but much more muted than that of employment: the years of high employment creation have been characterised by a slight reduction in the labour productivity gap that was reversed after the Global Financial Crisis. In any event, while the Spain-EU12 employment gap oscillates between below 0.85 and above

10 Note that the cyclical pattern of employment is also observed at sectoral level (see Chart A2.1 in Annex 2).

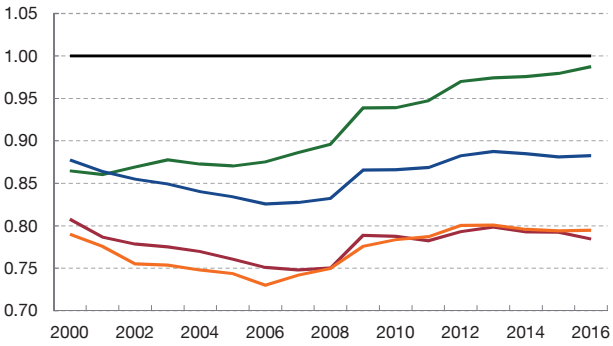
Chart 2

SPAIN GDP PER CAPITA CONVERGENCE AND ITS DETERMINANTS RELATIVE TO OTHER EUROPEAN ECONOMIES

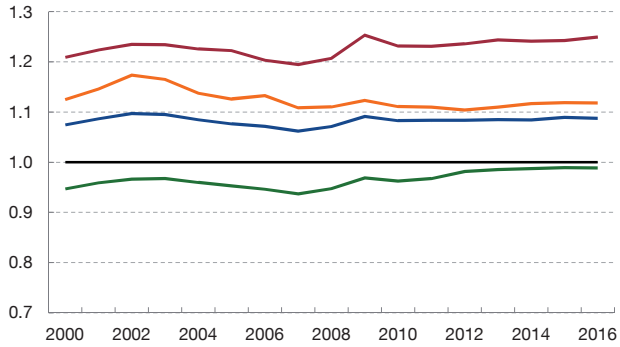
1 GDP PER CAPITA. RATIO BETWEEN SPAIN AND OTHER EUROPEAN COUNTRIES



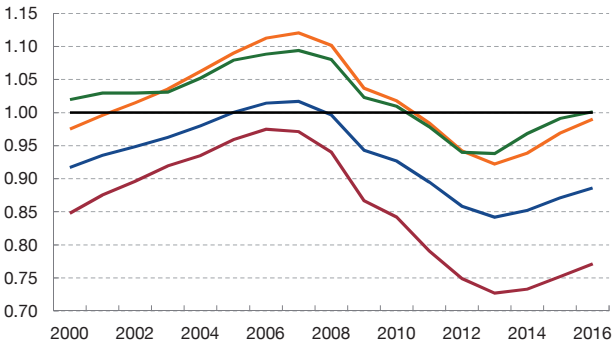
2 LABOUR PRODUCTIVITY. RATIO BETWEEN SPAIN AND OTHER EUROPEAN COUNTRIES (a)



3 HOURS WORKED PER WORKER. RATIO BETWEEN SPAIN AND OTHER EUROPEAN COUNTRIES



4 EMPLOYMENT RATE. RATIO BETWEEN SPAIN AND OTHER EUROPEAN COUNTRIES (b)



SOURCE: Eurostat.
NOTE: In this chart labour productivity is calculated as GDP per hour worked while in the rest of the document ilabour productivity is computed as value added per hour worked, therefore small differences can be found with the data plot in these charts and the data of labour productivity shown in the rest of the document.

a Employment is measured in hours worked.
b Employment rate defined as the ratio of total employment and total population.

1.00, the range of variation of the labour productivity gap is much smaller and the ratio is always below 0.90. These patterns indicate that the secular gap in labour productivity is at the root of the lack of convergence in GDP per capita of Spain with respect to EU12.

Finally, it is worth highlighting that the evolution of Spanish GDP per capita vis-à-vis our EU12 benchmark masks some heterogeneity across large Eurozone countries. For instance, Chart 2 shows a strong convergence process between Spain and Italy in terms of both GDP per capita and labour productivity. On the contrary, GDP per capita and the employment rate diverged significantly between Spain and Germany together with a relatively constant labour productivity gap. Turning to the gaps of Spain vis-à-vis France, they have all evolved very similarly to the EU12 aggregate gaps between 2000 and 2016.

4 Labour productivity gap by sector

A detailed sector-level analysis of productivity levels of Spain vis-à-vis its European peers and their time profile could be crucial for several reasons. First, future productivity growth prospects partly depend upon the current gap with the country leaders, the higher the level gap, the larger the scope for improvements in productivity growth in Spain. Second, with a higher productivity gap, the Spanish economy will have a lower capacity to compete with other countries for factors of production given that cost competitiveness and productivity gaps are expected to be negatively related. Third, the industries in which Spain´s productivity levels are consistently below (above) its European peers are expected to have a comparative disadvantage (advantage) vis-à-vis their counterparts. In this context, a detailed analysis of the industries performance in comparison with a European benchmark could help to identify which sectors have contributed to a greater or lesser extent to the relatively weak productivity performance of the Spanish economy, and therefore extract the most vulnerable aspects of our economy that have been preventing its convergence towards a European benchmark.

It is worth highlighting that two main measures of productivity can be considered: labour productivity or total factor productivity (TFP). Labour productivity relates output to the single input of employment (or capital in the case of the other single input) while total factor productivity relates an index of output to a composite index of all inputs. The most comprehensive measure of productivity is TFP, because it measures the efficiency of all inputs. However, we use labour productivity for two main reasons: i) it is a direct determinant of per capita GDP (as shown in equation [1]) as a proxy for living standards; ii) it is easy to understand, estimate and compare internationally as it entails few data requirements in comparison to TFP, that is usually estimated as a residual and makes more difficult level comparisons across countries.

4.1 The sectoral productivity gap in levels

Using sectoral data on constant PPPs value added and total hours worked, we compute estimates of the ratio of Spain and EU12 labour productivity level for 23 sectors (see Table 1). According to our estimates, for the whole economy, the relative labour productivity level vis-à-vis EU12 has not narrowed over the period under study. In 2000, the labour productivity level in Spain in the total economy was 8.7% (ratio of 0.91) below the EU12 and has not diminished since then.

The Spain-EU12 ratio is below one in all years for both manufacturing and services. Indeed, Spain presents a productivity advantage (ratio above one in all years) for only 4 out of 23 sectors vis-à-vis other EU countries, namely, accommodation and food services, agriculture, electricity and gas supply, and, to a lesser extent, information and communication services (see Table 1). On the contrary, sectors such as wholesale and retail trade, and professional services displayed the lowest productivity levels relative to EU12, with ratios below 0.8, which means that the productivity level in Spain in those sectors is 20% below

Table 1

RELATIVE LABOUR PRODUCTIVITY SPAIN VS EU12

Constant 2010 PPPs

Sectors	NACE code	Labour productivity ratio ES/EU12				Labour productivity in 2016 (a)		Sector worked hours share in 2016	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		2000	2007	2013	2016	ES	EU12	ES	EU12
Total economy (b)	**A-U**	**0.91**	**0.85**	**0.91**	**0.91**	**29.90**	**33.00**	**100.00**	**100.00**
Agriculture and mining	**A-B**	**0.75**	**0.87**	**1.02**	**1.05**	**22.18**	**21.16**	**4.79**	**3.52**
Agriculture	A	1.20	1.23	1.33	1.36	21.30	15.70	4.60	3.36
Mining and quarrying	B	0.21	0.26	0.42	0.33	44.30	134.10	0.20	0.16
Industrial sector	**C-E**	**0.89**	**0.87**	**0.93**	**0.95**	**44.39**	**46.62**	**13.32**	**14.89**
Manufacturing	C	0.88	0.84	0.90	0.92	39.95	43.58	12.00	13.54
Food products; beverages and tobacco products	C10-C12	0.89	0.99	0.90	0.81	28.54	35.27	2.72	2.05
Textiles, wearing apparel, leather and related products	C13-C15	0.79	0.81	0.86	0.75	18.81	24.96	0.91	0.69
Wood, paper, printing and reproduction	C16-C18	1.02	0.94	0.95	0.81	26.31	32.38	0.96	1.02
Coke and refined petroleum products	C19	1.32	1.15	0.79	3.91	1,014.74	259.61	0.05	0.05
Chemicals and chemical products	C20-C21	0.88	0.81	0.80	0.75	68.02	90.21	0.86	0.81
Rubber and plastic products and other non-metallic mineral products	C22-C23	1.08	0.93	1.03	0.99	36.31	36.57	0.97	1.25
Basic metals and fabricated metal products, except machinery and equipment	C24-C25	1.08	0.92	1.14	1.23	45.77	37.26	1.71	2.14
Electrical and optical equipment	C26-C27	0.76	0.79	0.83	0.82	45.18	55.03	0.60	1.12
Machinery and equipment n.e.c.	C28	0.82	0.77	0.91	0.83	34.10	41.17	0.78	1.51
Transport equipment	C29-C30	0.74	0.85	0.90	0.72	46.94	64.85	1.09	1.37
Other manufacturing; repair and installation of machinery and equipment	C31-C33	0.81	0.79	0.91	0.88	25.16	28.68	1.35	1.54
Electricity and gas supply	D-E	1.11	1.11	1.06	1.12	90.99	81.26	1.14	1.19
Construction	**F**	**1.07**	**0.88**	**1.35**	**1.29**	**34.15**	**26.40**	**6.36**	**7.15**
Services (b)	**G-U**	**0.92**	**0.86**	**0.88**	**0.87**	**27.55**	**31.50**	**75.70**	**74.60**
Wholesale and retail trade	G	0.79	0.72	0.76	0.75	21.79	29.05	18.91	14.85
Transportation and storage	H	1.08	0.85	0.91	0.96	30.90	32.03	4.65	5.25
Accomodation and food services	I	1.69	1.39	1.47	1.45	27.96	19.33	8.05	5.34
Information and communication services	J	1.17	1.04	1.05	1.05	64.70	61.63	2.76	3.37
Financial and insurance activities	K	0.79	1.12	0.94	0.86	57.92	67.26	1.91	2.85
Professional services	M-N	0.92	0.74	0.75	0.78	22.79	29.32	11.68	14.22
Public administration, defence, education, human health and social work activities	O-Q	0.96	1.01	1.01	0.98	30.44	30.91	20.16	22.71
Arts, entertainment, recreation; other services and service activities, etc.	R-U	0.78	0.80	0.83	0.84	17.97	21.46	7.58	6.01
Total economy (EU12 sector structure) (b)	**A-U**	**0.94**	**0.90**	**0.95**	**0.94**	**31.18**	**33.00**		

SOURCE: Banco de España based on Eurostat.

a Constant 2010 PPPs.
b Real estate not included.

the EU12. Within the industrial sector, the lowest productivity levels are observed in labour intensive industries such as textiles and clothing, and in some capital intensive industries such the chemical sector, electrical an optical equipment and transport equipment.

An interesting feature to take into consideration is to what extent the productivity differences are due to the Spanish sectoral specialization instead of productivity differentials within each sector. Indeed, aggregate labour productivity differences may occur within

sectors or stem from different allocation of resources across sectors. As a first approach, we estimate the counterfactual labour productivity levels for Spain combining the EU12 sectoral structure with the Spanish sectoral productivities. As shown in the last line of Table 1 the sectoral specialization is part of the story given that the productivity gap would be slightly lower with respect to EU12: 0.91 versus 0.94 in 2016. However, there was no converge so this counterfactual suggests that genuine productivity differences play an important role in explaining the Spain-EU12 gap.

In order to further explore this issue, Table 2 presents a decomposition of the productivity gap $\left(\frac{LP^{ES}}{LP^{UE12}}-1\right)$ equivalent to the ratio from Table 1 into two components: a first component capturing labour productivity differentials between Spain and EU12 by sector (genuine productivity differences), and a second component that captures the differences in the sectoral specialization of employment of Spain vis-à-vis EU12 (composition effect).

$$\frac{LP^{ES}}{LP^{EU12}}-1=\underbrace{\sum_{i=1}^{n}\left(\left(LP_i^{ES}-LP_i^{EU12}\right)\frac{H_i^{ES}}{H_{tot}^{ES}}\right)/LP^{EU12}}_{\text{Productivity differences}}+\underbrace{\sum_{i=1}^{n}\left(\left(\frac{H_i^{ES}}{H_{tot}^{ES}}-\frac{H_i^{EU12}}{H_{tot}^{EU12}}\right)LP_i^{EU12}\right)/LP^{EU12}}_{\text{Composition effect}} \qquad [2]$$

where LP_i^{EU12} denotes the productivity level for EU12 of industry i and LP_i^{ES} the productivity level for Spain in industry i. Weights $\frac{H_i^{ES}}{H_{tot}^{ES}}$ and $\frac{H_i^{EU12}}{H_{tot}^{EU12}}$ are the shares of industry i in total hours worked in Spain and EU12 respectively.

