Ernesto Nieto-Carrillo
University of Coimbra, CeBER, Faculty of Economics
enietoc@fe.uc.pt.
orcid.org/0000-0002-3345-9008

DOI: https://doi.org/10.14195/2183-203X_58_1

From Manufacturing Decline to the Rise of Consultancy: A Framework for Time-Consistent Industry Analysis in Portugal (1986-2018)

Do Declínio do Setor Transformador à Ascensão da Consultoria: Um Quadro para Análise Industrial Consistente ao Longo do Tempo em Portugal (1986-2018)

Ernesto Nieto-Carrillo

Received for publication: September 12, 2024
Revision accepted for publication: November 14, 2024

ABSTRACT
Since the creation of the Quadros de Pessoal (QP) in 1981, a longitudinal dataset of all Portuguese companies, four industry classifications have been used, hampering the ability to conduct long-term studies on firm dynamics and structural change. This paper proposes a framework for standardising the QP with time-consistent two-digit industry codes to analyse the impact of the ICT revolution on firm growth rates, net job creation, and employment composition across sectors. Our industry-consistent trends confirm the rise and fall of business dynamism and the contraction of manufacturing alongside the expansion of services. However, while the increased dispersion and positive skewness of growth rates and net job creation in ICT services played a crucial role, the technological paradigm shift in Portugal seems to be predominantly reflected in the vertical disintegration of firms and the subsequent substantial growth of administrative support activities.
Keywords: Structural change, deindustrialisation, firm dynamics, industry classification, longitudinal analysis.

JEL classification: D220; L160; L250; L860; L840; O330; O140

Acknowledgements: This work has benefited greatly from the valuable insights and contributions of Carlos Carreira and Paulino Teixeira, esteemed mentors and colleagues with whom we have pursued an extensive research agenda on the interplay between technological change and industrial dynamics, particularly focusing on the Portuguese economy. This work was funded by the FCT-*Fundação para a Ciência e a Tecnologia*, under Project ENtRY (PTDC/EGE-ECO/31117/2017) and the R&D Unit CeBER (UIDB/05037/2020).

1. Introduction

Over recent decades, most advanced Western economies have experienced a marked decline in the share of manufacturing in total employment. According to Rodrik (2016), while Asian countries and major manufacturing exporters have remained relatively insulated from this trend, the phenomenon has spread beyond advanced economies, with severe consequences for regions such as Latin America. As a result, premature deindustrialisation in peripheral economies has constrained income growth and reduced job opportunities for blue-collar workers.

Despite extensive research on this global process, the lack of firm-level databases that provide a consistent industrial classification over time has hindered a comprehensive understanding of the underlying microeconomic dynamics. Moreover, although globalisation and labour-saving innovations are commonly cited as the main causes (Rodrik, 2016; Tregenna, 2009), deindustrialisation has occurred simultaneously with the rise of the ICT revolution and the associated displacement of technological opportunities across sectors. It is, therefore, crucial to examine how the emergence of the ICT paradigm, in conjunction with globalisation and broader international trade, has changed the employment structure.

The purpose of this article is twofold. First, we present a novel methodology for transforming the Quadros de Pessoal (QP), a longitudinal database covering the universe of Portuguese firms, into a dataset with time-consistent industry codes at the firm level. Second, we analyse changes in the dispersion and skewness patterns in the distribution of firm growth rates, sectoral net job creation rates and, consequently, the composition of employment, with a particular focus on the ICT-driven industries. Given its position as a 'semiperipheral' economy, Portugal provides a crucial setting for understanding these dynamics.

Our industrial homogenisation process allows us to track longitudinally over one million firms across 59 two-digit industries, distributed among 16 aggregated sectors according to the CAE Rev. 2/NACE Rev. 1.1 classification (excluding the domestic work sector, which the QP does not cover) from 1986 to 2018. Our final dataset, with almost eight million year-firm observations, is only comparable to the industry-consistent US Census Bureau's Longitudinal Business Database.

Our results show that although the rise of the ICT technological paradigm led to a significant increase in job creation and business dynamism during the 1990s– particularly in wholesale and retail trade, accommodation and food services, and computer and business support services – this trend reversed after 2000. During the new century, we observe a sustained decline in the dispersion and positive skewness of business growth rates across all sectors, suggesting reduced resource reallocation and diminished contribution from high-growth firms. In addition, our results underline that net job creation, especially in the late 20th century, was mainly due to ICT industries, which followed a long-wave trend. However, the positive effect on employment was limited to ICT services, while ICT manufacturing saw a steady loss of jobs (virtually disappearing by 2018).

Finally, our findings reveal that the decline in the manufacturing employment share over 1986-2018 (from 45% to 22%) has been largely offset by the growth of administrative support activities (from 3% to 14%). This structural transformation indicates that the intersectoral changes driven by the new technological paradigm in Portugal are primarily reflected in the vertical disintegration of firms. While this process likely yielded short-term efficiency gains, its potential to foster long-term economic growth, innovation, and technological advancement remains limited.

The remainder of this article is structured as follows. The second section provides a brief literature review on technological revolutions and their impact on employment structure. The third section describes the information sources, while the fourth section details the methodology for homogenising industries and estimating trends in industrial dynamics and employment composition. The fifth section outlines the results, and the sixth concludes with final remarks and questions for future research.

2. Technological Revolutions and Employment Structure

Following Kondratiev (1935), several authors argue that capitalist development operates in long waves (Mandel, 1980; Schumpeter, 1939; Shaikh, 1992). According to Schumpeter (1939), these waves are determined by the diffusion of successive technological revolutions. Pérez (2002) and Freeman and Louçã (2001) complement this notion by suggesting that the exploitation and exhaustion of the underlying technological paradigm explain the wave pattern. These technological revolutions are triggered by radical innovations that, via incremental innovations and imitation processes, revitalise declining profit rates by reducing the overall cost structure and opening new avenues for innovation. While technical progress is constant, its pace exhibits discontinuities, primarily linked to the rise and fall of each technological revolution.

The capacity to transform other industries and activities stems from the influence of its associated technological paradigm, understood as the best practice shared by innovators when utilising new technologies, both within and outside emerging industries (Dosi, 1982; Perez, 2010). Thus, after the advent of a radical General-Purpose Technology (GPT), the paradigm is configurated, leading to explosive growth and rapid innovation in new industries. The second phase is characterised by rapid diffusion, where new industries and technological systems flourish due to intense investment and sustained market growth. The third phase maintains accelerated growth with the full deployment of the paradigm across the productive structure. However, when technological opportunities are exhausted, productivity, growth and profits are seriously threatened, encouraging unproductive investments to offset profit squeeze (Perez, 2002).

In terms of sectoral structure, each revolution involves a significant number of new, interrelated products and technologies, resulting in the arrival of new industries. According to Pérez (2010), the core sectors of each revolution can be classified into three main categories: motive branches, which produce widely applicable cheaper inputs; carrier branches, which are the most visible users of these inputs; and infrastructures, which influence the configuration and expansion of market boundaries for all industries. In the current technological revolution, the motive branches would be represented by the semiconductor industry; the carrier branches by computers, software, and mobile phones; and the infrastructures by global digital telecommunications (cable, fibre optic, radio, and satellite), as well as the Internet, email, and other flexible electrical networks.

Lastly, a new techno-economic paradigm is expected to transform the organisation within factories and firms. The widespread availability of personal computers and the rapid evolution in the design of processes and products have eroded the Fordist hierarchical structure, fostering networking both within and outside companies, which is also reflected in the rise of management consultancy services (Bresnahan and Malerba, 1997; Freeman and Louçã, 2001).

As a result, the significant decline in manufacturing employment share (Rodrik, 2016), characteristic of most developed Western economies, is likely to have been offset by industries driven by the ICT technological paradigm (Brynjolfsson et al., 2021; Louçã and Mendonça, 2002; OECD, 2024). In this paper, we document the effects of the ICT paradigm on Portuguese employment, leveraging a homogenised classification of firm-level industrial codes. While the aggregate employment share of this sector is expected to increase, it is crucial to identify which industries have experienced the most significant growth, especially in the context of increased trade openness and the relatively low productivity of Portuguese production.

3. Dataset

The primary dataset is the Quadros de Pessoal (QP). Established by Decree-Law No. 479 of 16 June 1976,[1] the Portuguese government mandated that all public and private enterprises employing at least one worker in both the mainland and the islands to submit 'QP' maps. The Ministry of Employment has been responsible for data collection since the initiative began in 1981, although information is only available from 1985 onwards.

