
**Deconstructing castles in the sky: Comparing the technology intensity
taxonomy against Portuguese industries**

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Acknowledgments

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To my supervisor Joana Costa, for the insights and trust in accomplish something truly great.

And to my wife, who has listened to every single complaint and hypothesis.

Honour Pledge

I declare that the present research proposal for my master dissertation is of my own authorship and has not been previously used in another course or curricular unit of this or any other institution. References to other authors (statements, ideas, thoughts) scrupulously respect the rules of attribution and are duly indicated in the text and the bibliographical references, in accordance with the referencing rules. I am aware that the practice of plagiarism and self-plagiarism constitute an academic offence.

Abstract

Innovation and technology intensity are concepts that are very familiar to the industry, they are used to measure and classify industries for some time. As the need to this comparison has become more prominent OECD has introduced a method to classify industrial sectors and manufacturers by level of technology. This classification has been largely used by scholars and police makers to classify industries around the globe, and has become the base for several policies worldwide. However, the concerns remain about the limitations of this classification as many says that it still is an imperfect indicator for it. This dissertation research and compare if the outlines from OECD classification do reflects the Portuguese industries, and in the process deconstructing the taxonomy to answer the questions proposed. Aiming to understand how the classification come to use and the limitations in order to find, as pointed by other authors, better proxies to classify the technology intensity of an industry, as R&D might not be the best indicative despite the weight it carries for the future of the industry and public polices being heavy. In the end, this dissertation propose a new framework for future taxonomy classification, hoping it can substitute the current method and provide a expanded view based in the technology intensity of the outcome product, beliving that understand the creation and the limitations of the classification in use today is the first step for its improvement.

Keywords: Technology Intensity, Innovation, R&D, Low-Tech, Portugal, OECD

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1. Introduction

“If you have built castles in the air, your work need not be lost; there is where they should be. Now put foundations under them.” – Thoreau, D. H.

Innovation is a concept that is not unfamiliar to the most of us. We live in an era of innovation and information. Never in the human history so much was created. From the industrial revolution in 1760's, followed by cars in 1880's and then the airplanes in the early 1900's. The last three hundred years have been exciting. Innovation has been the centre of discussions regarding the fourth industrial revolution (Procter, Glover, & Jones, 2020, p. 5), and other new concepts that are surrounding the term as Industry 5.0 and Society 5.0 and, the effects that the recent COVID-19 pandemic has caused.

Innovation can be used for an activity or the outcome of an activity. The Oslo manual provides a definition for both, however the general definition for the term according to the OECD:

Is a new or improved product or process (or combination theory) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)” (OECD/Eurostat, 2018, p. 20).

The Oslo manual has as key tenet that innovation can and, therefore, should be measured, and states that the key component for the concept of innovation is the role played by the knowledge as a base for novelty, utility and creation of value. Again, knowledge is a concept well known, however, the definitions might change under different scenarios. The notion of knowledge as discussed in the Oslo manual and it well defines what is information, knowledge and the difficulty to move those as noted:

Information consists of organised data and can be reproduced and transferred across organisations at low cost. Knowledge refers to an understanding of information and

the ability to use information for different purposes. Knowledge is obtained through cognitive effort and consequently new knowledge is difficult to transfer because it requires learning on the part of the recipient. Both information and knowledge can be sourced or created within or outside a relevant organisation. (OECD/Eurostat, 2018, p. 46).

Knowledge and innovation has always been a sinonim of high-technology, in order to have a tool that could provide a simple and consistent way to compare internationally the field, the OECD Secretariat's had developed, based on a previous classification produced in the United States a list, aggregating industry to the high technology field. This classification created by the OECD was based on the R&D expenditure in relation to output. Leading to a list of industries that were organised in high, medium and low technology (Hatzichronoglou, 1997).