Table 2 provides this decomposition in a horizontal reading for each sector and year, i.e. by column: (1) = (2) + (3). The productivity differences component is positive (negative) when Spain displayed higher (lower) productivity levels than its EU12 counterpart. Turning to the composition effect component, the interpretation is as follows: for sector-specific contributions such as that of professional services, a positive (negative) composition effect contribution simply captures that the Spanish employment share in this sector is higher (lower) than that of EU12 countries. However, for aggregate contributions such as total economy, manufacturing, or services, a positive (negative) contribution implies that Spain has higher (lower) employment shares relative to EU12 in sectors with high-productivity within each aggregate. Therefore, for the total economy, industrial, manufacturing, and services aggregates in Table 2, the composition effect characterises the differences in allocation of labour of the Spanish economy vis-à-vis the average EU12 country.

Also, Table 2 provides a vertical reading showing the sectors' contributions to the overall labour productivity gap for each of the two components. In fact, the contribution of each sector to the productivity gap[11] is also the sum of the two components explained in equation [2].

11 See Annex 3 for additional information on the calculation of the sectors' contributions to the productivity gap.

Table 2

DECOMPOSITION OF THE PRODUCTIVITY GAP AND SECTORS' CONTRIBUTIONS: SPAIN VS EU12

Constant 2010 PPPs

	Productivity gap (%) (a) (1)		Productivity differential (pp) (2)		Composition effect (pp) (3)	
	2000	2016	2000	2016	2000	2016
Total economy (b)	**-8.7**	**-9.3**	**-3.3**	**-4.8**	**-5.4**	**-4.5**

Sectors	Productivity gap contributions by sector (pp) (1)		Productivity differential contributions by sector (pp) (2)		Composition effect contributions by sector (pp) (3)	
	2000	2016	2000	2016	2000	2016
Agriculture and mining	**0.3**	**1.0**	**-0.5**	**0.3**	**0.8**	**0.6**
Agriculture	1.4	1.4	0.6	0.8	0.9	0.6
Mining and quarrying	-1.1	-0.4	-1.0	-0.5	-0.1	0.0
Industrial sector	**-2.7**	**-3.1**	**-1.4**	**-0.7**	**-1.2**	**-2.4**
Manufacturing	-2.3	-3.3	-1.7	-1.0	-0.6	-2.3
Food products; beverages and tobacco products	0.1	0.2	-0.3	-0.6	0.3	0.7
Textiles, wearing apparel, leather and related products	0.2	0.0	-0.3	-0.2	0.4	0.2
Wood, paper, printing and reproduction	0.0	-0.2	0.0	-0.2	0.0	-0.1
Coke and refined petroleum products	0.0	1.1	0.1	1.1	-0.1	0.0
Chemicals and chemical products	-0.3	-0.4	-0.2	-0.6	-0.1	0.1
Rubber and plastic products and other non-metallic mineral products	0.4	-0.3	0.1	0.0	0.2	-0.3
Basic metals and fabricated metal products, except machinery and equipment	0.2	0.0	0.2	0.4	0.0	-0.5
Electrical and optical equipment	-0.8	-1.1	-0.3	-0.2	-0.5	-0.9
Machinery and equipment n.e.c.	-1.1	-1.1	-0.2	-0.2	-0.9	-0.9
Transport equipment	-0.3	-1.1	-0.6	-0.6	0.3	-0.5
Other manufacturing; repair and installation of machinery and equipment	-0.5	-0.3	-0.3	-0.1	-0.2	-0.2
Electricity and gas supply	-0.4	0.2	0.3	0.3	-0.6	-0.1
Construction	**4.3**	**0.9**	**0.7**	**1.5**	**3.6**	**-0.6**
Services (b)	**-10.7**	**-8.0**	**-2.1**	**-5.9**	**-8.6**	**-2.1**
Wholesale and retail trade	-1.2	-0.6	-2.9	-4.2	1.7	3.6
Transportation and storage	-0.3	-0.7	0.4	-0.2	-0.7	-0.6
Accomodation and food services	4.4	3.7	3.2	2.1	1.2	1.6
Information and communication services	-0.6	-0.9	0.5	0.3	-1.1	-1.1
Financial and insurance activities	-2.8	-2.5	-0.9	-0.5	-1.9	-1.9
Professional services	-4.5	-4.6	-0.6	-2.3	-3.9	-2.3
Public administration, defence, education, human health and social work activities	-5.2	-2.7	-0.7	-0.3	-4.5	-2.4
Arts, entertainment, recreation; other services and service activities, etc.	-0.4	0.2	-1.1	-0.8	0.6	1.0

SOURCE: Banco de España based on Eurostat.
NOTES: (1) = (2) + (3). The sum of each sector contribution equals the productivity gap, the productiviy differential and the compostion effect respectively.

a For the productivity gap of the total economy a negative (positive) sign indicates a productivity disadvantage (advantage) vis-à-vis EU12.
b Real estate not included.

For the total economy the negative productivity gap widened from 8.7% in 2000 to 9.3% in 2016, which correspond to the ratios of 0.913 and 0.907 respectively in both years in Table 1. The services sector is the main responsible of this productivity gap (as it contributes 8.0 pp in 2016 out of –9.3). In particular, professional services and financial and insurance activities[12] account for the higher contribution to the overall productivity gap. The negative contribution of the manufacturing sector to the total economy productivity gap is also significant (–3.1 pp in 2016). The electrical and optical equipment, machinery equipment and transport equipment have contributed the most to the negative productivity gap while food products, basic metals and electricity and gas supply are the only sectors contributing positively within the industrial sector. These negative contributions to the overall gap from services and manufacturing are partially compensated by the positive contribution of agriculture (+1.0 pp) and construction (+0.9 pp).

Regarding the decomposition analysis in equation [2], i.e. horizontal reading of columns (2) and (3) in Table 2, genuine differentials in productivity levels play an important role in explaining the overall productivity gap (–4.8 pp in 2016 out of –9.3 pp). This means that productivity levels in Spain are lower than in EU12 for most sectors. Still, the composition component also explains a significant share of the overall gap in 2016, namely, –4.5 pp out of –9.3 pp. This negative composition effect implies that the sectoral structure of the Spanish economy in terms of employment is indeed biased towards low-productivity activities in EU12, as also suggested by the shift-share exercise in the last row of Table 1. We interpret this finding as a clear indication of potential improvements in the allocation of resources across sectors in the Spanish economy.

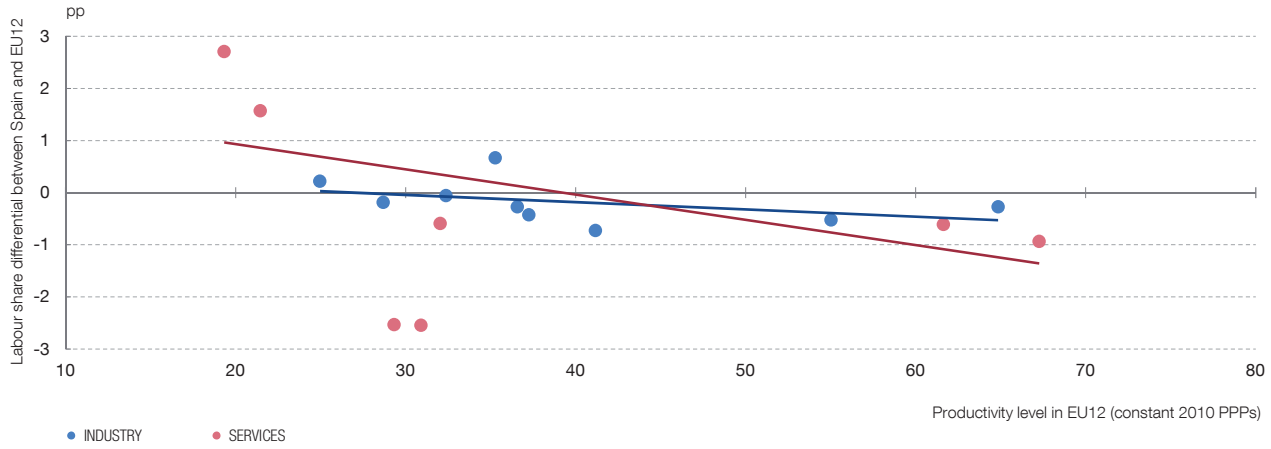
In order to have a better understanding of the composition effect, Chart 3 shows the relationship between the EU12 productivity level in 2016 and the labour share differentials of Spain against EU12 in manufacturing and services subsectors (see equation [2] composition effect component). The negative slope is consistent with the negative composition effect shown in Table 2 and indicates the scope for potential improvements in Spanish productivity through labour reallocation toward subsectors with higher productivity level: the higher the negative slope, the larger the scope. As it can be seen, the scope is higher in services than in manufacturing subsectors.

Turning to the analysis of individual sectors, in the case of services, the role of productivity differential is more important. In particular, in 2016, it accounts for –5.9 pp out of the total –8.0 pp services contribution to the whole economy gap. This implies that services industries in Spain are indeed less productive than their EU12 counterparts. However, the negative contribution from the composition effect (–2.1 pp) indicates that, within services, potential gains could be accrued through enhanced allocative efficiency within services sectors. In fact, as shown in Table A2.3 of Annex 2 the differential of employment shares between Spain and EU12 is positive in 2016 (1.1 pp) indicating that the

12 Without taking into consideration Public administration, defense, education, human health and social work activities.

Chart 3

COMPOSITION EFFECT. 2016



SOURCE: Banco de España based on Eurostat.

share of hours worked in the services sector is higher in Spain relative to EU12 countries, however the contribution of the composition effect is negative. To explain this feature we need to go deeper into the services sector structure. We find that higher productivity levels in some services sectors of the Spanish economy are related to relatively smaller employment shares and, also, some sectors with relatively lower productivity levels displayed higher employment shares. In these cases, the productivity and structural component have the opposite sign. For instance, the sector wholesale and retail trade present a clear productivity disadvantage in Spain (with a productivity differential contribution of –4.2 pp) but a much higher weight in terms of employment shares (as shown in the positive contribution from the composition effect of +3.6 pp). By contrast, the productivity advantage of Spain in information and communication services (with a productivity differential contribution of 0.3 pp) is more than offset by the relative lower share of this sector (which is translated into a negative contribution of the composition effect of –1.1pp). Such features illustrate two characteristics of the Spanish economy: i) the well-known deficit in high-tech activities of the Spanish economy, and ii) that Spain is more specialised in low productivity activities. Furthermore, for some service subsectors, namely professional services, public administration and financial and insurance activities they not only have a negative productivity gap contribution [column (2) of Table 2] but also lower shares in overall activities explaining the negative contribution of the composition effect in column [3].

Regarding the industrial sector, the composition effect explains most of its negative contribution to the overall gap (–2.4 pp out of –3.1 pp in the year 2016), which points to relatively lower shares in high-productivity sectors within manufacturing in comparison to EU12. In particular, we observe that some sectors exhibiting higher employment shares compared to EU12 show relatively lower productivity as indicated by the opposite signs of the two components of our decomposition, namely, negative in the case of productivity differentials and positive in the case of the composition effect. This is the case for several manufacturing

sectors such as food products, textile, and chemical products sectors. On the contrary, sectors with relatively high productivity levels within manufacturing such as basic metals show relatively lower shares of employment. We interpret these patterns as an indication of potential scope for improvements in the allocation of resources (employment) across sectors within manufacturing.[13]

In sum, we observe in both manufacturing and services a negative contribution from productivity differentials as well as a negative contribution from composition effects. This indicates that not only Spain presents lower productivity levels in most sectors vis-à-vis other EU12 countries, but also exhibits higher employment shares in low-productivity activities. Both components explain half of the aggregate productivity gap in levels for the year 2016. Also, the role of composition is relatively more important within manufacturing than within services. In the services sector genuine productivity differential explains most of the gap in levels.

4.2 Changes in the productivity gap by sector over the period 2000-2016

The previous section concluded that most sectors in industry and services show negative productivity gaps in levels and that the Spanish economy is biased towards low-productivity sectors vis-à-vis other EU12 countries. We now turn to the evolution over time of the sectoral productivities (see Chart 3) as well as the decomposition of the changes in the productivity gaps (see Table 3).