The QP provides longitudinal employer-employee information covering enterprise and establishment levels in all sectors (except for 'Activities of households'). Given the mandatory participation of firms with registered employees, the dataset is characterised by high coverage and reliability. Moreover, each firm and worker has a unique identification number, allowing tracking them longitudinally and generating business variables from the establishment and worker data. The employer reports all the information (i.e., firm-, establishment-, and worker-level) and relates to the situation observed in the reference month.

QP includes all types of companies according to their legal nature – including, among others, single proprietorship, general partnership, limited liability firms, and corporations – as well as non-profit and for-profit entities. Variables at the firm level include industry, location, number of employees, number of establishments, sales volume, legal nature, and ownership structure (i.e., domestic and foreign shares), inter alia. As of 2010, QP has two variables that report the total number of workers (full-time and part-time). The former reports the number of workers observed in the reference month (October), while the latter reports the number of workers observed on the last day of October. Before 2010 companies only reported the first variable, so this option is used for the entire period.

As the QP dataset does not contain industry codes at the highest level of disaggregation, we enhance the industry information by including the FUE and SCIE datasets. The FUE file, compiled annually by the National Statistical Office (INE by its acronym in Portuguese) during 1996-2004, was used for coordinating and harmonising information on the business

[1] See Decreto-Lei n.º 479/76 | DR (diariodarepublica.pt).

population. FUE received panel information from the various operations of the INE's statistical collection and production units and integrated administrative records from external entities. We can obtain demographic information, legal form, economic activity (at all levels of disaggregation), and social capital distribution in this database. For its part, the SCIE is a longitudinal dataset that reports the corporate balance sheet, whose responsibility for annual collection has also been in charge of INE. The data is built from a mandatory survey for all companies registered in Portugal and contains information from 2004 to 2018. This dataset reports the structure, industry (at the highest classification level), revenues, output, inputs, and other elements related to companies' economic, financial, and competitive nature.[2] Firms have the same identification number in QP, FUE, and SCIE, a key feature that allows all three datasets to be linked.

4. Methodology

4.1. Building time-consistent industry codes

Since the creation of the QP, four industrial classification methodologies have been in place: Portuguese Classification of Economic Activities (CAE by its acronym in Portuguese) Revision (Rev.) 1 (1985-1994), CAE Rev. 2 (1995-2002), CAE Rev. 2 (2003-2006) and CAE Rev. 3 (2007 onwards). These changes introduce limitations for conducting any long-term time-series analysis that requires industrial affiliation. In particular, companies may switch from one sector to another without any real change in the underlying economic activity, distorting the perceived variations in employment and production structures. Fort and Klimek (2018) noted, for instance, that a naive analysis of the changes in US employment composition during 1976-2009 would overstate the increase in service employment by approximately 36 percentage points while overestimating the decline in manufacturing employment by nearly 11 percentage points. Therefore, we aim to classify Portuguese enterprises using a consistent methodology that facilitates the analysis of, among other things, long-term industrial dynamics and changes in employment structure.

Given that the QP dataset includes industry codes with a maximum of three digits from 1985 to 2009 and four from 2010 onwards, we first merged this data with the FUE and SCIE files, which provide codes at the highest classification level (six digits in Rev. 1 and five in Revs. 2, 2.1, and 3). A key advantage of this merger is that all companies in the SCIE dataset were classified exclusively under Rev. 3, allowing us to assign both Rev. 2.1 and Rev. 3 codes to the same QP-SCIE firm from 2004 to 2006, thereby facilitating the harmonisation of classifications.

Subsequently, we applied the following three-step procedure:

i) *Using Official Tables for Unique 2-digit Matches in Rev. 2.* – The primary source of information is the official correspondence tables produced by the INE. These tables facilitate the reclassification of many economic activities in both directions;

[2] Unlike QP, both FUE and SCIE do not contain single-proprietorship enterprises.

however, disaggregated activities often lack a one-to-one correspondence between classification systems. For instance, code 10850 from CAE Rev. 3, corresponding to the "Manufacture of prepared meals and dishes" industry, is subdivided into five distinct codes in CAE Rev. 2.1: 15130 (Manufacture of meat products), 15204 (Drying, salting and other processing of fishery and aquaculture products), 15335 (Preparation and preservation of fruit and vegetables), 15850 (Manufacture of pasta, couscous and similar products), and 15893 (Manufacture of other miscellaneous food products). Moreover, the official tables only provide correspondences between sequential classifications, making it impossible to directly map a Rev. 1 code to its Rev. 3 equivalent.

Therefore, we decided to harmonise the industry codes at the 2-digit level, using Rev. 2 as the base classification. At this level, this methodology is directly equivalent to CAE Rev. 2.1 and, critically, Statistical Classification of Economic Activities in the European Community (NACE) Rev. 1.1. This approach allows us to assert that, although we cannot pinpoint the exact 5-digit code in Rev. 2.1 corresponding to 10850 in Rev. 3, we can reliably categorise this activity under code 15 in Rev. 2, which represents "Manufacture of food products and beverages."

ii) *Using Longitudinal Information for Multiple Destinations.* Many activities at the most detailed level may have several 2-digit equivalents in Rev. 2. For example, code 22230 in Rev. 3, which pertains to "Manufacture of builders' ware of plastic," is spread across two different 2-digit codes in Rev. 2: code 25 (Manufacture of rubber and plastic products) and code 36 (Manufacture of furniture). This indicates that, even at the 2-digit level, the official tables do not always provide a singular correspondence after reclassification.

Therefore, in cases with multiple 2-digit destinations, we used the longitudinal data structure to transfer industrial information from the period companies were classified under Rev. 2 to the other periods (before 1995 and after 2006) whenever firms have not changed their economic activity. To illustrate, in the case of multiple destinations of companies operating before and from 2007, we assigned the 2-digit code they had before that year, provided they remained in the same industry after that.

iii) *Modal mapping.* In only 5.32% of the total observations, we were unable to assign the corresponding 2-digit Rev. 2 code, either through official tables or longitudinal transfer. In these instances, we employed a modal mapping approach. This means that each industry Rev. 1 and Rev. 3 was assigned the 2-digit Rev. 2 code that was most likely to be mapped to in the probabilistic mapping, determined by the mode.

Once this harmonisation was applied, preliminary filtering of the raw data was required. In particular, companies not belonging to the productive sector (e.g., foundations, associations, unions, social security institutions, inter al.) and unreasonable observations (e.g., negative employment) were eliminated.

Our final dataset comprises 1,061,573 firms, resulting in 7,904,664 firm-year observations. Table 1 presents the pooled-sample distribution of observations over 1985–2018 and across the 59 two-digit industries within the 16 aggregated sectors of CAE Rev. 2 (excluding the domestic work sector, which the QP does not cover). Since the QP also provide worker-level data, our methodology enables the examination of both business dynamics and labour market conditions across industries.

Table 1. Pooled Sample Distribution of Firm-level Observations across time-consistent 2-Digit CAE Rev. 2 Industries, 1985-2018

Section		Division	Firms' observations
A	Agriculture, hunting and forestry	1	310165
		2	32445
B	Fishing	5	17827
C	Mining and quarrying	10	81
		11	28
		12	19
		13	291
		14	24759
D	Manufacturing	15	168309
		16	129
		17	79079
		18	154878
		19	64088
		20	118172
		21	11216
		22	69688
		23	244
		24	20394
		25	23271
		26	88556
		27	8939
		28	193085
		29	61277
		30	101
		31	11510
		32	2616
		33	13043
		34	10224
		35	7102
		36	135625
		37	4914

Section		Division	Firms' observations
E	Electricity, gas and water supply	40	3600
		41	1519
F	Construction	45	972149
G	Wholesale and retail trade	50	422328
		51	667272
		52	1379009
H	Accommodation and food services	55	926405
I	Transport, storage and communication	60	246865
		61	2761
		62	1301
		63	56310
		64	6878
J	Financial intermediation	65	17180
		66	3844
		67	45620
K	Real estate, renting and business support	70	177846
		71	26368
		72	56526
		73	2488
		74	574952
L	Public administration and defence; compulsory social security	75	853
M	Education	80	82733
N	Health and social work	85	272044
O	Other community, social and personal service activities	90	4800
		91	10767
		92	63161
		93	246822
Q	Extra-territorial organisations and bodies	99	188
Total			7904664

Notes: The table reports the distribution of firm-level observations across the time-consistent 2-digit CAE Rev. 2 industries.