Innovation and technology intensity, those are the two main concepts that will be discussed in this dissertation. The relation between the classification given to an industry, particularly to the *low-tech* industry, and how innovative they can be. As the wide-spread opinion in the public-political and scholars view is, that *high-tech industries* are the key to growth and future employment, and are considered a major driver in advanced countries. However, not only high-tech industries are found in a country's economic ecosystem. As Hirsch-Kreinsen noted:

The prevalent opinion is that high-tech industries are the key to the future growth and employment and that research and innovation policy actors are thus well-advised to promote such industries. (...) But at the same time it should not be forgotten that this outlook is accompanied by an inadmissible narrowing of the perspective with the result that the industrial and technological development potentials of industries not based on high-tech are overlooked and possibly misjudged. (Hirsch-Kreinsen, 2008b, p. 12)

OECD has introduced a method to classify industrial sectors and manufacturers by level of technology and since, this classification has been largely used by scholars and policy makers to classify industries and has become the base for several policies worldwide. However, the concerns remain about the limitations of this classification. Still is an imperfect indicator for other concepts, like wider forms of knowledge-based capital. Implying the need of an idea to better classify the industry level of technology, and how to link those indicators to others across the industry. This lack of proxies to define this classification in a better way, is mentioned by others as Zawislak et al. (2018) and Rotaba et al. (2012).

In this dissertation, the research will aim Portuguese data, in order to compare if the outlines from the OECD classification do reflect the reality of the Portuguese industries. Moreover, during the process, we will try to find an alternative for the current classification. It is organized in four chapters, starting with an introduction about the concepts that will be discussed and presenting the motivation and scope of work, followed by some background context. The second chapter will present the literature review, how the literature gap was identified and the process of selecting the papers, that provided base for this research is described. On the third chapter the methodology, research question and research design are explored and introduced based on the literature review. The fourth chapter will discuss the findings, answers to the research questions and propose a new model. Finally, the conclusions are presented in the fifth chapter.

1.1. Scope of Work

Understand the creation and the limitations of the classification in use today is the first step for improvement. Multiple authors point out the lack of strong indicators linking the industry level of technology with innovativeness, also which other indicators could

be used to help determine if an industry is innovative and, if the corresponding level of technology intensity of the industry is correlated.

In order to understand how the data is handled and linked, research was conducted based on the data public available in statistical sources such as the OECD, Eurostat and several Portuguese governmental databases. In this research Portugal was selected as a case study for the ease of data collection and how complete the information provided was, and as one of the funding countries of OECD, added some weight to the decision. The research was approached empirically, however, methodology and research design will be discussed further. Furthermore, this dissertation will try to understand if the classification reflects against data collected by CIS (Community Innovation Survey), and if can determine that industry in the lower classification of technology intensity is in fact less innovative and that Portugal is mostly a low-technology country.

This research will investigate several aspects of the industry, expenditure in R&D, classification of industry in the country, number of high skilled employees, to name a few, in search for overlapping data that can link proxies between the current classification and innovation. As the definition presented so far in the literature seems to leave some space for interpretation.

1.2. Background

The Organisation for Economic Co-Operation and Development or OECD is an intergovernmental economic organisation, that as today has 38 members countries, and is dedicated to stimulating economic progress and world trade. Its goal is to shape policies, working on evidence-based international standards in order to improve the economic performance (OECD, 2022). A large amount of data, specifically regarding statistical, are also sourced from Eurostat, whom is the statistical office of the

European Union (EU). Eurostat is responsible to provide statistical information and promote the harmonisation of the methods.

In order to compare and list countries, the OECD had an early work relating high technology and trade, based in the classification created in the United States at the time, with a major limitation that was extrapolating the America industry structure to the whole group. In 1984 a new classification based on direct R&D intensity was develop and placed industries in three technology levels (high, medium and low). In 1994 a revision was made to reflect the lessons learned and the developments in technology. This revision proposed the division of medium level into medium-high and medium-low, presenting a classification now divided into four levels (high, medium-high, medium-low and low), and the product approach in order to supplement the sectorial approach (Hatzichronoglou, 1997). In 2016 a new taxonomy was proposed this time including non-manufacturing industries, as services are now included in the fourth revision of the International Standard Industrial Classification (ISIC), and a new division into five groups (high, medium-high, medium, medium-low and low) of R&D intensity. As defined in the revision:

R&D intensity is usually defined as the ratio of R&D expenditure to an output measure, usually gross value added (GVA) or gross output (GO). This indicator is commonly used at the level of an economy to measure its relative R&D effort (GERD over GDP) or its business sector (BERD over GDP or a more closely aligned measure of GVA for the business sector). In this study, R&D intensity serves as the criterion for ranking and classifying economic activities. (Galindo-Rueda & Verger, 2016, p. 6)

As the reliability to compare statistics and indicators are of high importance, the OECD had in 1963 the first version of the Proposed Standard Practice for Surveys and Development, also known as the Frascati Manual. This document is a cornerstone

regarding understanding and analysing system of research and innovation while provides internationally accepted definitions of R&D and classifications of its components. The Frascati Manual is part of a series of methodological manuals, which includes guidance for measurement of innovation provided by the Oslo Manual (OECD, 2015).

Innovation is key to improvements, from products to living standards. It can have an effect in multiple fronts, from the individual to an entire economic sector, and therefore to a country. Consequently, having a trustful source of data and proper ways to measure and analyse this information is very important. Thus, having a crucial impact on how policy makers understand these changes, either social or economic, and assessing the contribution of innovation. As a goal, innovation fundamentally stands for novelty and utility, and the creation or preservation of value. These are very well aligned with the definitions outlined by Schumpeter and his forms of innovation covered by the following five cases:

First, the introduction of a new good – that is one with which consumers are not yet familiar, or of a new quality of good; second, the introduction of a new method of production, that is not yet tested by experience in the branch of manufacture concerned, which need by no means be founded upon a discovery scientifically new, and can also exist in a new way of handling a commodity commercially; third, the opening of a new market, that is a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before; forth, the conquest of a new source of supply of raw materials or half-manufactured goods, again irrespective of whether this source already exists or whether it has first to be created; fifth, the carrying out of the new organisation of any industry, like the creation of a monopoly position or the breaking up of a monopoly position. (Schumpeter, 1949)

Taking the view Schumpeter provides, and comparing these forms of innovation, it is noticeable that they compose the economic process from the supply of raw materials or half-manufactured goods, to introduce a novelty and bring to market. Under his understanding, being able to fulfil the whole process or just part of it would be considered an innovation.

The Oslo Manual 2018 has a much broader definition for innovation that is further reduced to product innovations and business process innovations. Accordingly, a product innovation is defined as a new or improved good or service that differs significantly from the firm's previous goods or services and has been introduced on the market, while a business process innovation is a new or improved business process for one or more business functions that differs significantly from the firm's previous business processes and that has been brought into use by the firm (OECD/Eurostat, 2018). Therefore, under the view of the Oslo Manual innovation must be put into use or brought to market.

The community Innovation Survey (CIS) is a survey conducted across the EU, EFTA and the EU Candidate countries and has become a regular biennial data collection. This survey is designed to collect information on the innovativeness of business, and collect data regarding product innovations, business process innovations, innovation development, innovation activities, innovation expenditure, turnover from innovative products, incentives for implementation of innovation, innovation cooperation, source of financing of innovation, sources of information on innovation, barriers of innovation and others (Eurostat, 2022).

In the global panorama, technology advancement is linked to enhancing growth and competitiveness in business, thus impossible to put apart the connection between technology advancements and innovation, consequently relating to R&D.

2. Literature review

2.1. Introduction

In any project, gathering the relevant sources is key to success, in an academic project it starts with founding the relevant literature to firmly create the foundation of a discussion. In the next section we will present the details on how the research was conducted in order to uncover the gap that will be discussed on this dissertation.

2.2. Search criteria

The preparation for the literature review started with defining the main keywords to search among the published papers for the ones that will point to an literature gap. Early on the process a concern arose, as the terms *innovation* and *low-tech*, and variations of those, were vastly used across multiple fields of study and research. These terms were found in papers not related to technology *per se* and usually referred to a subject not within the scope of our research, this rendered large numbers in the first search findings.