According to the patterns in Chart 4, productivity growth in the manufacturing sector exceeded that of utilities (electricity, gas and water supply) and construction, and it grew at similar rates in both Spain and EU12. In the case of construction, productivity growth followed a counter-cyclical pattern mainly due the employment destruction experienced during the recession years, which was larger in Spain than in EU12 countries. Manufacturing productivity growth was driven by efficiency gains in industries with relatively higher capacity for innovation. A group of medium- and high-technology industries seemed to drive productivity growth, exhibiting the highest average annual productivity growth rates: transport equipment and electrical and optical equipment for the case of Spain, plus chemicals and chemical in the case of EU12 countries (see Charts 4.3 and 4.4).

In the case of services, the heterogeneity in productivity growth of the different sub-sectors is substantial in the case of Spain. Sectors such as information and communication activities, financial and insurance activities, and to a lesser extent, wholesale and retail trade exhibited strong productivity growth from 2000 to 2016. These are also the sub-sectors with higher productivity growth in EU12 countries. In contrast, sub-sectors such as accommodation and food services activities and professional services presented a fall

13 Tables A2.1 and A2.2 in Annex 2 provides additional information on this discussion showing the evolution of labour productivity levels as well as the share of working hours in Spain and EU12.

Table 3

CHANGES IN THE PRODUCTIVITY GAP AND ITS DECOMPOSITION: SPAIN VS EU12

Constant 2010 PPPs

	Changes in the productivity gap (pp) (1)	Changes in the productivity differential (pp) (2)	Changes in the composition effect (pp) (3)
	2000-2016	2000-2016	2000-2016
Total economy (a)	**-0.6**	**-1.5**	**0.9**

Sectors	Productivity gap contributions by sector (pp) (1)	Productivity differential contributions by sector (pp) (2)	Composition effect contributions by sectors (pp) (3)
	2000-2016	2000-2016	2000-2016
Agriculture and mining	**0.6**	**0.8**	**-0.2**
Agriculture	-0.1	0.2	-0.3
Mining and quarrying	0.7	0.6	0.1
Industrial sector	**-0.5**	**0.8**	**-1.2**
Manufacturing	-1.1	0.7	-1.8
Food products; beverages and tobacco products	0.1	-0.3	0.4
Textiles, wearing apparel, leather and related products	-0.2	0.1	-0.3
Wood, paper, printing and reproduction	-0.2	-0.2	0.0
Coke and refined petroleum products	1.1	1.0	0.1
Chemicals and chemical products	-0.1	-0.3	0.2
Rubber and plastic products and other non-metallic mineral products	-0.7	-0.2	-0.5
Basic metals and fabricated metal products, except machinery and equipment	-0.3	0.2	-0.5
Electrical and optical equipment	-0.3	0.1	-0.4
Machinery and equipment n.e.c.	0.0	0.0	0.0
Transport equipment	-0.8	0.0	-0.8
Other manufacturing; repair and installation of machinery and equipment	0.2	0.1	0.1
Electricity and gas supply	0.6	0.1	0.5
Construction	**-3.4**	**0.8**	**-4.2**
Services	**2.7**	**-3.8**	**6.5**
Wholesale and retail trade	0.6	-1.3	1.9
Transportation and storage	-0.4	-0.5	0.1
Accomodation and food services	-0.8	-1.1	0.4
Information and communication services	-0.3	-0.2	-0.1
Financial and insurance activities	0.3	0.3	0.0
Professional services	0.0	-1.7	1.7
Public administration, defence, education, human health and social work activities	2.6	0.4	2.1
Arts, entertainment, recreation; other services and service activities, etc.	0.7	0.3	0.4

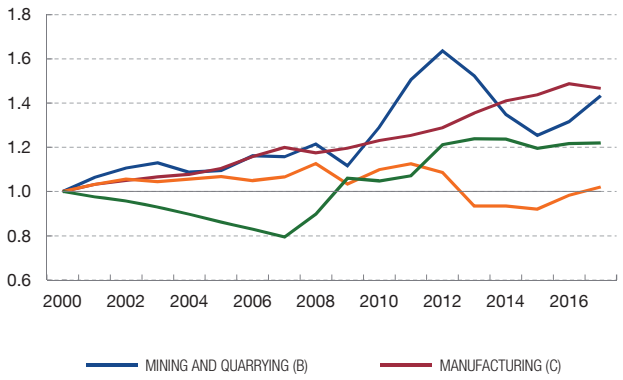
SOURCE: Banco de España based on Eurostat.
NOTES: (1) = (2) + (3). Changes calculated as the difference between the end and the beginning of the period.

a Real estate not included.

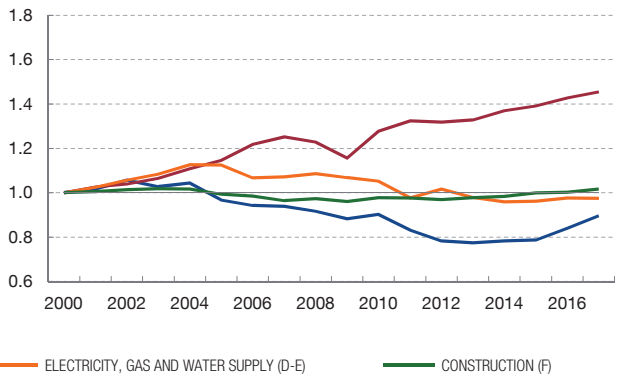
Chart 4

REAL VALUE ADDED PER HOUR WORKED CUMULATIVE GROWTH. SECTORAL ANALYSIS (2000 = 1)

1 SPAIN. INDUSTRIAL SECTORS AND CONSTRUCTION

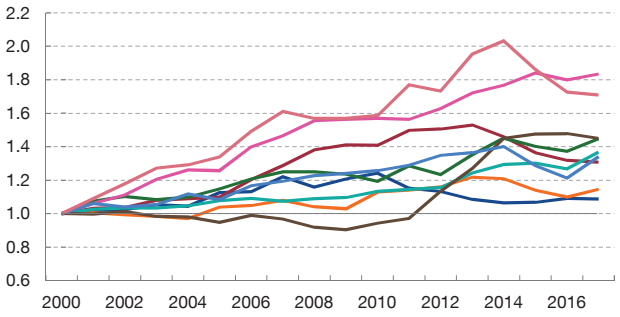


2 EU12. INDUSTRIAL SECTORS AND CONSTRUCTION

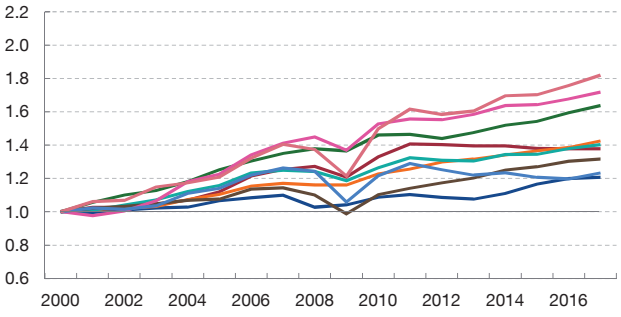


MINING AND QUARRYING (B) — MANUFACTURING (C) — ELECTRICITY, GAS AND WATER SUPPLY (D-E) — CONSTRUCTION (F)

3 SPAIN. MANUFACTURING SECTORS

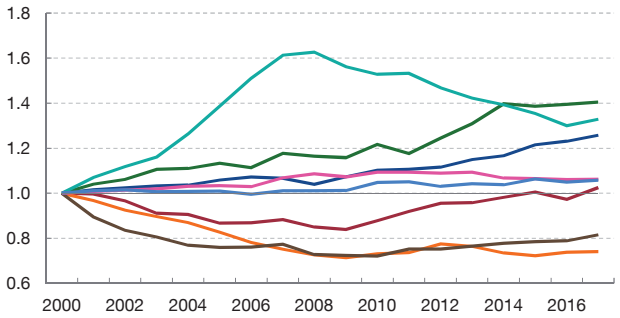


4 EU12. MANUFACTURING SECTORS

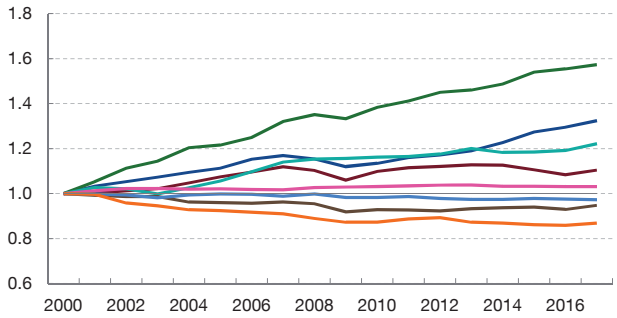


MANUFACTURE OF FOOD PRODUCTS (C10-C12)
MANUFACTURE OF WOOD, PAPER, PRINTING AND REPRODUCTION (C16-C18)
MANUFACTURE OF RUBBER AND PLASTIC PRODUCTS (C22-C23)
ELECTRICAL AND OPTICAL EQUIPMENT (C26-C27)
MANUFACTURE OF MOTOR VEHICLES (C29-C30)
MANUFACTURE OF TEXTILES (C13-C15)
CHEMICALS AND CHEMICAL PRODUCTS (C20-C21)
MANUFACTURE OF BASIC METALS AND FABRICATED METAL PRODUCTS (C24-C25)
MANUFACTURE OF MACHINERY (C28)

5 SPAIN. SERVICES SECTORS



6 EU12. SERVICES SECTORS



WHOLESALE AND RETAIL TRADE (G)
TRANSPORTATION AND STORAGE (H)
ACCOMMODATION AND FOOD SERVICE ACTIVITIES (I)
INFORMATION AND COMMUNICATION (J)
FINANCIAL AND INSURANCE ACTIVITIES (K)
PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES (M-N)
PUBLIC SECTOR (O-Q)
RECREATIVE ARTS AND OTHERS (R-U)

SOURCE: Eurostat.

in labour productivity in Spain much more pronounced than that of EU12 countries. While these patterns are informative about the heterogeneity in productivity performance across sectors, they do not provide a clear picture of the evolution of the Spain-EU12 productivity gap over the 2000-2016 period.

Turning to the contributions to the productivity gap, Table 3 shows the changes in the productivity gap between 2000 and 2016 and its decomposition – productivity differences and composition contributions – analogously to the structure of Table 2 for levels.

The overall lack of convergence between Spain and other EU countries over the 2000-2016 period (–0.6 pp) is the result of a divergence in terms of productivity differentials (contributing in –1.5 pp) offset by an improvement in the composition effects component (+0.9 pp), which captures a converge of employment structure in Spain vis-à-vis EU12. This aggregate pattern is more marked in the services sector: the strong deterioration of the contribution of productivity differentials in services (–3.8 pp) is more than compensated by the increases of the contribution of employment shares in services sub-sectors (+6.5 pp), which suggests a reallocation of employment towards services. The opposite pattern is observed in manufacturing from 2000 to 2016: the improvement in the contribution to the productivity differentials (+0.8 pp) is offset by the fall in the contribution of employment shares of manufacturing sectors (–1.2 pp). This pattern in composition effects, namely, tertiarization of employment, is the result of the late structural transformation of the Spanish economy [see González-Díez and Moral-Benito (2019)]. In particular, both in manufacturing and construction, the share of hours worked decreased relatively more in Spain than in EU12 countries, being this fall absorbed by the services sector.