4.2. Industrial Dynamics Statistics

A key advantage of our industry homogenisation process is the ability to analyse long-term firm dynamics and understand, among other things, changes in the distribution of firm-level growth rates, firm and job flows (i.e., creation, destruction, and reallocation), and the composition of employment.

To compute employment growth rates, we follow the approach of Davis et al. (1996), calculated as follows:

$$g_{i,t} = \frac{E_{i,t} - E_{i,t-1}}{X_{i,t}}, \tag{1}$$

where, $g_{i,t}$ is the employment growth rate of firm i in period t; E_i denotes employment and $X_{i,t}$ is the average employment between t and t-1 so that $X_{i,t} = \frac{E_{i,t} + E_{i,t-1}}{2}$. As Haltiwanger et al. (2013) point out, using the average employment as the growth rate denominator aims to neutralise the "regression-to-the-mean" bias. Specifically, since employment in t induces a downward bias and employment in t-1 an upward bias, both effects are expected to cancel out.

In our case, this approach required generating observations for the years a company temporarily did not report to QP – which was interpreted as a temporary closure – and for the year following the last time it reported positive employment – interpreted as a definitive exit. Thus, a temporary closure is one in which a firm reports positive employment in "t-τ," employment equal to zero in "t" and positive employment in "t+τ" (occurring the reopening in "t+1"). Likewise, a definitive closure occurs when the company reports positive employment in "t-τ," employment equal to zero in "t", and the identifier definitively disappears in "t+τ."

We start by analysing the evolution of the employment-weighted growth rate distribution across sectors and 2-digit industries. Afterwards, following Haltiwanger et al. (2009), we computed the Net Job Creation rate (NJCR) as the difference between the Job Creation (JCR) and Job Destruction (JDR) rates, which are just weighted sums of firm-level employment growth rates for the various aggregation levels, as follows:

$$\mathrm{JCR}_{s,t} = \Sigma_{\substack{i\varepsilon s \\ g_{i,t} \geq 0}} \left(\frac{X_{i,t}}{X_{s,t}} \right) g_{i,t}; \tag{2}$$

$$\mathrm{JDR}_{s,t} = \Sigma_{\substack{i\varepsilon s \\ g_{i,t} < 0}} \left(\frac{X_{i,t}}{X_{s,t}} \right) | \, g_{i,t} \, |; \tag{3}$$

$$\mathrm{NJCR}_{s,t} = \mathrm{JCR}_{s,t} - \mathrm{JDR}_{s,t}; \tag{4}$$

where $X_{s,t} = \Sigma_{i\varepsilon s} X_{i,t}$, and s denotes either the entire economy, size categories, age groups or sectors.[3]

The long sample period allows us to isolate the effect of the business cycle. Thus, to separate the time series into trend and cyclic components, we apply the Hodrick-Prescott (HP) filter. Given the annual nature of the information, the smoothing parameter is set to 100.

[3] The methodology closely follows the contributions by Haltiwanger et al. (2009) and Decker et al. (2016).

Finally, we analyse how the intersectoral variations in net job creation rates influence the employment structure's evolution. These sectoral dynamics and composition have probably been influenced by both the ICT revolution and Portugal's entry into the European Union (and the widespread reduction of trade barriers). So, to map the different trajectories resulting from the emergence of the ICT technological paradigm, we apply the OECD methodology to classify industries as ICT-driven or non-ICT-driven.[4] Furthermore, recognising that the ICT revolution likely transformed business structures by promoting vertical disintegration and the expansion of the consultancy market (Bresnahan and Malerba, 1997; Freeman and Louçã, 2001), we also include the business support services subsector (code 74). A full list of ICT-driven industries at the CAE Rev. 2/NACE Rev. 1.1 two-digit level is provided in Table 2.

Table 2: OECD definition of the ICT sector

CAE Rev.2/ NACE Rev 1.1	DESCRIPTION
30	Manufacture of office machinery and computers
31	Manufacture of electrical machinery and apparatus
32	Manufacture of radio, television, and communication equipment and apparatus
33	Manufacture of medical, precision, and optical instruments, watches, and clocks
64	Post and telecommunications
71	Renting of machinery and equipment without operator
72	Computer and related activities
74	Business services

Notes: The OECD define the ICT sector as a combination of manufacturing and services industries that capture, transmit and display data and information electronically. Due to the limitations in identifying industries at a 4-digit disaggregation level, we could not incorporate the ICT wholesale industry (code 5150). Moreover, following Freeman and Louçã (2001), we included the business services subsector (code 74).

5. Results

5.1. Cross-industry growth-rate analysis

The distribution of the growth rate provides important insights into understanding firm dynamics. A high degree of dispersion indicates significant job turnover, typically associated with periods of intense creative destruction (Aghion and Akcigit, 2019; Decker et al., 2014). Moreover, the existing literature documents that the average growth rate masks considerable heterogeneity. The median growth rate tends to be around zero, while growth in the right tail of the distribution skews and conditions average growth. Accordingly, the skew-

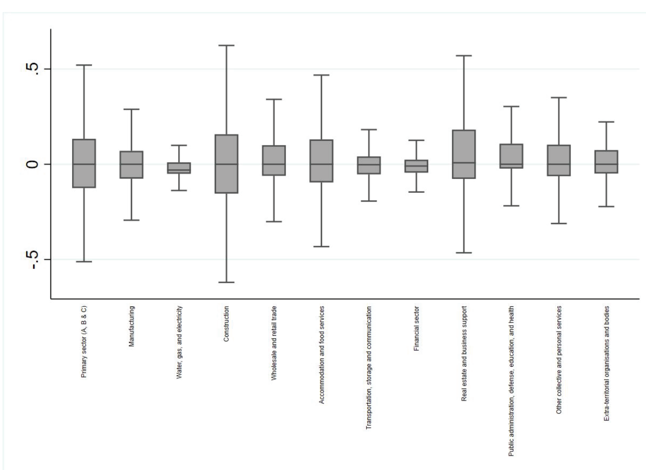
[4] The methodology is available at https://www.oecd.org/digital/ieconomy/2771153.pdf. However, notice that we made some small adjustments as we couldn't identify industries at a level beyond 2 digits.

ness of the distribution further enables examining the presence and impact of high-growth (typically young) firms, which contribute the most to net job creation (Decker et al., 2014; Haltiwanger et al., 2013). Consequently, our industry homogenisation at the firm level allows us to analyse changes in the distribution of growth rates and characterise the evolution of business dynamism across sectors.

Figure 1 shows the distribution of growth rates by sector. We weight by employment to assess their aggregate impact. To facilitate the analysis, we group sectors A (agriculture, animal husbandry, hunting and forestry), B (fishing) and C (extractive industries) together as the primary sector. We also combine sectors L (public administration, defence and compulsory social security), M (education) and N (health and social work) due to their non-profit and public nature.

The results confirm that although the median growth rate fluctuates around zero (except for 'Water, gas and electricity', which has a negative median rate), there is considerable heterogeneity across sectors, marked by different dispersion and skewness patterns. The sectors 'primary activities,' 'construction', 'accommodation and food services,' and 'real estate and business support' show the highest dynamism and dispersion (i.e. a greater distance between the extremes). The opposite is true for 'water, gas and electricity', 'transport, storage and communication' and 'financial activities.' Finally, a greater positive skewness (i.e. a greater distance between the upper extreme and the median) is observed in the 'wholesale and retail trade,' 'accommodation and food services', and 'real estate and business support activities.' Since the median fluctuates around zero, preliminary evidence suggests that these sectors are likely to have made the highest net contributions to aggregate employment (i.e. more job creation than destruction).

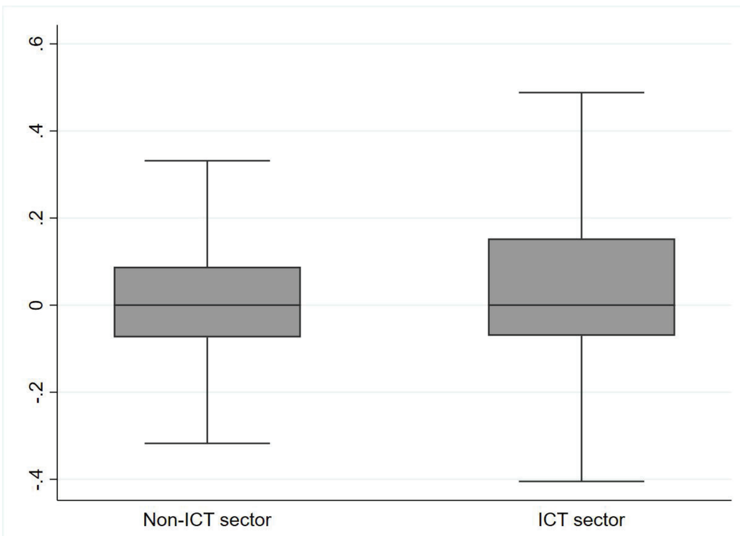
Figure 1: The growth rate distribution by sector, 1986-2018



Notes: The figure shows the employment-weighted box-and-whisker plot for all firms (i.e., entering, continuing, and exiting entreprises) across sectors over 1986-2018. Industries are defined on a time-consistent CAE Rev.2 basis.