In order to be as comprehensive as possible, we choose to search for the keywords across the three main search fields (title, abstract and key words). Two main databases were used for searching the published papers, Scopus and Web of Science (WoS), both with access through the Faculty of Engineering of Porto University (FEUP). As an external source, Google Scholar and other websites also were used during the research, most of the documentation and articles referred to OECD were published by the organization and made available on their web site repository to the public.

The first step was to have a general idea on the reach and the application of the terms selected. Starting with a general search, applying the terms selected to all the main search fields (title, author, abstract, etc.) to have an idea of how largely used those terms are across the publications in these databases. Those steps were not performed

using Google Scholar, as the number of results would be not viable to proper assess. The search terms used on WoS are displayed in the Table 1. As show, the search on WoS started using the core database called *Web of Science Core Collection*, which has allowed to export all the findings to a BibTex file, a format that the software R and the *Bibliometrix* could understand. However, the tools for merging multiple databases were causing errors and for that reason this initial part of the research was changed to a manual process¹.

To keep an open mind regarding the results, two other searches were conducted, one using all the databases available in WoS and, a second searching applying only the terms as ‘Author Keywords’. Those were not used, as the results were recurrent, despite the type of search.

Table 1. Search on Web of Science

Search Combination – Web of Science	Results	Date
ALL=(low tech* innovation)	225,408	23.11.2021
(ALL=(low tech* innovation)) AND (TASCA==("MANAGEMENT" OR "BUSINESS" OR "AREA STUDIES" OR "BUSINESS FINANCE" OR "ECONOMICS" OR "EDUCATION SCIENTIFIC DISCIPLINES" OR "ENGINEERING INDUSTRIAL" OR "ENGINEERING MANUFACTURING" OR "MULTIDISCIPLINARY SCIENCES" OR "OPERATIONS RESEARCH MANAGEMENT SCIENCE" OR "PUBLIC ADMINISTRATION" OR "SOCIAL SCIENCES INTERDISCIPLINARY" OR "STATISTICS PROBABILITY"))	19,539	23.11.2021
(ALL=("low tech*" OR "low-tech*" OR "Low Tech*"OR "Low-Tech*"OR "Low tech*"OR "Low-tech*"OR "low-Tech*"OR "low Tech*"))	4,036	25.11.2021
(ALL=("low tech*" OR "low-tech*" OR "Low Tech*"OR "Low-Tech*"OR "Low tech*"OR "Low-tech*"OR "low-Tech*"OR "low Tech*")) AND (LA==("ENGLISH") AND OAJ==("ALL OPEN ACCESS") AND TASCA==("ECONOMICS" OR "MANAGEMENT" OR "BUSINESS" OR "ENGINEERING MULTIDISCIPLINARY" OR "ENGINEERING INDUSTRIAL" OR "PUBLIC ADMINISTRATION" OR "COMPUTER SCIENCE INTERDISCIPLINARY APPLICATIONS" OR "AUTOMATION CONTROL SYSTEMS" OR "INDUSTRIAL RELATIONS LABOR"))	232	25.11.202112
TI=(low-tech*) AND AB=(low-tech*) AND AK=(low-tech*)	76	02.12.2021

¹ Originally the findings would be merged and analysed using R, which is both a programming language and a software designed for statistical computing (Ihaka & Gentleman, 1996). Together with the Bibliometrix package, that is an application for quantitative analysis and statistics of publications for comparing citations counts (Bibliometrix, 2022).

Search Combination – Web of Science	Results	Date
AK=(low-tech*)	216	31.01.2022

Note: The search query presented in the table was extracted after each search. Due the fact that the searches could not be saved for future reference, this was the closes way to keep a track of each.

The same process was then used to search across Scopus, having similar results. The documents found on each database did not repeat themselves as much as we were expecting. Using Scopus, multiple other searches were conducted using different terms, as we came across during the first searches, in order to get the best results possible. Those terms, as shown on the Table 2, were used to conduct multiple searches using only *Keywords* as search criteria. Most of those results were discarded, as a quick screening of the documents showed that either they were already in previous searches, or not relevant at all. Those terms and results can be seen at the end of the table below to provide repeatability.