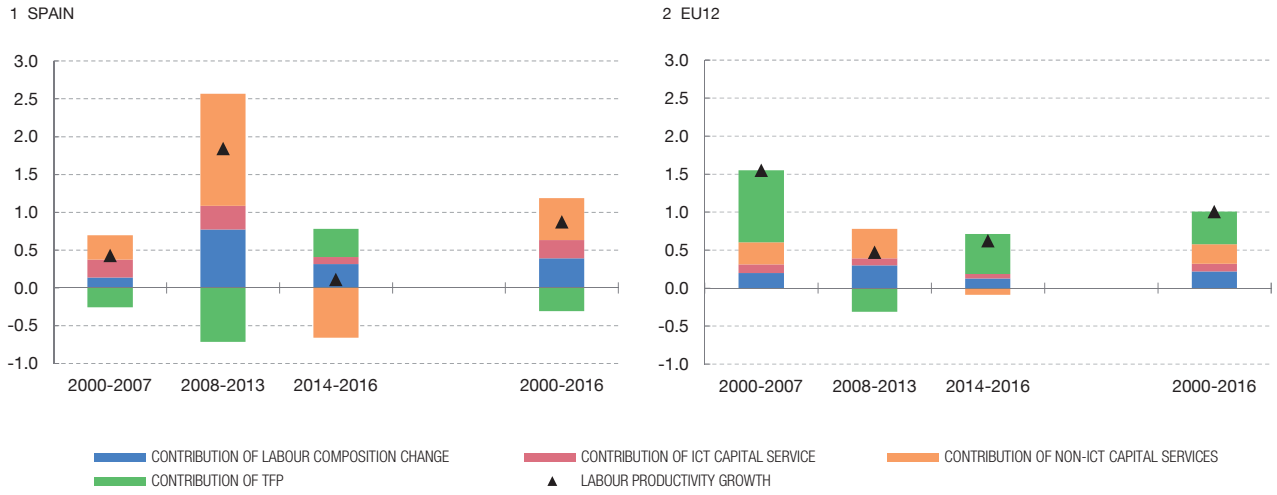
Beyond the composition effects it is worth highlighting the across-the-board divergence in productivity within services sectors. The deterioration in relative productivities is especially marked in the case of professional services, wholesale and retail trade, and accommodation and food services. In contrast, there is an improvement in productivity differentials within the primary and industrial sectors between 2000 and 2016. However, it is important emphasizing that the improvement is relatively modest in most sectors and very much influenced by the construction and coke and refined petroleum sectors. We thus conclude that relative productivities between 2000 and 2016 strongly diverged within most services subsectors, while they remained more or less stable within manufacturing subsectors.

4.3 The contribution of the different inputs and TFP by sector

An alternative decomposition of the time evolution of the productivity gap is based on the growth accounting exercise from EU KLEMS data. As explained in section 2.2, the growth of labour productivity can be decomposed into the contribution of labour composition, capital per hour worked (distinguishing ICT and non-ICT capital), and total factor productivity (TFP). The purpose of this section is to discuss the role that these four factors have played in determining the relatively poor growth of labour productivity in Spain in comparison to its European peers.

Chart 5

CONTRIBUTIONS TO GROWTH IN VALUE ADDED PER HOUR WORKED



SOURCE: EU KLEMS.

Chart 5 shows the growth accounting exercise quantifying the contributions of TFP, capital deepening, and labour composition to labour productivity growth in Spain and EU12 countries over the 2000-2016 period. In Spain, on average, labour productivity grew at an annual rate of 0.9%. This was mainly due to the contribution of the labour composition (0.4%), as well as increases in capital endowments (0.8%), whereas TFP contributed negatively (–0.3%) to labour productivity growth. In the case of EU12, labour productivity grew at an annual rate of 1.0%, being the main contributors the capital services (0.4%) and the TFP (0.4%), while the labour composition only contributed 0.2%. These results clearly point to the crucial role of TFP in explaining the divergence in labour productivity documented so far. However, this aggregate behaviour might hide differences among the different sectors. Table 4 shows the results of the growth accounting exercise at the sectoral level over the period 2000-2016 that we discuss next.

The role of labour composition

The contribution of changes in labour composition to productivity growth in Spain was larger than in the EU12 for the total economy. The services sector experienced a much larger contribution than that of manufacturing (C), especially in sectors such as professional services (M-N), transportation and storage (H), and public administration, defense, education, human health and social work activities (O-Q) (see Table 4). The improvements observed in the composition of labour are also documented in other studies providing a more detailed analysis. For instance, Lacuesta *et al.* (2009) and Lacuesta *et al.* (2011) conclude that labour quality in Spain improved substantially over this period. Chart 6 presents the annualised growth of labour services[14] showing that in the services sector, which represent more than

14 Labour services is defined as the hours worked by the different categories of workers in terms of education, age and gender weighted by its nominal cost shares (see Annex 1 for more details).

Table 4

GROWTH ACCOUNTING EXERCISE: AVERAGE PRODUCTIVITY GROWTH AND CONTRIBUTION TO THE AVERAGE PRODUCTIVITY GROWTH IN SPAIN AND EU12 (2000-2016)

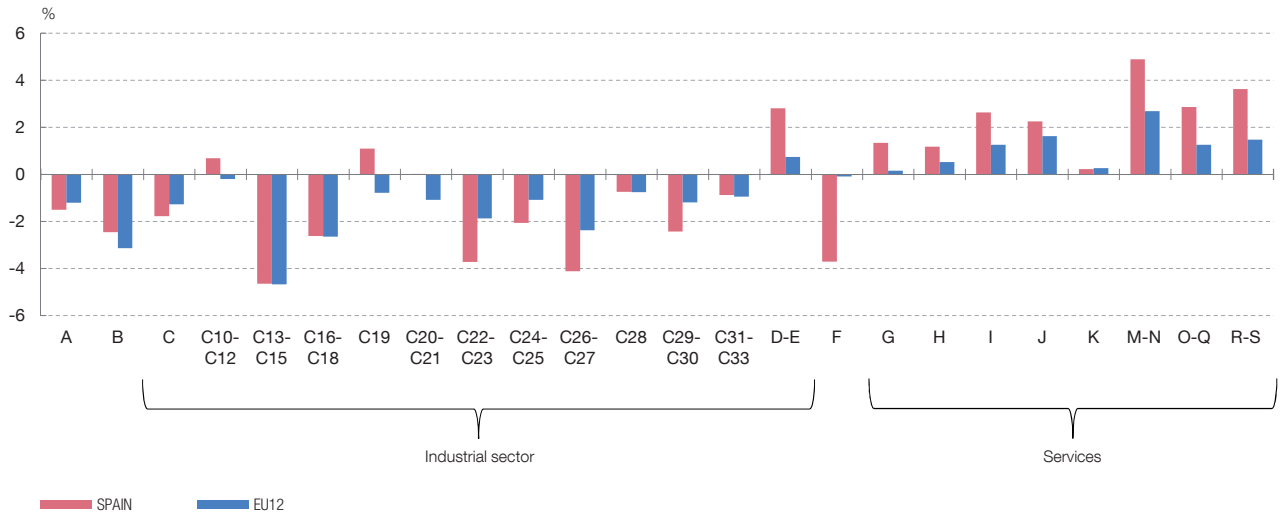
	Productivity growth (%) (1)			Contributions											
				Labour composition change (pp) (2)			Non-ICT capital services (pp) (3)			ICT capital services (pp) (4)			Total factor productivity (pp) (5)		
	ESP	EU12	ESP - EU12	ESP	EU12	ESP - EU12	ESP	EU12	ESP - EU12	ESP	EU12	ESP - EU12	ESP	EU12	ESP - EU12
Total economy	**0.9**	**1.0**	**-0.1**	**0.4**	**0.2**	**0.2**	**0.6**	**0.3**	**0.3**	**0.2**	**0.1**	**0.1**	**-0.3**	**0.4**	**-0.7**
Agriculture and mining (a)	**3.0**	**1.6**	**1.4**	**0.1**	**0.3**	**-0.1**	**1.6**	**0.4**	**1.1**	**0.0**	**0.0**	**0.0**	**1.2**	**0.9**	**0.4**
Agriculture	3.1	1.7	1.4	0.2	0.3	-0.1	1.6	0.4	1.2	0.0	0.0	0.0	1.3	0.9	0.3
Mining and quarrying	1.1	-0.3	1.4	-0.5	-0.1	-0.4	1.1	0.5	0.6	0.1	0.1	0.0	0.4	-0.9	1.2
Industrial sector (a)	**1.6**	**2.0**	**-0.4**	**0.1**	**0.2**	**-0.1**	**0.4**	**0.3**	**0.1**	**0.4**	**0.2**	**0.2**	**0.7**	**1.3**	**-0.6**
Manufacturing (a)	1.7	2.2	-0.4	0.1	0.3	-0.1	0.4	0.3	0.1	0.4	0.2	0.1	0.9	1.4	-0.6
Food products; beverages and tobacco products	0.6	1.4	-0.7	-0.1	0.2	-0.3	0.6	0.3	0.3	0.3	0.1	0.2	-0.1	0.8	-0.9
Textiles, wearing apparel, leather and related products	1.8	2.6	-0.8	0.5	0.4	0.1	0.1	0.3	-0.2	0.5	0.2	0.3	0.8	1.8	-1.0
Wood, paper, printing and reproduction	0.7	2.2	-1.5	0.2	0.2	0.0	0.8	0.2	0.6	0.4	0.1	0.3	-0.7	1.7	-2.4
Coke and refined petroleum products	8.2	1.5	6.7	0.1	0.5	-0.4	1.9	1.5	0.4	0.5	0.3	0.2	5.7	-0.9	6.6
Chemicals and chemical products	1.6	3.2	-1.6	-0.1	0.2	-0.3	0.2	0.5	-0.3	0.7	0.6	0.2	0.8	1.9	-1.1
Rubber and plastic products and other non-metallic mineral products	1.4	2.1	-0.7	0.4	0.2	0.2	0.7	0.3	0.4	0.5	0.2	0.3	-0.2	1.4	-1.6
Basic metals and fabricated metal products, except machinery and equipment	2.6	1.9	0.7	0.3	0.3	0.0	0.2	0.2	0.0	0.3	0.1	0.2	1.7	1.3	0.5
Electrical and optical equipment	3.2	3.7	-0.5	-0.2	0.3	-0.5	0.6	0.2	0.4	0.4	0.4	0.0	2.4	2.8	-0.4
Machinery and equipment n.e.c.	1.4	1.8	-0.5	0.0	0.3	-0.3	0.2	0.2	0.0	0.5	0.4	0.1	0.7	1.0	-0.2
Transport equipment	3.0	2.9	0.1	0.4	0.3	0.1	0.0	0.3	-0.3	0.4	0.6	-0.2	2.3	1.7	0.6
Other manufacturing; repair and installation of machinery and equipment	1.9	1.5	0.4	-0.2	0.2	-0.4	0.1	0.1	0.0	0.3	0.1	0.2	1.7	1.0	0.6
Electricity and gas supply	0.0	-0.1	0.1	0.1	0.0	0.1	0.9	0.6	0.3	0.4	0.0	0.4	-1.4	-0.7	-0.8
Construction	**0.7**	**0.0**	**0.6**	**0.2**	**0.2**	**0.0**	**1.9**	**0.3**	**1.6**	**0.0**	**0.0**	**0.0**	**-1.5**	**-0.5**	**-1.0**
Services (a) (b)	**0.2**	**0.6**	**-0.4**	**0.4**	**0.2**	**0.2**	**0.3**	**0.2**	**0.1**	**0.3**	**0.1**	**0.1**	**-0.8**	**0.1**	**-0.9**
Wholesale and retail trade	1.1	1.7	-0.6	0.1	0.1	0.0	0.5	0.3	0.2	0.1	0.1	0.0	0.3	1.2	-0.8
Transportation and storage	0.0	0.8	-0.7	0.6	0.2	0.3	0.8	0.5	0.3	0.3	0.1	0.2	-1.6	-0.1	-1.6
Accomodation and food services	-2.0	-0.6	-1.4	0.1	0.0	0.1	-0.1	-0.1	0.0	0.2	0.0	0.1	-2.2	-0.6	-1.6
Information and communication services	2.3	2.9	-0.6	-0.1	0.3	-0.3	-0.2	-0.1	-0.1	1.1	0.6	0.6	1.5	2.2	-0.7
Financial and insurance activities	2.1	1.3	0.8	0.0	0.2	-0.2	0.9	0.3	0.6	0.4	0.3	0.1	0.8	0.4	0.4
Professional services	-1.2	-0.3	-0.9	0.7	0.2	0.5	0.2	0.2	0.0	0.4	0.1	0.3	-2.5	-0.8	-1.7
Public administration, defence, education, human health and social work activities	0.4	0.2	0.1	0.6	0.3	0.4	0.1	0.0	0.1	0.2	0.0	0.1	-0.5	-0.1	-0.4
Arts, entertainment, recreation; other services and service activities, etc.	0.0	0.0	0.0	0.7	0.4	0.4	0.3	0.3	0.0	0.2	0.1	0.2	-1.2	-0.8	-0.5

SOURCE: EU Klems.
NOTE: (1) = (2) + (3) + (4) + (5).

a Weighted average of the subsectors included in the aggregate where the weights are the corresponding working hours share.
b Real estate not included.

Chart 6

LABOUR SERVICES ANNUALISED GROWTH OF SPAIN AND EU12 SECTORAL ANALYSIS (2000-2016)



SOURCE: EU KLEMS.

70% of total employment, labour services increased relatively more in Spain than in the EU12. Therefore the observed relative weakness in labour productivity growth cannot be attributed to lower accumulation of human capital of the workforce.