Figure 2 characterises the distribution of employment growth rates, distinguishing between Information and Communication Technology (ICT)-driven and non-ICT sectors. The estimates suggest that ICT industries, being younger and driven by the dominant technological paradigm, exhibit greater dispersion and positive skewness. In contrast, the distribution of the non-ICT sector appears to be almost symmetrical. Therefore, the ICT sector seems to have experienced more significant high-growth events and job turnover, leading to a more intense process of creative destruction.

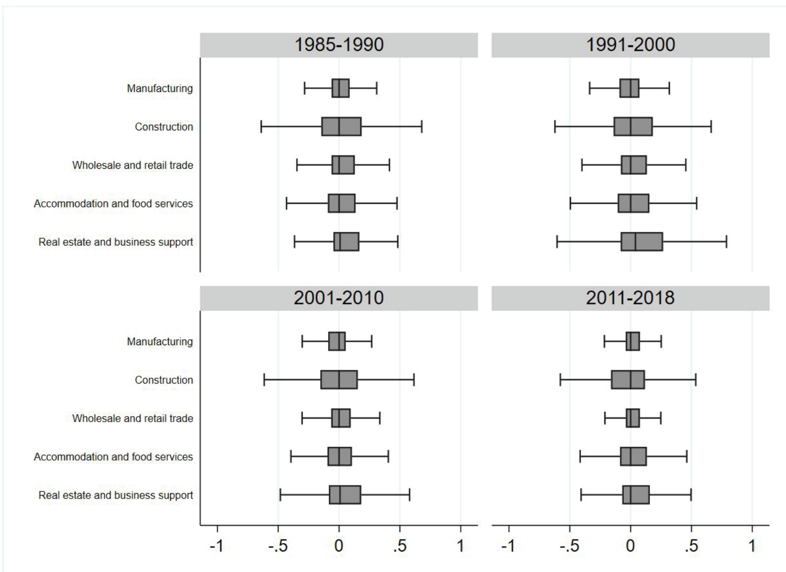
Figure 2: The growth rate distribution across ICT and non-ICT sectors, 1986-2018



Notes: The figure shows the employment-weighted box-and-whisker plot for all firms over 1986-2018. Industries are defined on a time-consistent CAE Rev.2 basis. The ICT sector is classified by using the methodology developed by the OECD.

We then characterise the evolution of the distribution of growth rates, focusing on the manufacturing and non-financial market services sectors over the periods 1986-1990, 1991-2000, 2001-2010 and 2011-2018. Figure 3 shows that, during the 1990s, dispersion and skewness increased significantly in all sectors except for 'manufacturing,' where change was minimal, and 'construction', which already exhibited high degrees of dispersion and positive skewness in the 1980s. However, it should be noted that the 'real estate and business support services' sector experienced the most pronounced increase in dispersion and skewness over this period. From 2000 onwards, despite intersectoral heterogeneity, the stagnation of the Portuguese economy is mirrored in a widespread reduction in both dispersion and skewness, except for 'construction', which maintained its dynamism throughout the new century (albeit showing a slightly negative skewness over 2011-2018). These results, therefore, point to a decline in job turnover and the contribution of high-growth enterprises in all sectors over the new century.

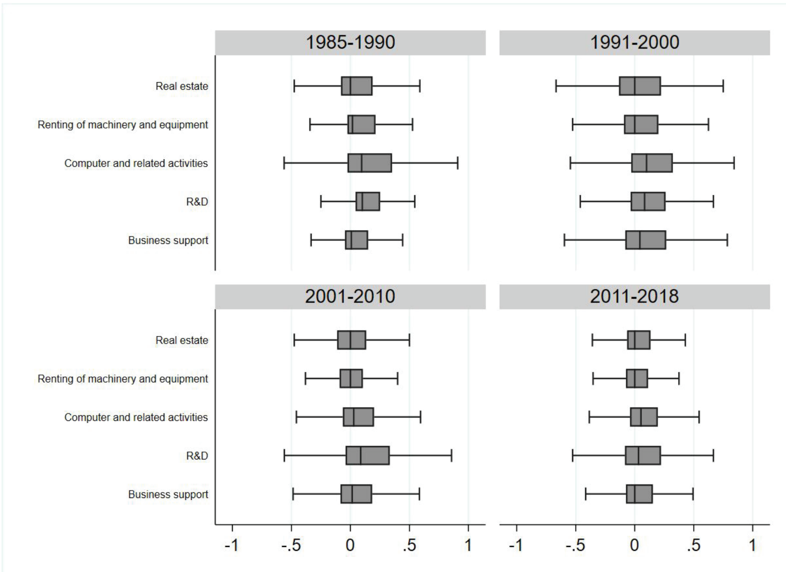
Figure 3: The growth rate distribution by sector and period



Notes: The figure shows the employment-weighted box-and-whisker plot for all firms across sectors for the periods 1986-1990, 1991-2000, 2001-2010, 2011-2018. Industries are defined on a time-consistent CAE Rev.2 basis.

To disentangle the sharp shift in the dynamics of the growth rate of the 'real estate, renting and business support services' sector during the 1990s, Figure 4 presents the evolution of the underlying distribution within its two-digit industries. Four main conclusions can be drawn: i) the dispersion and positive skewness of growth rates increased in all activities during the 1990s; ii) the largest increases occurred in 'real estate activities' and 'business support services,' with the latter showing the most pronounced change; iii) 'computer services and related activities' stood out as having the highest dispersion and positive skewness in both the 1980s and 1990s; and iv) the dispersion and positive skewness of growth rates decreased in all activities since 2000, except for the 'research and development' industry, whose dynamism even increased in the new century.

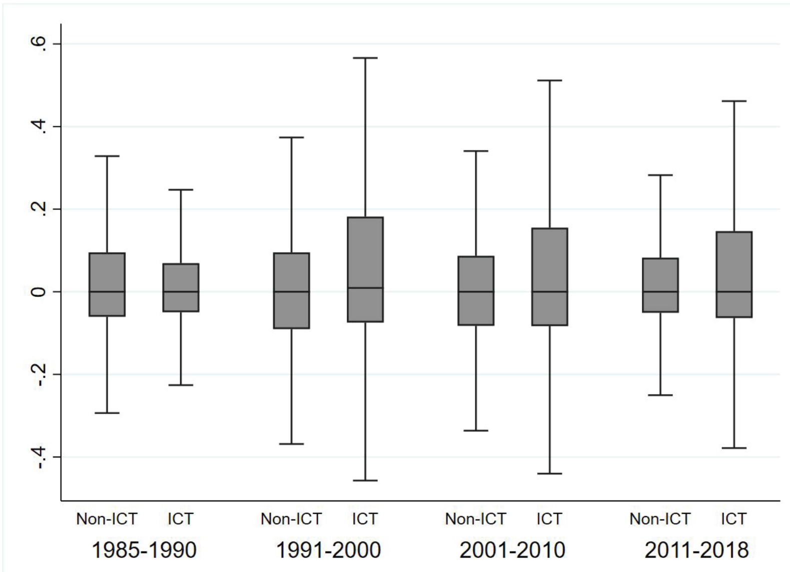
Figure 4: The growth rate distribution within the 'Real Estate, Renting, and Business Support' Sector, by period



Notes: The figure shows the employment-weighted box-and-whisker plot for all firms for the periods 1986-1990, 1991-2000, 2001-2010, 2011-2018. Industries are defined on a time-consistent CAE Rev.2 basis.