Table 2. Search on Scopus

Search Combination - Scopus	Results	Date
ALL (low AND tech* AND innovation)	483,386	23.11.2021
TITLE-ABS-KEY (low AND tech* AND innovation)	18,082	23.11.2021
KEY (low PRE/0 tech*)	343	25.11.2021

Search Combination - Scopus	Results	Date
KEY (low PRE/0 tech*) AND (LIMIT-TO (EXACTKEYWORD, "Low-tech") OR LIMIT-TO (EXACTKEYWORD, "Innovation") OR LIMIT-TO (EXACTKEYWORD, "Low Technology") OR LIMIT-TO (EXACTKEYWORD, "Low Tech") OR LIMIT-TO (EXACTKEYWORD, "Low-technology") OR LIMIT-TO (EXACTKEYWORD, "Low-tech Industries") OR LIMIT-TO (EXACTKEYWORD, "High-tech") OR LIMIT-TO (EXACTKEYWORD, "Low-tech Industry") OR LIMIT-TO (EXACTKEYWORD, "High Technology") OR LIMIT-TO (EXACTKEYWORD, "High Tech") OR LIMIT-TO (EXACTKEYWORD, "Low-tech Firms") OR LIMIT-TO (EXACTKEYWORD, "Low-technology Products") OR LIMIT-TO (EXACTKEYWORD, "High Technology Industry") OR LIMIT-TO (EXACTKEYWORD, "Innovation System") OR LIMIT-TO (EXACTKEYWORD, "Innovation Systems") OR LIMIT-TO (EXACTKEYWORD, "Low-technology Industries") OR LIMIT-TO (EXACTKEYWORD, "Technological Innovation") OR LIMIT-TO (EXACTKEYWORD, "Technology Industry") OR LIMIT-TO (EXACTKEYWORD, "High-tech Firms") OR LIMIT-TO (EXACTKEYWORD, "High-tech Industries") OR LIMIT-TO (EXACTKEYWORD, "High-technology Industries") OR LIMIT-TO (EXACTKEYWORD, "Low Tech Industries") OR LIMIT-TO (EXACTKEYWORD, "Low Technology Industry") OR LIMIT-TO (EXACTKEYWORD, "Low-tech Manufacturing")) AND (LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "ENGI") OR LIMIT-TO (SUBJAREA, "ECON") OR LIMIT-TO (SUBJAREA, "COMP") OR LIMIT-TO (SUBJAREA, "DECI") OR LIMIT-TO (SUBJAREA, "MULT")) AND (LIMIT-TO (LANGUAGE, "English"))	131	25.11.2021
TITLE-ABS-KEY(lowPRE/0tech*)AND (LIMIT-TO (OA,all")) AND (LIMIT-TO (LANGUAGE,"English"))	1,389	02.12.2021
TITLE-ABS-KEY (low PRE/0 tech*) AND (LIMIT-TO (OA, "all")) AND (EXCLUDE (SUBJAREA, "MEDI") OR EXCLUDE (SUBJAREA, "ENER") OR EXCLUDE (SUBJAREA, "EART") OR EXCLUDE (SUBJAREA, "MATH") OR EXCLUDE (SUBJAREA, "PHYS") OR EXCLUDE (SUBJAREA, "CENG") OR EXCLUDE (SUBJAREA, "CHEM") OR EXCLUDE (SUBJAREA, "IMMU") OR EXCLUDE (SUBJAREA, "PSYC") OR EXCLUDE (SUBJAREA, "NEUR") OR EXCLUDE (SUBJAREA, "HEAL") OR EXCLUDE (SUBJAREA, "VETE") OR EXCLUDE (SUBJAREA, "NURS") OR EXCLUDE (SUBJAREA, "DENT") OR EXCLUDE (SUBJAREA, "PHAR") OR EXCLUDE (SUBJAREA, "BIOC") OR EXCLUDE (SUBJAREA, "ARTS") OR EXCLUDE (SUBJAREA, "AGRI") OR EXCLUDE (SUBJAREA, "ENVT") OR EXCLUDE (SUBJAREA, "MATE") OR EXCLUDE (SUBJAREA, "COMP"))	384	04.12.2021
KEY (classification AND ("industrial sectors" OR "tech* intensity"))	42	16.01.2022
KEY ("technological intensity")	85	16.01.2022