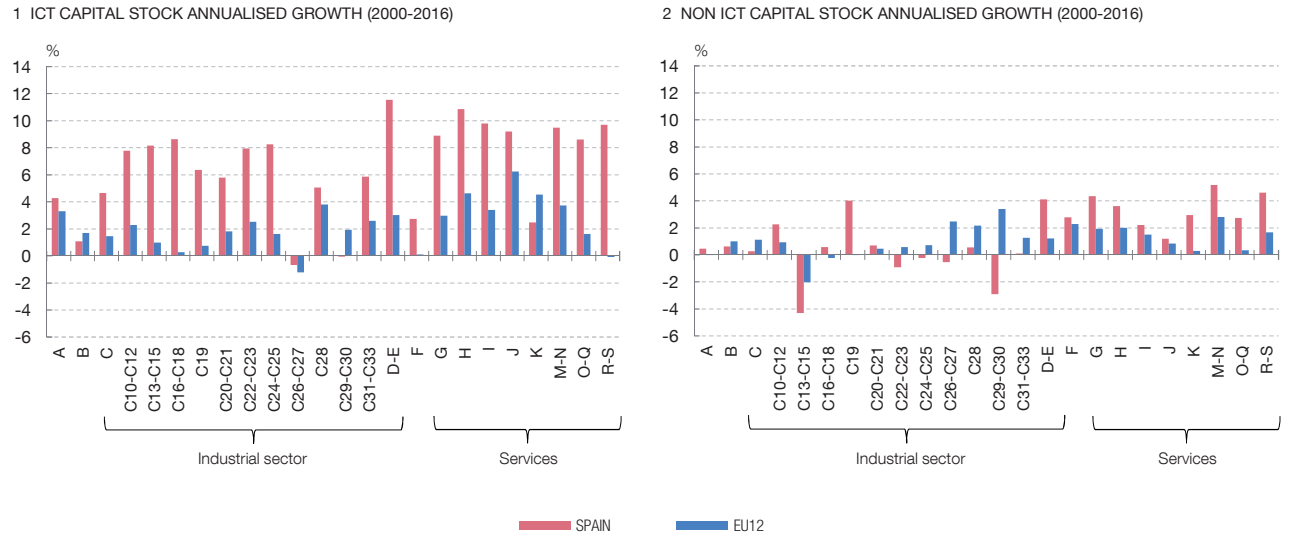
The role of capital accumulation

The contribution of total capital per hour worked to productivity growth was stronger in Spain than in EU12 countries for all sectors. In fact, capital input in Spain grew by 60% over the whole period, while in the EU12 it grew by 21%. Distinguishing between ICT and non-ICT capital, it turns out that the contribution of both types of capital per hour are higher in Spain, though considerably larger for the non-ICT capital. The sectors where the contribution of non-ICT capital is greater are construction (F), agriculture (A), transportation and storage (H) and financial and insurance activities (K). Regarding the contribution of ICT capital, it was relatively strong in the information and communication services (J), but also in several manufacturing sectors such as chemical products (C20-C21), textiles, wearing apparel, leather and related products (C13-C15) and machinery and equipment (C28) (see Table 4). Therefore, trends in capital deepening[15] do not seem to explain the relative weakness in trend productivity in Spain. In fact, capital accumulation in the various sectors was fast and higher than in the EU12. Chart 7 shows the annualised growth of ICT and NON-ICT capital stocks over the period under study, where ICT capital grew on average and in all sectors at higher rates than in EU12. Regarding non-ICT capital, in Spain, capital stocks grew significantly more in the services sector, mainly in the professional services sector (M-N) and wholesale and retail trade sector (G).

15 Capital deepening understood as contribution of the rate of growth of capital per hour worked.

Chart 7

CAPITAL STOCK ANNUALISED GROWTH OF SPAIN AND EU12 SECTORAL ANALYSIS (2000-2016)



SOURCE: EU KLEMS.

The role of TFP growth

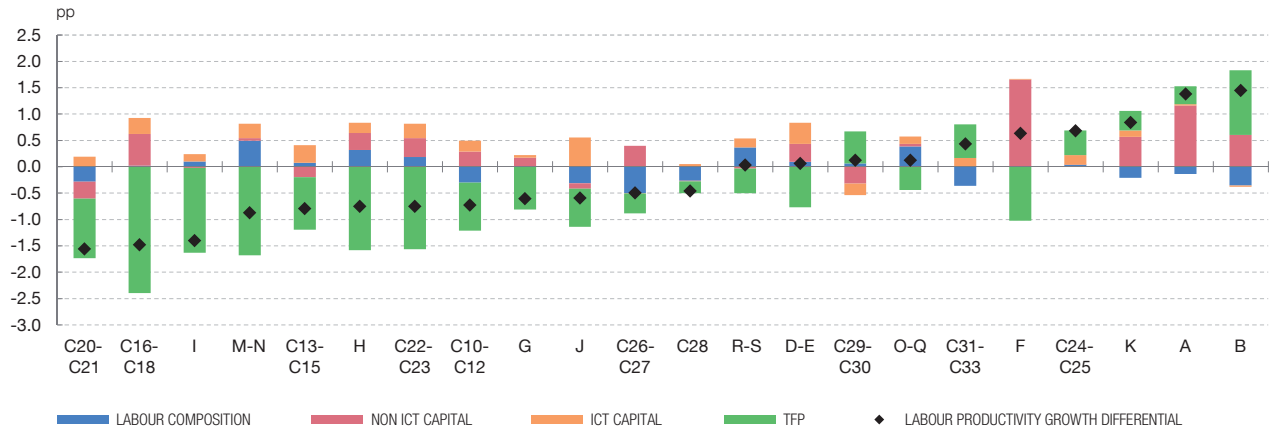
TFP growth, is derived residually as the part of output growth that cannot be accounted for by inputs accumulation (Solow residual). It is often defined as "technological progress" and it captures the effect of different factors such as the capacity of an economy to innovate. As suggested by Chart 5, the dismal evolution of TFP is the key factor that explains the low performance of labour productivity growth in Spain vis-à-vis EU12 countries. For the total economy, the Spanish TFP contribution to labour productivity growth is not only lower than in the EU12 but even negative. In order to explore in which sectors the contribution of TFP is lower, we compute at sectoral level the differences on the different contributions to labour productivity growth between Spain and EU12. Chart 8 shows the results.

Sectors in which TFP growth is lower in comparison with EU12 displayed poorer labour productivity growth. This is particularly the case for several manufacturing sectors – for instance, in the case of chemicals and chemical products (sector C20-C21), the difference of the TFP growth between Spain and EU12 is –1.1 pp, and –2.4 pp for wood, paper, printing and reproduction (C16-C18) – but also for some service sectors such as professional services (M-N), accommodation and food services (I) and transportation and storage (H) where the negative contribution of TFP to productivity growth is particularly high. On the contrary, in the primary sector (sectors A and B), where the labour productivity growth is larger, the contribution of TFP growth is positive and higher than in the EU12.

Therefore, we need to explain why Spanish TFP growth fell behind in most sectors. Interestingly enough, we see in Chart 9 that in sectors where the contribution of ICT capital

Chart 8

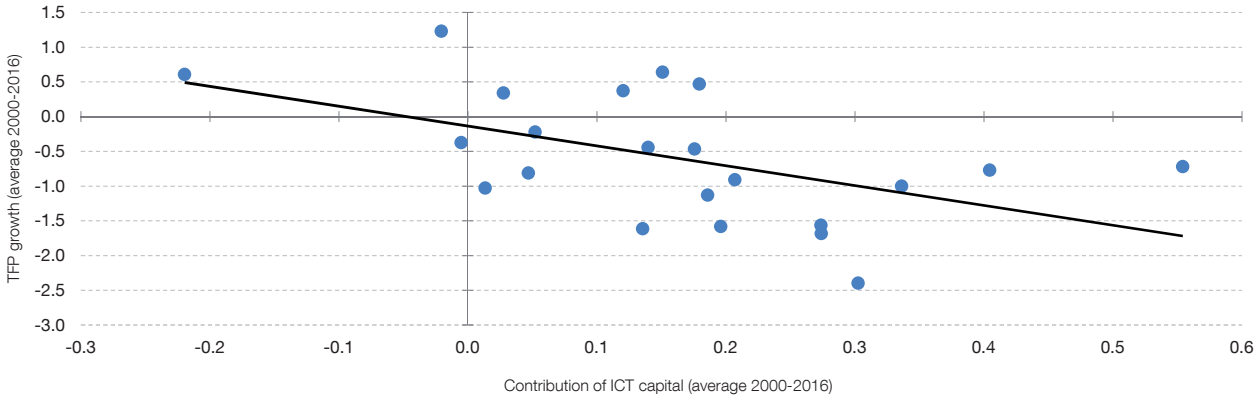
AVERAGE PRODUCTIVITY GAINS AND LOSSES AND CONTRIBUTION DIFFERENTIALS BETWEEN SPAIN AND EU12. SECTORAL ANALYSIS (2000-2016)



SOURCE: EU KLEMS.
NOTE: The dots represent the differences in the average labour productivity growth between ES and EU12 over the period 2000-2016 and the bars show the labour composition, ICT and non-ICT capital and TFP contribution differentials to the labour productivity growth differential.

Chart 9

ICT CONTRIBUTION AND TFP GROWTH DIFFERENTIALS BETWEEN SPAIN AND EU12. SECTORAL ANALYSIS (2000-2016)



SOURCE: EU KLEMS.

is larger the contribution of TFP growth is relatively lower and negative. Indeed, Chart 9 plots such observation where a negative link between ICT contribution and TFP growth is observed. However, in theory, the impact of ICT on productivity growth should bring gains to labour productivity growth due to capital deepening and/or gains arising from spillover effects or embodied technical progress. Though, it seems that Spain is unable to extract all these benefits. In the next section we will explore to what extent the population's skills play a role in this TFP divergence.

5 The role of skills-capital complementarities as a source of TFP divergence

The dismal evolution of Spanish TFP with respect to other advanced countries over the 2000-2016 period has been widely studied in the literature. Cross-country differences in TFP growth may be related to different variables, sometimes difficult to estimate, such as rigidities in the labour market, R&D expenditure, Foreign Direct Investment flows, among others. Evidence based on firm-level data suggests that the deterioration in the allocation of resources across firms is the main responsible of the fall in aggregate productivity during the expansion and the mild improvement during the recovery period. In particular, the allocation of credit to low-productivity but high-collateral firms can partly explain these developments. [see for instance Moral-Benito (2018) and Fu and Moral-Benito (2018)].

Alternatively, a recent strand of the literature emphasises the role of management practices in the context of the IT revolution. Schivardi and Schmitz (2019) for Southern Europe and Pellegrino and Zingales (2019) for Italy in particular, argue that inefficient managerial practices in these countries hampered the efficient use of new technologies brought by the surge of the IT revolution since the late nineties. In turn, according to the latest release of the World Management Survey (WMS), in a scale from 1 to 5 the average score of Spanish firms was 2.7 while it was 3.2 in Germany for instance [see Bloom *et al.* (2014)].

In this paper, we highlight an alternative hypothesis inspired by the fact that the lack of convergence in productivity between Spain and the rest of advanced Europe dates back to the eighteen century. Indeed, the Spanish deficit in human capital is well-documented even since the year 1750 when the literacy rate in Spain was 8% of the population against 85%, 54%, 48%, and 38% for Netherlands, Great Britain, Sweden, and Germany, respectively [see Roser and Ortiz-Ospina (2016).] Making the analogy with the management practices hypothesis, if individual's skills are not good enough to take advantage of new technologies, investments in ICT capital will result in lower labour productivity gains and will materialise in a lower contribution from TFP. In other words, ICT capital by itself might have little impact on productivity, but its impact may be substantial when it is adopted in conjunction with a labour force able to take advantage of it.

The paper by Garicano and Heaton (2010) serves as an illustration of the mechanism we have in mind: using a sample of US police departments covering 1987-2003, Garicano and Heaton (2010) show that IT adoption by each department is associated to lower crime rates or higher clearance rates only in those police departments participating in the Compstat program, which included, among other things, hiring of skilled officers and training programs. In this example, IT adoption consisted of using computers for tasks such as crime investigation based on data analysis. If police officers are not well-trained in data analysis, the effect of having a computer for recording and analyzing the data would have little impact on clearance rates.