It is important to emphasise that three of the 2-digit "Real Estate and Business Support" industries that experienced the more intense growth dynamics towards the end of the twentieth century – namely 'renting of machinery and equipment' (code 71), 'computer services and related activities' (code 72), and 'business support activities' (code 74) – have been driven by the ICT technological paradigm. Accordingly, Figure 5 shows the evolution of the employment-weighted growth rate distribution, broken down into ICT and non-ICT sectors. The estimates show that the non-ICT sector exhibited a wider dispersion of growth rates in the 1980s. However, the relationship reversed since the 1990s. While both sectors experienced increased dynamism in the 1990s, the change in the ICT sector was significantly greater. The distribution's right tail in this sector moved further from the median, indicating a greater presence and impact of high-growth enterprises. Since 2000, dispersion and positive skewness have decreased in both sectors, but the ICT sector has still shown greater dynamism over the last two decades.

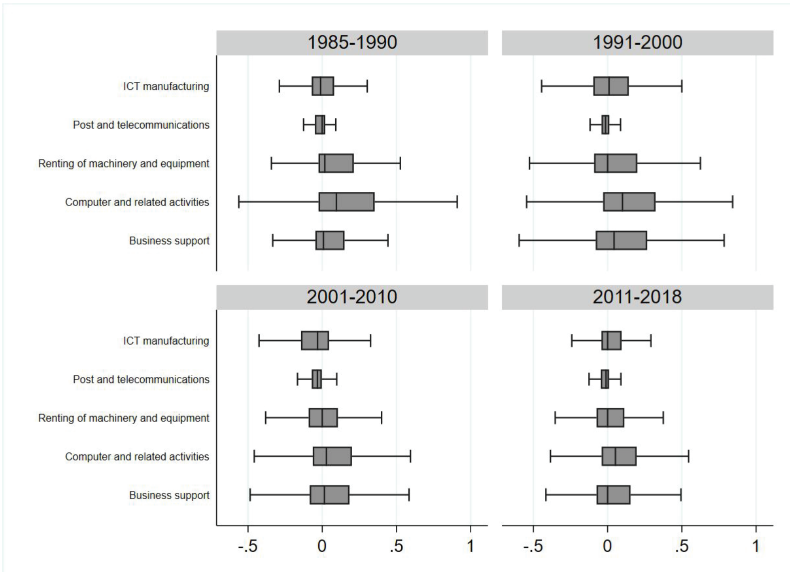
Figure 5: The growth rate distribution across ICT and non-ICT sectors, by period



Notes: The figure shows the employment-weighted box-and-whisker plot for all firms across sectors for the periods 1986-1990, 1991-2000, 2001-2010, 2011-2018. Industries are defined on a time-consistent CAE Rev.2 basis. The ICT sector is classified by using the methodology developed by the OECD.

Figure 6 focuses exclusively on the industries within the ICT sector, distinguishing between ICT manufacturing activities (codes 30 – 'office machinery and computers,' 31 – 'electrical machinery and apparatuses,' and 32 – 'radio, television, and communication equipment') and the rest of the industries. The estimates indicate that while all subsectors experienced a marked increase in dispersion and positive skewness during the 1990s (with minimal changes in the telecommunications sector), ICT services activities (codes 71, 72, and 74) exhibited more substantial shifts than their ICT manufacturing counterparts. Moreover, the figure highlights that, despite a general decline in dispersion and skewness across all sectors since 2000, ICT manufacturing has experienced the largest reductions, with a slightly left-skewed distribution in the first decade of the new century, suggesting that job destruction outpaced job creation rates.

Figure 6: The growth rate distribution within the ICT sector, by period



Notes: The figure shows the employment-weighted box-and-whisker plot for all firms across industries for the periods 1986-1990, 1991-2000, 2001-2010, 2011-2018. Industries are defined on a time-consistent CAE Rev.2 basis. The ICT sector is classified by using the methodology developed by the OECD.

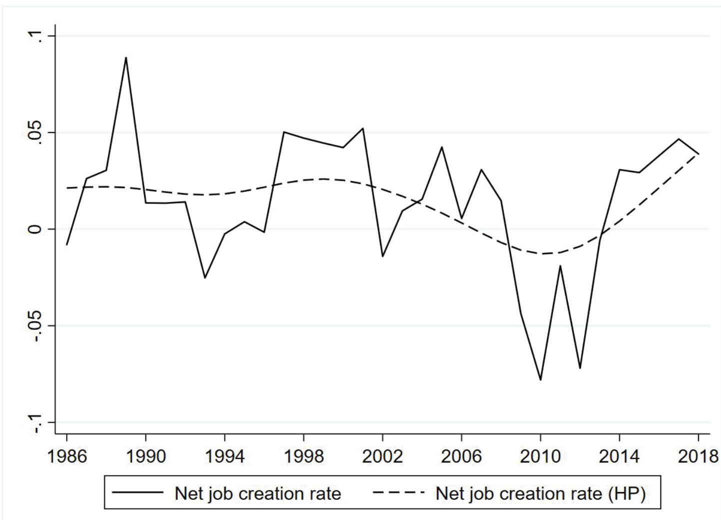
5.2. Sectoral net job creation trends

The net job creation rate is defined as the difference between job creation and job destruction, i.e., jobs generated by firms with positive growth rates minus jobs lost by firms with negative growth. The productive heterogeneity of firms shapes this dynamic, mirrored in differentiated entry, growth, and survival patterns (Aghion and Akcigit, 2019; Dosi and Nelson, 2010). However, this phenomenon is also conditioned by idiosyncratic industry characteristics—i.e., demand, technology, information and risk—and (time-varying) technological opportunities. These opportunities influence the likelihood of innovation and the expected rate of return (Dosi and Nelson, 2010; Perez, 2010).

During the sample window, Portugal experienced two major shocks that likely changed the structural parameters of industrial dynamics: the emergence of the ICT revolution and the accession to the European Union (together with a higher degree of globalisation). The former is likely to have modified technological opportunities and intersectoral profit rates, while the latter is likely to have expanded markets and increased the productivity dispersion within them (now including foreign competitors). The differences in the magnitude and evolution of the distribution of growth rates across sectors, observed in the previous section, stem from these exogenous shocks. This heterogeneity is expected to lead to equally different net job creation patterns and employment composition changes.

Figure 7 shows the evolution of the economy-wide net job creation rate from 1986 to 2018. Our approach, based on firm-level growth rates, is, thus, able to reproduce the growth pattern of the Portuguese economy: a period of persistently high rates in the late 20th century, followed by stagnation and decline in the early 21st century, a prolonged crisis between 2008 and 2013, and a subsequent recovery after that.

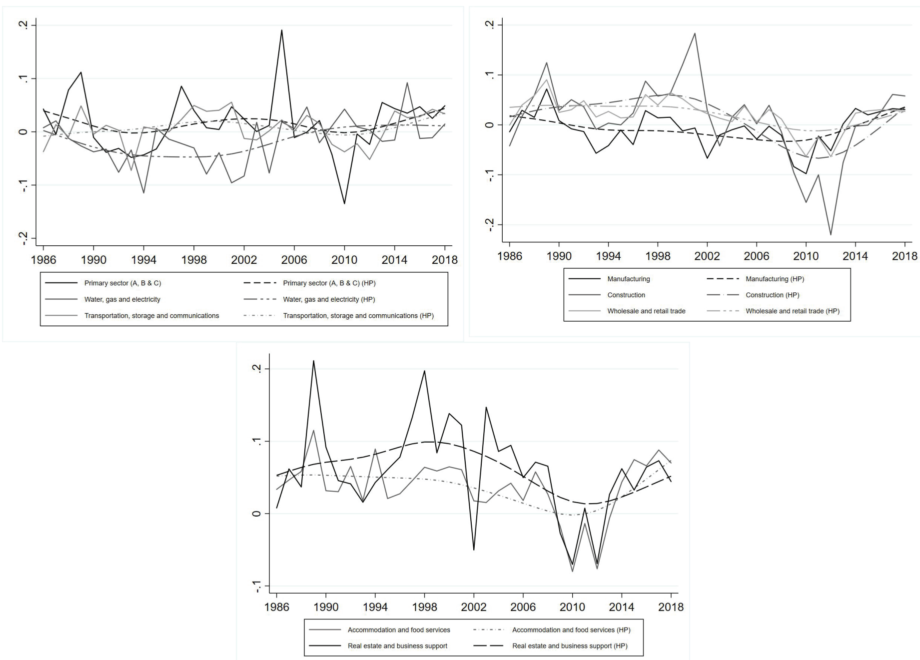
Figure 7: The economy-wide Net Job Creation rate, 1986-2018



Notes: The net job creation rate is computed as the difference between the job creation and job destruction rates. The job creation (destruction) rate is computed as the employment-weighted average of the absolute value of employment-growth rates of all firms with non-negative (negative) growth rates. Trends are computed by applying a Hodrick-Prescott (HP) filter with a smoothing parameter of 100.