A natural proxy for the skills of the labour force is given by the scores obtained in the Program for the International Assessment of Adult Competencies (PIAAC) for adult population of the OECD Skills Surveys. In terms of both mathematical reasoning (numeracy) and reading

comprehension (literacy), Spain is situated in the last and second-to-last position among the OECD countries. These figures suggest that the Spanish labour force might present more difficulties that that of other countries in taking advantage of new technologies, and this would be captured by the TFP divergence in EU KLEMS statistics discussed above.

Formally, the TFP contribution from EU KLEMS data is based on a neoclassical production function with unitary elasticity of substitution between all inputs. However, an alternative configuration could be a nested-CES function in which adults' skills enter as an additional input and the elasticity of substitution between skills and ICT capital is larger than one, i.e. they are gross complements.

Under the assumption that skills are proxied by a linear function of PIAAC scores, we postulate the following regression [see Pellegrino and Zingales (2019) for a related approach]:

$$\widehat{TFP_{cs}} = \theta_0 + \theta_1 \widehat{ICT_{cs}} + \theta_2 \widehat{ICT_{cs}} \ln\left(PIAAC_c\right) + \mu_c + \omega_s + \vartheta_{cs}$$

where $\widehat{TFP_{cs}}$ and $\widehat{ICT_{cs}}$ refer to the EU KLEMS TFP and ICT capital contributions to labour productivity growth of country c and sector s. ϑ_{cs} proxies for TFP contributions at the country-sector level net of the skill-ICT capital complementarity. Finally, a set of country and sector dummies are also included.

The parameter of interest is θ_2, which captures the complementarity between skills and ICT capital. If $\theta_2 > 0$, the ICT contribution to TFP is larger in those countries with higher PIAAC scores. Despite admittedly simple, we interpret this test as suggestive evidence of the presence of complementarities in the production function between ICT capital and skills that are incorporated in the TFP contribution in EU KLEMS data. In particular, those countries with lower skills would present lower TFP contributions. In case $\theta_2 = 0$, the TFP contribution would be properly measuring TFP per se and we would conclude that ICT capital and skills are not complements in the production function.

Tables 5 and 6 show the estimated coefficients. Table 5 reports the results with PIAAC literacy scores and Table 6 with PIAAC numeracy scores. In both tables, column (1) reports the baseline specification with PIAAC scores. The estimates of θ_2 are positive and significant. Interestingly enough, the estimated coefficient turns negative and not statistically significant in column (2) when considering non-ICT capital instead of ICT capital, which we interpret as placebo-based evidence in favor of our hypothesis since we do not expect complementarities between skills and non-ICT capital. Finally columns (3)-(6) show that the complementarity of skills and ICT capital is due to two types of ICT capital: R&D investments and software, while the estimate is not significant for tangible ICT and other ICT capital.

In order to gauge the aggregate magnitude of the estimates in Tables 5 we conduct the following counterfactual: using the baseline estimate of θ_2, we compute the increase in Spanish TFP EU KLEMS contribution using the Spanish sector-level ICT contributions but interacted with the Finnish PIAAC literacy score of 288 (the 95th percentile of the cross-

Table 5

RESULTS OLS REGRESSION USING PIAAC LITERACY SCORES

Independent variables	(I)	(II)	(III)	(IV)	(V)	(VI)
ICT- CONTRIBUTION	-0.197 (-0.360)		-0.374 (0.345)	-0.276 (0.342)	-0.328 (0.318)	-0.344 (0.294)
ICT* PIAAC LITERACY	0.489*** (0.158)					
NON-ICT CONTRIBUTION		-0.059 (0.140)				
NON- ICT* PIAAC LITERACY		-0.086 (0.188)				
ICT- Other* PIAAC LITERACY			-0.062 (0.054)			
ICT- R&D* PIAAC LITERACY				0.260* (0.140)		
ICT-SOTWARE* PIAAC LITERACY					0.412* (0.201)	
ICT-TANGIBLE* PIAAC LITERACY						0.077
Observations	453	453	453	453	453	453
R-squared	0.257	0.243	0.244	0.248	0.254	0.244
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes

SOURCE: Own calculations.
NOTES: Robust standard errors in parentheses. *** p<0,01, ** p<0,05, * p<0,1.

Table 6

RESULTS OLS REGRESSION USING PIAAC NUMERACY SCORES

Independent variables	(I)	(II)	(III)	(IV)	(V)	(VI)
ICT- CONTRIBUTION	-0.165 (-0.335)		-0.370 (0.346)	-0.230 (0.342)	-0.329 (0.321)	-0.349 (0.304)
ICT* PIAAC LITERACY	0.448*** (0.122)					
NON-ICT CONTRIBUTION		-0.101 (0.147)				
NON- ICT* PIAAC NUMERACY		-0.547* (0.295)				
ICT- Other* PIAAC NUMERACY			-0.017 (0.083)			
ICT- R&D* PIAAC NUMERACY				0.353*** (0.113)		
ICT- SOTWARE* PIAAC NUMERACY					0.346** (0.159)	
ICT-TANGIBLE* PIAAC NUMERACY						0.053 (0.190)
Observations	453	453	453	453	453	453
R-squared	0.253	0.243	0.244	0.250	0.251	0.244
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes

SOURCE: Own calculations.
NOTES: Robust standard errors in parentheses. *** p<0,01, ** p<0,05, * p<0,1.

country PIAAC distribution) as opposed of the actual PIAAC literacy score of 251 in Spain (the 5th percentile). The unweighted average increase in labour productivity growth across sectors (without taking into account composition effect) would be 43%. According to EU KLEMS, the average annual labour productivity growth over the 2000-2016 was 0.9% in Spain and 1% in EU12. In the counterfactual scenario, Spanish labour productivity growth could have been 1.3% leading to an average 0.3 pp convergence every year and thus a 5 pp convergence over the 16 years (ratio of per capita GDPs from 90% to 95%).

6 Conclusion

Relative to our EU12 benchmark, Spanish labour productivity is around 10% lower. This negative productivity gap is due to two facts: i) lower productivity levels in most sectors (Spain exhibits a positive productivity gap in only 4 out of 23 sectors: two services sectors – accommodation and food services, and information and communication – one industrial sector – electricity and gas supply – and agriculture); ii) an allocation of employment skewed towards low-productivity sectors.

Turning to the evolution over time, Spain is not catching up. This means that the productivity gap with our European peers has widened slightly from 2000 to 2016. This divergence is due to a deterioration in relative productivities in most sectors. At the root of the lack of convergence is the fact that the productivity gap in services has widened over time, together with the greater tertiarisation of the Spanish economy. In particular, this lack of convergence vis-à-vis EU12 is especially marked in professional services, wholesale and retail trade, and accommodation and food services, while we observe a relative stability in productivity gaps within manufacturing sectors.

With respect to the growth accounting decomposition, negative TFP growth in most sectors is chiefly responsible for the divergence in the labour productivity gap. This is so despite Spain's relative convergence vis-à-vis EU12 in terms of labour composition, ICT and non-ICT capital between 2000 and 2016. Indeed, in those sectors in which the ICT capital convergence was stronger, there was a more marked divergence in TFP. According to our analysis, the full effects of ICT capital on Spanish TFP growth might not materialise because the Spanish population's skills (proxied by PIAAC scores) do not seem good enough to take advantage of new technologies. Thus, this is a possible source of TFP divergence with respect other advanced EU countries.

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Annex 1 Growth accounting exercise. EU KLEMS methodology[1]

Suppose a generic production function for output Y (measured as value added at constant prices) by combining capital K and labour L for every country c, sector s and time t:

$$Y_{cst} = A_{cst} \cdot F_{cst}\left(K_{cst}, L_{cst}\right) \quad [1]$$

A is technology. Capital itself is broken down into two different types: ICT and non-ICT capital:

$$K_{cst} = K_{cst}\left(K^{I}_{cst}, K^{N}_{cst}\right) \quad [2]$$

Regarding labour, there are J different categories of workers, which differ by age, education and gender. The total labour input is a combination of the hours worked by the different categories of workers:

$$L_{cst} = L_{cst}\left(H^{1}_{cst}, H^{2}_{cst}, \ldots, H^{J}_{cst}\right) \quad [3]$$

where the total hours worked is defined as:

$$H_{cst} = \sum_{J=1}^{J} H^{J}_{cst} \quad [4]$$

Under the assumption of constant returns to scale and competitive markets, we have:

$$P_{cst}\, Y_{cst} = R_{cst}\, K_{cst} + W_{cst}\, L_{cst} \quad [5]$$

$$R_{cst}\, K_{cst} = R^{I}_{cst}\, K^{I}_{cst} + R^{N}_{cst}\, K^{N}_{cst} \quad [6]$$

$$W_{cst}\, L_{cst} = \sum_{J=1}^{J} W^{J}_{cst}\, H^{J}_{cst} \quad [7]$$

where P, R^{I}, R^{N}, W^{J} are respectively the prices of output, ICT capital, non-ICT capital and type-j labour.

Since the growth accounting methodology is based on a loglinearization of the production function, labour productivity growth is then defined as the log-differences of value added minus log-difference of hours worked. The decomposition of productivity growth into its contribution is shown in equation [8] with hats representing log-changes in a variable.

1 Please refer to the "Report on methodologies and data construction for the EU KLEMS Release 2019". October 29, 2019. WIIW https://euKLEMS.eu/wp-content/uploads/2019/10/Methodology.pdf.

$$\left(\widehat{Y_{cst}} - \widehat{H_{cst}}\right) = \widehat{A_{cst}} + \left(1 - \frac{W_{cst}\ L_{cst}}{P_{cst}\ Y_{cst}}\right)\left(\widehat{K_{cst}} - \widehat{H_{cst}}\right) + \left(\frac{W_{cst}\ L_{cst}}{P_{cst}\ Y_{cst}}\right)\left(\widehat{L_{cst}} - \widehat{H_{cst}}\right) \quad [8]$$

TFP growth | Capital contribution | Labour composition change

To summarise, the yearly growth of the labour productivity at the sector level is decomposed, in the EU KLEMS database, into the sum of the following contributions:

$$\text{ICT contribution: } \left(1 - \frac{W_{cst}\ L_{cst}}{P_{cst}\ Y_{cst}}\right)\left(\frac{R^{I}_{cst}\ K^{I}_{cst}}{R_{cst}\ K_{cst}}\right)\left(\widehat{K^{I}_{cst}} - \widehat{H_{cst}}\right) \quad [9]$$

$$\text{Non - ICT contribution: } \left(1 - \frac{W_{cst}\ L_{cst}}{P_{cst}\ Y_{cst}}\right)\left(\frac{R^{N}_{cst}\ K^{N}_{cst}}{R_{cst}\ K_{cst}}\right)\left(\widehat{K^{N}_{cst}} - \widehat{H_{cst}}\right) \quad [10]$$

$$\text{Labour composition change: } \left(\frac{W_{cst}\ L_{cst}}{P_{cst}\ Y_{cst}}\right)\left(\widehat{L_{cst}} - \widehat{H_{cst}}\right) \quad [11]$$

So that the TFP contribution measured as the growth in labour productivity not explained by input and labour composition (i.e. Solow residual) can be expressed as:

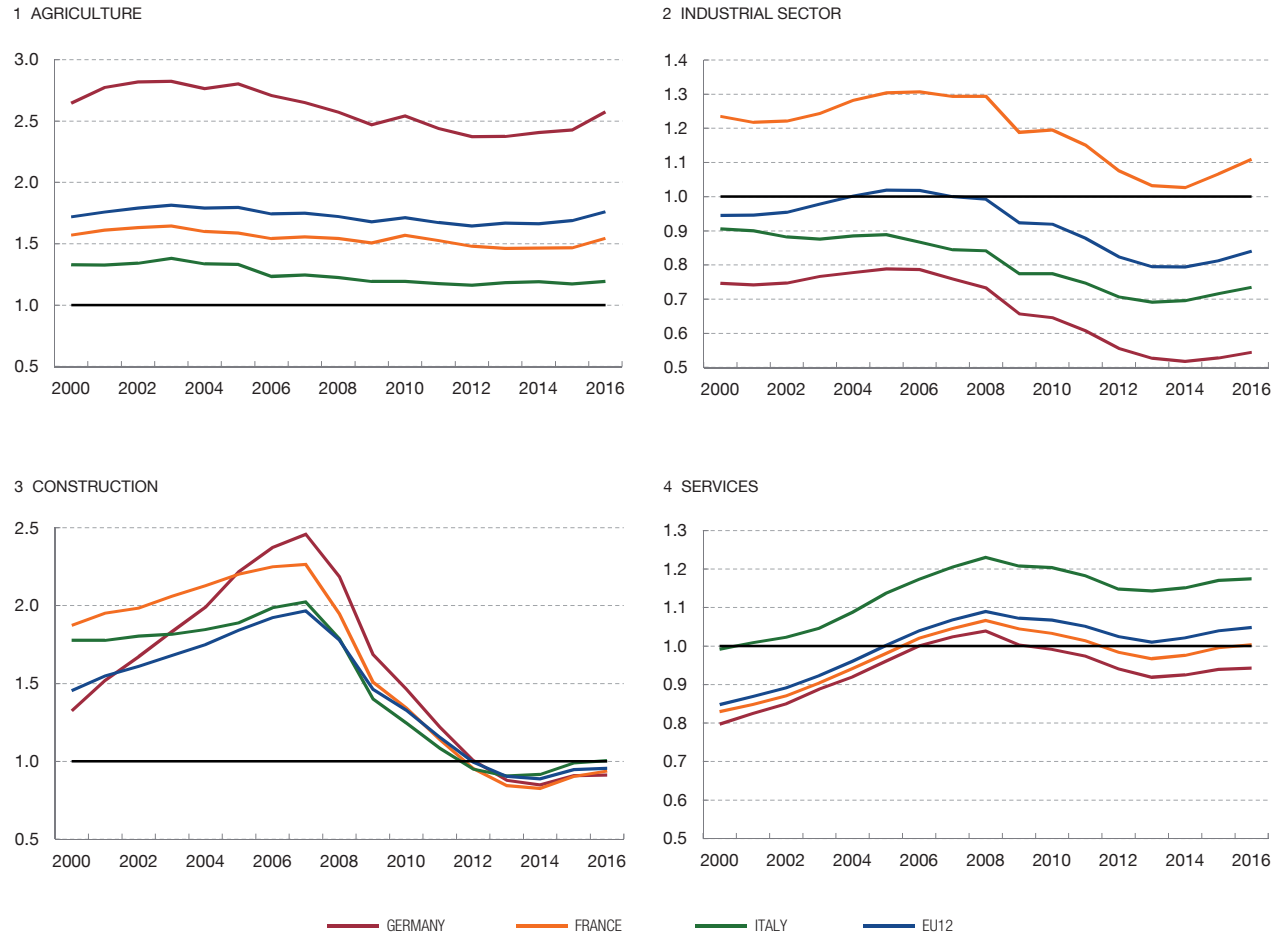
$$\text{TFP growth: } \widehat{TFP_{cst}} = \left(\widehat{Y_{cst}} - \widehat{H_{cst}}\right) - (9) - (10) - (11)$$

However, TFP may be hiding measurement errors on factors production. The growth rate of TFP is measured as a residual calculated as the difference between the growth rates of output and the combined growth rates of capital and labour weighted by their respective elasticities. Therefore, the methodology imposes the need for an accurate measure of output, capital, labour and the capital and labour shares in total output. The literature points to the following improvements to measure the factors of production: including corrections for quality factor (EU KLEMS methodology takes into account age, gender and education of workers) and factor utilization (in our study we assume constant factor utilization intensity, while intensity of input factor utilization may differ in different business cycle periods).

Annex 2 Additional tables and charts

Chart A2.1

EMPLOYMENT RATE PER SECTOR. RATIO BETWEEN SPAIN AND OTHER EUROPEAN COUNTRIES



SOURCE: Eurostat.
NOTE: Employment rate defined as the ratio of total employment and total population.

Table A2.1

LABOUR PRODUCTIVITY LEVELS AND SHARE OF WORKING HOURS IN SPAIN

Sectors	NACE code	Labour productivity levels (a)				Share worked hours per sector			
		2000	2007	2013	2016	2000	2007	2013	2016
Total economy (b)	**A-U**	**26.6**	**26.9**	**29.4**	**29.9**	**100.0**	**100.0**	**100.0**	**100.0**
Agriculture and mining	**A-B**	**14.6**	**17.9**	**21.1**	**22.2**	**7.1**	**5.0**	**5.0**	**4.8**
Agriculture	A	13.9	16.6	19.9	21.3	6.8	4.7	4.8	4.6
Mining and quarrying	B	33.7	39.0	51.3	44.3	0.2	0.3	0.2	0.2
Industrial sector	**C-E**	**30.0**	**36.2**	**41.0**	**44.4**	**18.6**	**14.6**	**13.2**	**13.1**
Manufacturing	C	26.8	32.2	36.4	40.0	17.7	13.7	12.0	12.0
Food products; beverages and tobacco products	C10-C12	26.2	32.0	28.4	28.5	2.6	2.4	2.7	2.7
Textiles, wearing apparel, leather and related products	C13-C15	14.3	18.4	21.8	18.8	2.2	1.1	0.9	0.9
Wood, paper, printing and reproduction	C16-C18	23.9	25.8	29.1	26.3	1.6	1.3	1.0	1.0
Coke and refined petroleum products	C19	231.0	195.5	83.6	1,014.7	0.0	0.0	0.1	0.0
Chemicals and chemical products	C20-C21	49.5	61.8	67.0	68.0	1.0	0.8	0.8	0.9
Rubber and plastic products and other non-metallic mineral products	C22-C23	28.6	30.7	35.5	36.3	2.0	1.5	1.0	1.0
Basic metals and fabricated metal products, except machinery and equipment	C24-C25	31.0	29.9	39.3	45.8	2.7	2.3	1.7	1.7
Electrical and optical equipment	C26-C27	25.1	36.8	43.2	45.2	1.2	0.8	0.6	0.6
Machinery and equipment n.e.c.	C28	28.1	33.6	38.4	34.1	0.9	0.8	0.8	0.8
Transport equipment	C29-C30	27.2	43.8	53.1	46.9	1.9	1.1	1.0	1.1
Other manufacturing; repair and installation of machinery and equipment	C31-C33	19.4	22.6	26.3	25.2	1.6	1.6	1.3	1.4
Electricity and gas supply	D-E	92.5	98.6	86.3	91.0	0.9	0.9	1.2	1.1
Construction	**F**	**28.1**	**22.3**	**34.8**	**34.1**	**12.1**	**14.5**	**6.3**	**6.4**
Services (b)	**G-U**	**26.7**	**26.5**	**27.4**	**27.6**	**62.3**	**65.9**	**75.6**	**75.7**
Wholesale and retail trade	G	17.7	18.8	20.4	21.8	17.7	18.0	19.3	18.9
Transportation and storage	H	31.8	28.0	30.4	30.9	4.7	4.6	4.7	4.7
Accomodation and food services	I	37.9	28.5	29.0	28.0	6.1	7.0	7.5	8.0
Information and communication services	J	46.4	54.6	60.7	64.7	2.2	2.2	2.6	2.8
Financial and insurance activities	K	44.5	71.8	63.4	57.9	2.1	1.9	2.1	1.9
Professional services	M-N	28.9	22.3	22.1	22.8	6.8	9.6	11.0	11.7
Public administration, defence, education, human health and social work activities	O-Q	28.7	30.7	31.4	30.4	16.4	16.1	20.6	20.2
Arts, entertainment, recreation; other services and service activities, etc.	R-U	17.1	17.3	17.8	18.0	6.3	6.6	7.7	7.6

SOURCE: Banco de España based on Eurostat.

a Constat 2010 PPS.
b Real estate not included.

Table A2.2

LABOUR PRODUCTIVITY LEVELS AND SHARE OF WORKING HOURS IN EU12

Sectors	NACE code	Labour productivity levels (a)				Share worked hours per sector			
		2000	2007	2013	2016	2000	2007	2013	2016
Total economy (b)	**A-U**	**29.2**	**31.6**	**32.3**	**33.0**	**100.0**	**100.0**	**100.0**	**100.0**
Agriculture and mining	**A-B**	**19.4**	**20.5**	**20.7**	**21.2**	**4.8**	**4.0**	**3.7**	**3.5**
Agriculture	A	11.6	13.5	15.0	15.7	4.6	3.8	3.5	3.4
Mining and quarrying	B	159.5	149.6	123.5	134.1	0.3	0.2	0.2	0.2
Industrial sector	**C-E**	**33.6**	**41.6**	**43.8**	**46.6**	**18.9**	**16.4**	**15.1**	**14.7**
Manufacturing	C	30.5	38.2	40.5	43.6	17.8	15.3	13.9	13.5
Food products; beverages and tobacco products	C10-C12	29.4	32.3	31.6	35.3	2.3	2.1	2.1	2.1
Textiles, wearing apparel, leather and related products	C13-C15	18.1	22.7	25.3	25.0	1.5	0.9	0.7	0.7
Wood, paper, printing and reproduction	C16-C18	23.4	27.4	30.8	32.4	1.6	1.4	1.1	1.0
Coke and refined petroleum products	C19	175.4	169.7	105.4	259.6	0.1	0.1	0.1	0.0
Chemicals and chemical products	C20-C21	56.6	76.4	83.5	90.2	1.0	0.9	0.8	0.8
Rubber and plastic products and other non-metallic mineral products	C22-C23	26.5	33.1	34.6	36.6	1.8	1.5	1.3	1.2
Basic metals and fabricated metal products, except machinery and equipment	C24-C25	28.6	32.7	34.4	37.3	2.7	2.5	2.2	2.1
Electrical and optical equipment	C26-C27	32.8	46.3	52.0	55.0	1.6	1.3	1.2	1.1
Machinery and equipment n.e.c.	C28	34.4	43.4	42.0	41.2	1.7	1.6	1.5	1.5
Transport equipment	C29-C30	36.9	51.8	59.2	64.8	1.7	1.4	1.3	1.4
Other manufacturing; repair and installation of machinery and equipment	C31-C33	24.0	28.7	28.9	28.7	1.9	1.7	1.6	1.5
Electricity and gas supply	D-E	83.2	89.2	81.5	81.3	1.1	1.1	1.2	1.2
Construction	**F**	**26.3**	**25.4**	**25.7**	**26.4**	**8.1**	**8.8**	**7.2**	**7.2**
Services (b)	**G-U**	**29.0**	**30.7**	**31.1**	**31.5**	**68.1**	**70.9**	**74.0**	**74.6**
Wholesale and retail trade	G	22.4	26.2	26.7	29.1	15.6	15.3	15.2	14.9
Transportation and storage	H	29.5	33.1	33.3	32.0	5.4	5.3	5.2	5.3
Accomodation and food services	I	22.5	20.5	19.6	19.3	4.5	5.0	5.1	5.3
Information and communication services	J	39.6	52.3	57.9	61.6	3.0	3.1	3.3	3.4
Financial and insurance activities	K	56.5	64.4	67.8	67.3	3.1	3.0	3.0	2.8
Professional services	M-N	31.5	30.3	29.4	29.3	10.4	12.4	13.4	14.2
Public administration, defence, education, human health and social work activities	O-Q	30.0	30.5	31.2	30.9	20.8	21.2	22.8	22.7
Arts, entertainment, recreation; other services and service activities, etc.	R-U	22.0	21.7	21.4	21.5	5.5	5.7	6.0	6.0

SOURCE: Banco de España based on Eurostat.

a Constat 2010 PPS.
b Real estate not included.