Subsequently, Figure 8 presents the net job creation rates in the most representative sectors. In the 'primary' and the 'transport, storage and telecommunications' sectors, the net rates have fluctuated around zero, indicating that their economic share has relatively constant. This is not the case for the 'water, gas and electricity supply' sector, which has shown persistently negative rates until the new century's first decade. The 'construction' and 'wholesale and retail trade' sectors have, in turn, exhibited consistently high and positive rates, except during the 2008-2013 crisis. In sharp contrast, the manufacturing sector has exhibited secularly negative net creation rates since 1990 (with a slight recovery from 2013), suggesting that job destruction has exceeded job creation. Finally, in line with the growth rate analysis, the 'accommodation and food services' and the 'real estate, renting and business support activities' sectors have maintained positive net rates, especially towards the end of the twentieth century, with the latter sector standing out for its upward trend over this period, with rates above 10% at various points in the analysis.

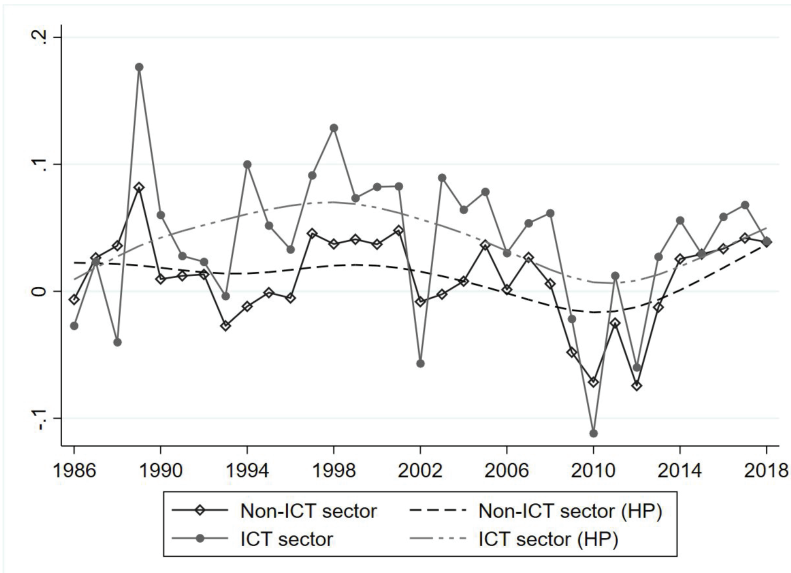
Figure 8: Net Job Creation rates rates by sector, 1986-2018



Notes: The net job creation rate is computed as the difference between the job creation and job destruction rates. The job creation (destruction) rate is computed as the employment-weighted average of the absolute value of employment-growth rates of all firms with non-negative (negative) growth rates, by sector. Trends are computed by applying a Hodrick-Prescott (HP) filter with a smoothing parameter of 100. Industries are defined on a time-consistent CAE Rev.2 basis.

Figure 9 shows the evolution of the net job creation rate, distinguishing between ICT-driven and non-ICT-driven sectors. The estimates confirm that net job creation in the ICT sector has followed a 'long-wave' pattern, with an expansionary phase at the end of the 20th century and a recessionary phase after that (although there has been some recovery in the last decade). In addition, the results show that the net job creation rate has been consistently higher in the ICT sector than in its non-ICT counterpart, especially in the 1980s and 1990s. As a result, Portugal's late 20th-century expansion appears to have been primarily fuelled by the rise of industries shaped by the ICT technological paradigm.

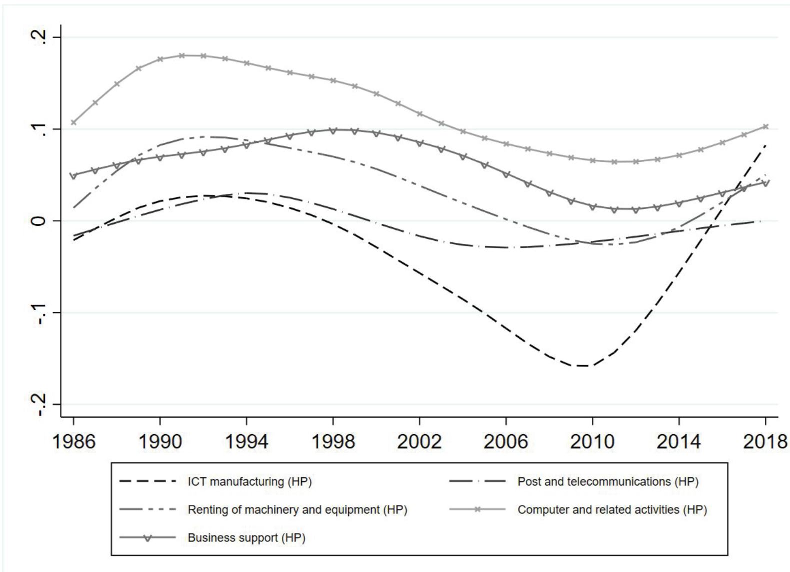
Figure 9: Net Job Creation rates rates across ICT and non-ICT sectors, 1986-2018



Notes: The net job creation rate is computed as the difference between the job creation and job destruction rates. The job creation (destruction) rate is computed as the employment-weighted average of the absolute value of employment-growth rates of all firms with non-negative (negative) growth rates, by sector. Trends are computed by applying a Hodrick-Prescott (HP) filter with a smoothing parameter of 100. Industries are defined on a time-consistent CAE Rev.2 basis. The ICT sector is classified by using the methodology developed by the OECD.

Finally, Figure 10 indicates that the 'long-wave' pattern is evident across all ICT activities. However, sustained positive employment growth is only observed in ICT services, i.e., 'renting of machinery and equipment,' 'computer and related activities,' and 'business support activities.' Instead, the 'post and telecommunications' sector experienced modest net job creation in the late 20th century, followed by net job losses. Critically, our estimates further confirm that, despite a brief upward trend in the late 1980s, the ICT manufacturing sector experienced significant and prolonged net job destruction from 1992 to 2010, after which a steady recovery began. Therefore, these structural trends suggest that the ICT revolution in Portugal, in the context of rising trade openness, has mainly boosted the growth of ICT services. In sharp contrast, ICT manufacturing has been marked by persistent net job destruction, particularly up to the Great Recession.

Figure 10: Net Job Creation rates rates within the ICT sector, 1986-2018



Notes: The net job creation rate is computed as the difference between the job creation and job destruction rates. The job creation (destruction) rate is computed as the employment-weighted average of the absolute value of employment-growth rates of all firms with non-negative (negative) growth rates, by industry. Trends are computed by applying a Hodrick-Prescott (HP) filter with a smoothing parameter of 100. Industries are defined on a time-consistent CAE Rev.2 basis. The ICT sector is classified by using the methodology developed by the OECD.

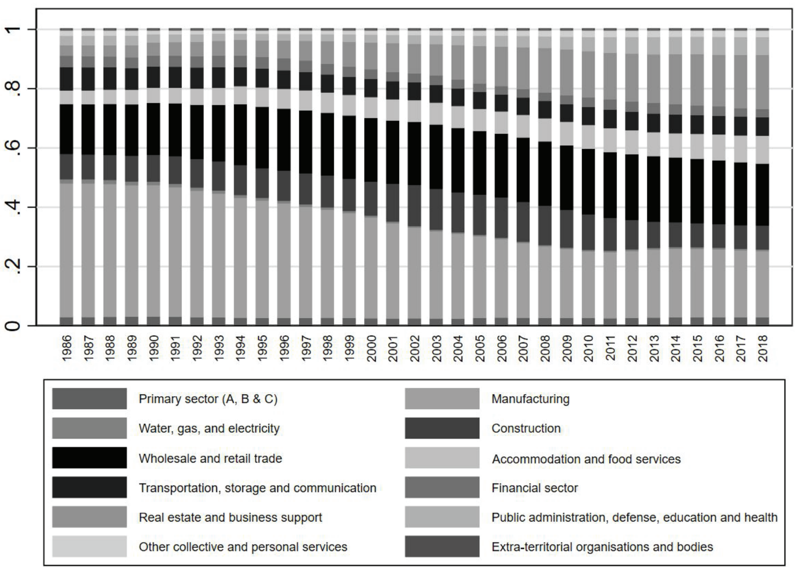
5.3. From manufacturing to consultancy

Due to the differentiated impact of exogenous institutional and technological shocks and the resulting heterogeneity in the evolution of sectoral net job creation rates, some industries are expected to have increased their aggregate share (through above-average net job creation rates), while the opposite is true for those facing relatively lower technological opportunities or higher international competitive pressure (which may reduce the expected return of followers (Aghion et al., 2005)).