Table A2.3

ADDITIONAL INFORMATION

	Productivity gap (%) (a) (b)				Labour productivity level differentials (constant 2010 PPPs per hour worked) (b)				Share of hours worked differentials (pp) (c)			
	2000	2007	2013	2016	2000	2007	2013	2016	2000	2007	2013	2016
Total economy (d)	**-8.7**	**-15.0**	**-9.1**	**-9.3**	**-2.5**	**-4.7**	**-2.9**	**-3.1**	—	—	—	—
Agriculture and mining	**-24.8**	**-12.8**	**1.7**	**4.8**	**-4.8**	**-2.6**	**0.4**	**1.0**	**2.2**	**1.0**	**1.3**	**1.3**
Agriculture	20.4	22.9	32.5	36.2	2.4	3.1	4.9	5.7	2.3	0.9	1.3	1.3
Mining and quarrying	-78.9	-74.0	-58.4	-66.9	-125.8	-110.7	-72.2	-89.7	0.0	0.1	0.0	0.0
Industrial sector	**-10.8**	**-13.0**	**-6.5**	**-4.8**	**-3.6**	**-5.4**	**-2.9**	**-2.2**	**-0.3**	**-1.8**	**-1.9**	**-1.6**
Manufacturing	-12.0	-15.7	-10.2	-8.3	-3.7	-6.0	-4.1	-3.6	-0.1	-1.6	-1.9	-1.5
Food products; beverages and tobacco products	-10.9	-1.1	-10.2	-19.1	-3.2	-0.4	-3.2	-6.7	0.3	0.3	0.7	0.7
Textiles, wearing apparel, leather and related products	-21.2	-19.2	-13.5	-24.6	-3.8	-4.4	-3.4	-6.2	0.7	0.2	0.2	0.2
Wood, paper, printing and reproduction	2.4	-5.7	-5.3	-18.7	0.6	-1.6	-1.6	-6.1	-0.1	0.0	-0.1	-0.1
Coke and refined petroleum products	31.7	15.2	-20.7	290.9	55.6	25.8	-21.8	755.1	0.0	0.0	0.0	0.0
Chemicals and chemical products	-12.5	-19.1	-19.8	-24.6	-7.1	-14.6	-16.5	-22.2	0.0	-0.1	0.0	0.0
Rubber and plastic products and other non-metallic mineral products	7.9	-7.3	2.8	-0.7	2.1	-2.4	1.0	-0.3	0.2	0.0	-0.3	-0.3
Basic metals and fabricated metal products, except machinery and equipment	8.2	-8.4	14.1	22.8	2.3	-2.7	4.9	8.5	0.0	-0.2	-0.5	-0.4
Electrical and optical equipment	-23.5	-20.6	-16.9	-17.9	-7.7	-9.5	-8.8	-9.8	-0.4	-0.5	-0.6	-0.5
Machinery and equipment n.e.c.	-18.2	-22.8	-8.6	-17.2	-6.3	-9.9	-3.6	-7.1	-0.8	-0.8	-0.8	-0.7
Transport equipment	-26.3	-15.4	-10.2	-27.6	-9.7	-8.0	-6.0	-17.9	0.2	-0.3	-0.3	-0.3
Other manufacturing; repair and installation of machinery and equipment	-19.2	-21.3	-9.1	-12.3	-4.6	-6.1	-2.6	-3.5	-0.3	-0.1	-0.3	-0.2
Electricity and gas supply	11.1	10.5	6.0	12.0	9.3	9.4	4.9	9.7	-0.2	-0.2	0.0	0.0
Construction	**6.6**	**-12.1**	**35.1**	**29.3**	**1.7**	**-3.1**	**9.0**	**7.7**	**3.9**	**5.8**	**-1.0**	**-0.8**
Services (d)	**-7.8**	**-13.8**	**-12.0**	**-12.5**	**-2.3**	**-4.2**	**-3.7**	**-3.9**	**-5.9**	**-5.0**	**1.6**	**1.1**
Wholesale and retail trade	-21.1	-28.1	-23.8	-25.0	-4.7	-7.4	-6.3	-7.3	2.2	2.7	4.1	4.1
Transportation and storage	7.5	-15.2	-8.7	-3.5	2.2	-5.0	-2.9	-1.1	-0.7	-0.6	-0.5	-0.6
Accomodation and food services	68.5	39.2	47.5	44.7	15.4	8.0	9.3	8.6	1.6	2.0	2.4	2.7
Information and communication services	17.1	4.3	4.9	5.0	6.8	2.3	2.8	3.1	-0.8	-0.9	-0.6	-0.6
Financial and insurance activities	-21.2	11.5	-6.5	-13.9	-12.0	7.4	-4.4	-9.3	-1.0	-1.1	-0.9	-0.9
Professional services	-8.3	-26.4	-24.9	-22.3	-2.6	-8.0	-7.3	-6.5	-3.6	-2.8	-2.4	-2.5
Public administration, defence, education, human health and social work activities	-4.4	0.6	0.7	-1.5	-1.3	0.2	0.2	-0.5	-4.4	-5.1	-2.2	-2.5
Arts, entertainment, recreation; other services and service activities, etc.	-22.2	-20.5	-16.7	-16.3	-4.9	-4.5	-3.6	-3.5	0.8	0.8	1.7	1.6

SOURCE: Banco de España based on Eurostat.

a Defined as the level difference in percentage points between the labour productivity in Spain versus EU12.
b A negative (positive) sign indicates a productivity disadvantage (advantage) vis-à-vis EU12.
c Differentials of the share of hours worked per sector between Spain versus EU12. A negative (positive) sign indicates a lower (greater) specialization of the corresponding sector in Spain than in UE12.
d Real estate not included.

Table A2.4

CHANGES IN THE PRODUCTIVITY GAP CHANGES IN ITS DECOMPOSITION: SPAIN VS EU12

Constant 2010 PPPs

	Changes in the productivity gap (pp) (1)				Changes in the productivity differential (pp) (2)				Changes in the composition effect (pp) (3)			
	2000-2016	2000-2007	2007-2013	2013-2016	2000-2016	2000-2007	2007-2013	2013-2016	2000-2016	2000-2007	2007-2013	2013-2016
Total economy (a)	**-0.6**	**-6.3**	**5.9**	**-0.2**	**-1.5**	**-6.2**	**5.2**	**-0.5**	**0.9**	**-0.1**	**0.7**	**0.3**
Sectors	Productivity gap contributions by sector (pp) (1)				Productivity differential contributions by sector (pp) (2)				Composition effect contributions by sectors (pp) (3)			
	2000-2016	2000-2007	2007-2013	2013-2016	2000-2016	2000-2007	2007-2013	2013-2016	2000-2016	2000-2007	2007-2013	2013-2016
Agriculture and mining	**0.6**	**-0.1**	**0.7**	**0.1**	**0.8**	**-0.1**	**0.9**	**0.0**	**-0.2**	**0.0**	**-0.2**	**0.1**
Agriculture	-0.1	-0.6	0.5	0.1	0.2	-0.1	0.3	0.1	-0.3	-0.5	0.2	0.0
Mining and quarrying	0.7	0.5	0.2	0.0	0.6	0.0	0.6	-0.1	0.1	0.5	-0.4	0.1
Industrial sector	**-0.5**	**-2.2**	**1.1**	**0.6**	**0.8**	**-0.2**	**0.7**	**0.3**	**-1.2**	**-1.9**	**0.3**	**0.4**
Manufacturing	-1.1	-2.2	0.6	0.6	0.7	-0.2	0.8	0.1	-1.8	-2.0	-0.2	0.5
Food products; beverages and tobacco products	0.1	0.2	0.1	-0.2	-0.3	0.3	-0.2	-0.3	0.4	0.0	0.3	0.1
Textiles, wearing apparel, leather and related products	-0.2	-0.2	0.1	0.0	0.1	0.1	0.1	-0.1	-0.3	-0.3	0.0	0.0
Wood, paper, printing and reproduction	-0.2	-0.1	-0.1	-0.1	-0.2	-0.1	0.0	-0.1	0.0	0.0	-0.1	0.0
Coke and refined petroleum products	1.1	0.0	0.0	1.1	1.0	-0.1	-0.1	1.1	0.1	0.0	0.1	0.0
Chemicals and chemical products	-0.1	-0.2	0.1	0.0	-0.3	-0.1	-0.1	-0.2	0.2	-0.1	0.2	0.1
Rubber and plastic products and other non-metallic mineral products	-0.7	-0.5	-0.2	0.0	-0.2	-0.3	0.1	0.0	-0.5	-0.2	-0.3	0.0
Basic metals and fabricated metal products, except machinery and equipment	-0.3	-0.6	0.1	0.2	0.2	-0.4	0.5	0.2	-0.5	-0.2	-0.3	0.0
Electrical and optical equipment	-0.3	-0.2	-0.1	0.0	0.1	0.1	0.1	0.0	-0.4	-0.3	-0.1	0.0
Machinery and equipment n.e.c.	0.0	-0.2	0.3	0.0	0.0	0.0	0.2	-0.1	0.0	-0.2	0.1	0.1
Transport equipment	-0.8	-0.5	0.1	-0.5	0.0	0.3	0.1	-0.4	-0.8	-0.8	0.1	-0.1
Other manufacturing; repair and installation of machinery and equipment	0.2	0.1	0.1	0.0	0.1	-0.1	0.2	0.0	0.1	0.1	-0.2	0.1
Electricity and gas supply	0.6	0.1	0.5	0.1	0.1	0.0	-0.1	0.2	0.5	0.1	0.6	-0.1
Construction	**-3.4**	**-1.1**	**-2.2**	**-0.1**	**0.8**	**-2.1**	**3.2**	**-0.3**	**-4.2**	**1.1**	**-5.4**	**0.1**
Services (a)	**2.7**	**-3.0**	**6.4**	**-0.8**	**-3.8**	**-3.8**	**0.5**	**-0.6**	**6.5**	**0.8**	**6.0**	**-0.2**
Wholesale and retail trade	0.6	-0.8	1.6	-0.2	-1.3	-1.3	0.4	-0.4	1.9	0.5	1.2	0.2
Transportation and storage	-0.4	-1.1	0.5	0.2	-0.5	-1.1	0.3	0.3	0.1	0.0	0.2	-0.1
Accomodation and food services	-0.8	-1.4	0.5	0.1	-1.1	-1.4	0.4	0.0	0.4	0.1	0.1	0.1
Information and communication services	-0.3	-0.7	0.4	0.0	-0.2	-0.3	0.1	0.0	-0.1	-0.4	0.3	0.0
Financial and insurance activities	0.3	1.0	-0.4	-0.3	0.3	1.3	-0.7	-0.3	0.0	-0.3	0.3	0.0
Professional services	0.0	-0.6	0.4	0.1	-1.7	-1.8	-0.1	0.2	1.7	1.3	0.4	-0.1
Public administration, defence, education, human health and social work activities	2.6	0.4	2.9	-0.7	0.4	0.8	0.0	-0.4	2.1	-0.5	2.9	-0.3
Arts, entertainment, recreation; other services and service activities, etc.	0.7	0.1	0.6	0.0	0.3	0.1	0.1	0.1	0.4	-0.1	0.6	-0.1

SOURCE: Banco de España based on Eurostat.
NOTES: (1) = (2) + (3). Changes calculated as the differnece between the end and the beginning of the period.

a Real estate not included.

Annex 3 Gap descomposition by sector contributions

The formula used for the sector contributions to the productivity gap is as follows:

$$\frac{LP^{ES}}{LP^{EU12}} - 1 = \sum_{i=1}^{n} \frac{H_i^{ES}}{H_{tot}^{ES}} * \frac{LP_i^{EU12}}{LP_{tot}^{EU12}} * \left(\frac{LP_i^{ES}}{LP_i^{EU12}} - 1 \right) - \sum_{i=1}^{n} \frac{H_i^{ES}}{H_{tot}^{ES}} * \frac{LP_i^{EU12}}{LP_{tot}^{EU12}} * \left(\frac{\frac{H_i^{EU12}}{H_{tot}^{EU12}}}{\frac{H_i^{ES}}{H_{tot}^{ES}}} - 1 \right)$$

where LP_i^{EU12} denotes the productivity level for EU12 of industry i and LP_i^{ES} the productivity level for Spain in industry i. Weights $\frac{H_i^{ES}}{H_{tot}^{ES}}$ and $\frac{H_i^{EU12}}{H_{tot}^{EU12}}$ are the shares of industry i in total hours worked in Spain and EU12 respectively.

The intuition behind this formula is:

— If EU12 – our benchmark – is an economy with the same productivity levels in each sector and the economic structure (in terms of hours worked) in Spain is similar to the one of UE12, $\frac{LP_i^{EU12}}{LP_{tot}^{EU12}}$ and $\frac{\frac{H_i^{EU12}}{H_{tot}^{EU12}}}{\frac{H_i^{ES}}{H_{tot}^{ES}}}$ would be equal to 1 for each i sector. In this case, the global gap would be simply the weighted average of sector gaps, being the weights equal to the hour share of the corresponding sector in Spain.

— If EU12 has different levels of productivity in each sector, the formula corrects each sector contribution to the global gap taking into account if the sector productivity is above (below) its global productivity, i. e. if $\frac{LP_i^{EU12}}{LP_{tot}^{EU12}}$ is greater (smaller) than 1.

— Finally, if the Spanish economic structure (in terms of hours) differs from the EU12 structure, the formula adjusts each sector contribution to the global gap by subtracting the relative hours share differentials between EU12 and Spain in each sector. This means that if the i sector had a productivity disadvantage in Spain, its negative contribution to the Spanish global gap would be larger in the case in which the EU12 economy had a greater hour share than in Spain, i. e. $\frac{\frac{H_i^{EU12}}{H_{tot}^{EU12}}}{\frac{H_i^{ES}}{H_{tot}^{ES}}} - 1 > 0$. On the contrary, if the hour share differential was favorable to Spain, i. e. $\frac{\frac{H_i^{EU12}}{H_{tot}^{EU12}}}{\frac{H_i^{ES}}{H_{tot}^{ES}}} - 1 < 0$, its negative contribution would be lower than in the case of equal hour shares in i sector.

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