Figure 11 accordingly shows the evolution of employment composition in the Portuguese economy. In line with previous trends, we observe a sharp decline in the manufacturing sector, whose share in total employment fell from 45.1% to 22.2% between 1986 and 2018. This decline in manufacturing has gone hand-in-hand with a rise in the 'wholesale and retail trade', 'accommodation and food services', and, most notably, the 'real estate and business support activities' sectors. The latter increased its share of employment from 3.5% to 18.2% over the same period, while the former two sectors expanded from 16.8% to 20.9% and from

4.5% to 9.4%, respectively. These results thus mirror the deindustrialisation pattern and the service sector's corresponding rise that has characterised developed Western economies in recent decades (Rodrik, 2016; Tregenna, 2009).

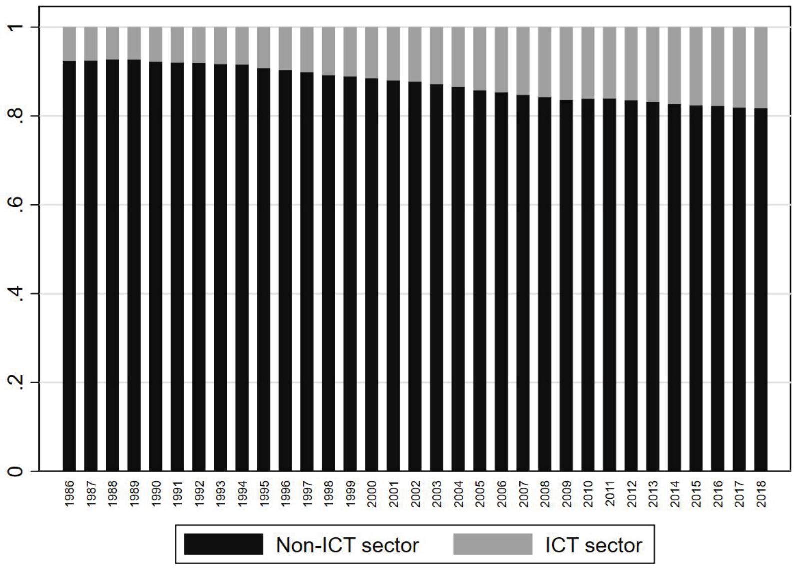
Figure 11: The evolution of the Portuguese employment structure, 1986-2018



Note: Industries are defined on a time-consistent CAE Rev.2 basis.

A technological revolution brings about structural change, typically shifting the composition of employment towards sectors driven by the new dominant paradigm (Freeman & Louçã, 2001; Gordon, 2012; Perez, 2002). As previous trends have shown, net job creation has been consistently higher in the ICT sector. Figure 12 confirms this, showing that the ICT sector's share of total employment increased significantly from 7.5% in 1986 to 18.3% in 2018 – an increase of around 11 percentage points. Our findings thus highlight the ICT paradigm's significant role in reshaping the employment landscape. Nevertheless, the Portuguese economy remains fundamentally dependent on old sectors, which still account for more than 80% of total employment.

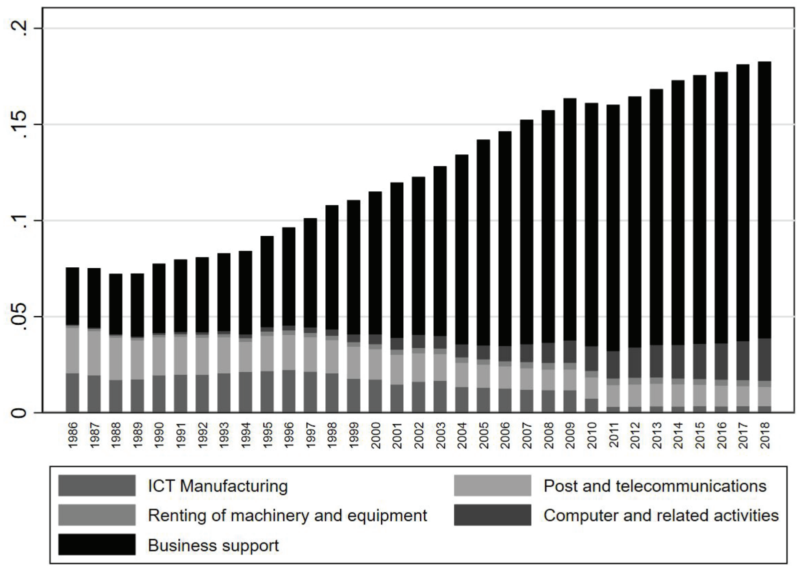
Figure 12: The evolution of employment composition between ICT and non-ICT sectors, 1986-2018



Notes: Industries are defined on a time-consistent CAE Rev.2 basis. The ICT sector is classified by using the methodology developed by the OECD.

Finally, Figure 13 breaks down the evolution of the share of the ICT sector in its component industries. On the one hand, the results confirm that the expansion of the ICT-driven sector in terms of total employment is mainly evident in two service industries: computer and related activities, with an increase from 0.05% to 2.2% between 1986 and 2018 and most of all, business support activities, with an increase from 2.9% to 14.4%. The latter sector seems, therefore, to have absorbed most of the contraction in aggregate manufacturing. On the other hand, the results confirm that ICT manufacturing has instead contracted sharply after a slight growth in the 1990s. Its share of total employment fell from 2.1% to less than 0.4%.

Figure 13: The evolution of the share of ICT industries in total employment, 1986-2018



Notes: Industries are defined on a time-consistent CAE Rev.2 basis. The ICT sector is classified by using the methodology developed by the OECD.

Our findings, therefore, suggest that ICT manufacturing – involving the production of microprocessors, computers, semiconductors, and digital equipment, all central to the ICT revolution – has all but vanished from the Portuguese economy, limiting the country's potential for innovation and technological development. Conversely, while computer services have increased their share in total employment, the broader impact of the ICT technological paradigm has been largely concentrated on expanding business support activities (code 74). According to the CAE Rev. 2 classification, this sector is devoted to assisting businesses with administrative and promotional functions, as shown in Table 3. The growth of this sector is a clear result of the vertical disintegration of enterprises made possible by ICT technologies such as the Internet, computers and digital software. This disintegration has probably led to overall efficiency gains due to increased flexibility, reduced fixed costs, economies of scale and specialisation in management support tasks. Nevertheless, its contribution to technological progress, innovation and long-term economic growth is likely to be limited.

Table 3: CAE Rev. 2 Business support activities (code 74)

74110	Legal activities
74120	Accounting, auditing and tax consultancy activities.
74130	Market research and opinion polling.
74140	Business and management consultancy activities.
74150	Holding company activities.
74201	Architectural activities.
74202	Engineering and related technical activities.
74300	Technical testing and analysis activities.
74401	Advertising agencies.
74402	Advertising media management.
74500	Personnel selection and placement.
74600	Research and security activities.
74700	Industrial cleaning activities.
74810	Photographic activities.
74820	Packaging activities.
74850	Secretarial, translation and addressing activities.
74860	Call centre activities.
74871	Organisation of fairs, exhibitions and other events.
74872	Other Miscellaneous business service activities.

Notes: The table reports the list of activities classified within the business support services industry (code 74) according to the Portuguese Classification of Economic Activities (CAE) Revision 2.

6. Conclusions and Future Research

This research aimed to investigate the impact of the emergence of the ICT technological paradigm on the employment structure of a semiperipheral economy such as Portugal. To this end, we introduced a novel methodology that allows us to transform the *Quadros de Pessoal*, a longitudinal data covering the universe of Portuguese firms in all sectors, into a dataset with a time-consistent industrial classification from 1986 to 2018. Our approach seeks to understand the micro and macro drivers of structural change. Therefore, we focus on intersectoral shifts in the distribution of firm growth rates, net job creation and employment composition. Understanding this phenomenon is crucial in the context of a general decline in the share of manufacturing in advanced economies.

The analysis of growth rate distribution reveals persistent intersectoral heterogeneity in dispersion and skewness. A significant increase in business dynamism was observed in the 1990s, mainly driven by ICT-driven services such as computing and business support. However, since 2000, dispersion and positive skewness have declined across all sectors, indicating reduced reallocation and fewer contributions from high-growth firms. Notably, despite the rise of the ICT technological paradigm, dispersion and skewness in ICT manufacturing sharply declined, showing levels below those seen at the end of the 1980s.

These heterogeneous firm-level growth dynamics – shaped by time-invariant industry characteristics, time-varying technological opportunities, the competitive environment, and within-industry productivity dispersion – subsequently led to equally differentiated net employment growth patterns across sectors. In particular, structural trends show that, in the late 20th century, sectors such as accommodation and food services, wholesale and retail trade, and real estate and business support activities, experienced positive and above-average net job creation rates. In contrast, manufacturing and utilities exhibited predominantly negative rates. Moreover, our findings highlight that net job creation was primarily driven by ICT industries, which followed a long-wave pattern. However, the positive impact on employment was confined to ICT services, while ICT manufacturing experienced secular net job destruction until the first decade of the 21st century.

The ICT revolution has certainly fostered structural changes within industries and enterprises. However, in terms of intersectoral shifts, the evolution of the Portuguese employment composition finally confirms that while ICT services with higher value-added and innovation potential experienced modest growth, ICT manufacturing virtually disappeared. The contraction of manufacturing's employment share (from 45% to 22% in 1986-2018) was instead reflected in an expansion of wholesale and retail trade, accommodation and food services and, primarily, activities supporting administrative business functions, with the latter sector increasing its aggregate share from 2.9% to 14.4% over the same interval.

The rise and fall of business dynamism, coupled with the increased growth activity in ICT-driven sectors, supports the view that capitalism evolves in long waves shaped by successive technological revolutions. The steep decline in manufacturing employment thus appears to be part of this structural process. However, while technological opportunities are expected to shift towards emerging sectors with each revolution, our findings suggest that how a new technological paradigm unfolds is influenced by country-specific productive and institutional characteristics. In Portugal, except for computer services, the decline of traditional manufacturing has not led to an increase in high-value-added ICT goods and services but rather the opposite. Although the rise of consulting services is indeed a result of the vertical disintegration enabled by the new technological paradigm and its automation and networking technologies, it is likely to have limited long-term benefits for growth, technological progress and innovation.

In a context of secular stagnation and potential exhaustion of the ICT paradigm (Gordon, 2012, 2015), it is therefore essential to reorient public policies towards strengthening the aggregate stock of knowledge and the absorptive capacity of firms, equipping them to adapt to new general-purpose-technologies such as artificial intelligence and those aimed at energy transition. Such a setting may benefit new entrepreneurs with lower opportunity costs of technology adoption (Arrow, 1962; Holmes et al., 2012). In an environment of increased international free trade, the decline of manufacturing and the growth of low-value-added sectors further underline the need to rethink industrial policy. Investment incentives, access to technology, lowering barriers to entry and fostering competition appear to be crucial, especially for emerging industries. Finally, strengthening the links between basic science and applied technology is essential to uncover and harness unexplored innovations.

Our findings have theoretical and policy implications that require further research. Key questions include whether technological revolutions narrow or widen technological gaps between countries. How has Portugal's accession to the EU and the resulting increase in productivity dispersion in enlarged markets affected the decline of manufacturing and the limited growth of higher value-added ICT industries? Is there room for protecting infant industries? Did this change in the productive structure affect job quality and income growth? These questions should be a priority for future research.

Data Availability Statement

The final correspondence tables and the codes used for the industry homogenisation process are available upon request from the author.

References

Aghion, P.; Akcigit, U. (2019) Innovation and Growth: The Schumpeterian Perspective. In Matyas, L.; Blundell, R.; Cantillon, E.; Chizzolini, B.; Ivaldi, M.; Leininger, W. ;. Marimon, R. ; Steen, F. (Eds.), *Economics without Borders: Economic Research for European Policy Challenges*, Cambridge University Press, 29-72

Aghion, P.; Bloom, N.; Blundell, R.; Griffith, R.; Howitt, P. (2005) Competition and Innovation: An Inverted-U Relationship. *Quarterly Journal of Economics*, 120(2), 701-728.

Arrow, K. J. (1962) Economic Welfare and the Allocation of Resources for Invention. In National Bureau of Economic Research (Ed.), *The Rate and Direction of Inventive Activity: Economic and Social Factors*, Princeton University Press, 609-626.

Bresnahan, T.; Malerba, F. (1997) *Industrial Dynamics and the Evolution of Firms and Nations: Competitive capabilities in the World Computer Industry*. Centro studi sui processi di internazionalizzazione, Università commerciale'Luigi Bocconi'.

Brynjolfsson, E.; Rock, D.; Syverson, C. (2021) The productivity J-curve: How intangibles complement General Purpose Technologies†. *American Economic Journal: Macroeconomics*, 13(1), 333-372.

Davis, S. J.; Haltiwanger, J.; Schuh, S. (1996) Small business and job creation: Dissecting the myth and reassessing the facts. *Small Business Economics*, 8, 297-315.

Decker, R. A.; Haltiwanger, J.; Jarmin, R. S.; Miranda, J. (2014) The role of entrepreneurship in US job creation and economic dynamism. *Journal of Economic Perspectives*, *28*(3), 3-24.

Decker, R. A.; Haltiwanger, J.; Jarmin, R. S.; Miranda, J. (2016) Where has all the skewness gone? The decline in high-growth (young) firms in the U.S. *European Economic Review*, 86, 4-23.

Dosi, G. (1982) Technological paradigms and technological trajectories. A suggested interpretation of the determinants and directions of technical change. *Research Policy*, 11(3), 147-162.

Dosi, G.; Nelson, R. R. (2010) Technical Change and Industrial Dynamics as Evolutionary Processes. In B. Hall & N. Rosenberg (Eds.), *Handbook of Economics of Innovation*, North-Holland, 52-127

Fort, T. C.; Klimek, S. D. (2018) The Effects of Industry Classification Changes on US Employment Composition. *CES Working Paper Series*, 18(28), 1-23.

Freeman, C.; Louçã, F. (2001) *As Time Goes By: From the Industrial Revolutions to the Information Revolution*. Oxford University Press.

Gordon, R. J. (2012) Is U.S. economic growth over? Faltering innovation confronts the six headwinds. NBER Working Paper Series, WP 18315, 1-23.

Gordon, R. J. (2015) Secular stagnation: A supply-side view. *American Economic Review*, 105(5), 54-59.

Haltiwanger, J.; Jarmin, R.; Miranda, J. (2009) Business Dynamics Statistics: An Overview. *SSRN Electronic Journal*, *January* (1), 1-8.

Haltiwanger, J.; Jarmin, R. S.; Miranda, J. (2013) Who creates jobs? Small versus large versus young. *Review of Economics and Statistics*, **95(**2), 347-361.

Holmes, T. J.; Levine, D. K.; Schmitz, J. A. (2012) Monopoly and the incentive to innovate when adoption involves switchover disruptions. *American Economic Journal: Microeconomics*, 4(3), 1-33.

Kondratiev, N. (1935) The Long waves in economic life. *Review of Economics and Statistics*, 17(6), 105-115.

Louçã, F.; Mendonça, S. (2002) Steady change: The 200 largest US manufacturing firms throughout the 20th century. *Industrial and Corporate Change*, 11(4), 817-845.

Mandel, E. (1980) *Long Waves of Capitalist Development: A Marxist Interpretation*. Cambridge University Press.

OECD. (2024) OECD Digital Economy Outlook 2024. In *OECD Digital Economy Outlook 2024* (Vol. 1).

Perez, C. (2002) *Technological Revolutions and Financial Capital.* Edward Elgar Publishing Limited.

Perez, C. (2010) Technological revolutions and techno-economic paradigms. *Cambridge Journal of Economics*, 34(1), 185-202.

Rodrik, D. (2016) Premature deindustrialization. *Journal of Economic Growth*, 21(1), 1-33.

Schumpeter, J. A. (1939) *Business Cycles: A Theoretical, Historical and Statistical Analysis of the Capitalist Process.* McGraw-Hill.

Shaikh, A. (1992) The Falling Rate of Profit as the Cause of Long Waves: Theory and Empirical Evidence. In A. Kleinknecht, E. Mandel, & I. Wallerstein (Eds.), *New Findings in Long-Wave Research,*The MacMillan Press LTD, 174-194

Tregenna, F. (2009) Characterising deindustrialisation: An analysis of changes in manufacturing employment and output internationally. *Cambridge Journal of Economics*, 33(3), 433-466.