Search Combination - Scopus	Results	Date
KEY ("technology index")	64	16.01.2022
KEY (industry AND classification AND oecd)	3	16.01.2022
KEY ("low tech" OR "low-tech")	228	16.01.2022

Note: The search query presented in this table was copied from the saved searches on Scopus. They were made in order to reduce the number of un-wanted or un-related papers.

2.3. Eligibility process

From the searches across WoS and Scopus database and using the search criteria provided in the tables above 460 papers were identified, a relatively small number taking into consideration how freely the terms ‘innovation’ and ‘low-tech’ are used. The filters and limitations applied to the search had the goal of exclude obvious sub-areas that were not on the best interest of this research. Both databases were exported to a spreadsheet from a comma-separated-value (CSV) file, then merged on a single spreadsheet in order to apply further filtering. With the aid of Microsoft Excel software, using the embedded function *Remove duplicates*, seven repeated values were found and removed from the documents pool.

The screening process started with removing any papers that were obviously not relevant for the research based on the title of the paper, due to the large number of papers this first screening was used to reduce the total number of papers that were used for this work. This screening reduced the pool to a total of 95 papers, based on the title of the paper and when not clear, the journal name were used to provide an indication if the paper is related to the research. On those, a second screening was done, this time assessing the abstract of the aforementioned documents. The second process was carried with the criteria to classify the papers on how helpful they are to the research, grouping the papers from 0 to 3 (from no relevance to the research, to papers that were used in the literature review and provide a base for the research), if none of those criteria was met the document was discarded accordingly with the first

screening. The value that was given to each document and the description of the values are presented on Table 3 below.

Table 3. Sort criteria value

Value	Motive	Papers
0	Papers that have no relevance to the research after the second screening.	4
1	Paper that can provide base to arguments but not direct related to the research.	43
2	Papers that have no relevance to the research but can be used as secondary research source if needed.	39
3	Papers that will be used on the literature review and provide base for the research.	9

Note: the motives presented were select by the author based in empirical reference.

Even though most of those documents might be not directly mentioned or used in the future document, they remained at hand to provide support, different points of view and possible references. As mentioned earlier, this is a very broad and complex topic, requiring a large base of knowledge to link all the concepts and references discussed. After screening the documents, a pool of 9 articles were then select for the literature review and critical discussion. To ensure transparency and trustworthiness for the literature review findings, we applied the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA). This method was developed to facilitate transparency and completeness for reports of systematic reviews as stated by Page (2021).

Below on the Table 4, the numbers of documents throughout the PRISMA diagram steps. This diagram shows how the eligibility process was conducted until the phase of reviewing the articles, and the detailed flow diagram showing the decision process can be found in Appendix A.

Table 4. PRISMA Flow number of papers

Step	Number of documents
Records identified through database searching	460

Step	Number of documents
Additional records identified through other sources	3
Total records before remove duplicates	463
Duplicates removed	7
Records screened	456
Records excluded	361
Abstracts assessed for eligibility	95
Full text assessed for eligibility	11
Records selected for literature review	9

Note: the number of documents reflect the output of each decision, as described in the column 'Step'.

2.4. Synthesis

In order to better understand the papers selected, and to ease the analysis of said papers the Table 5 was made to indicate the reference for the paper, which concepts covered on it and future research identified by the author.

Table 5. Synthesis for the literature review

Reference	Concepts Covered	Future research / Limitations
Hirsch-Kreinsen, 2008a	This paper is cited multiple time throughout the literature, answer the question of how innovation is perceived and pursued in the usual socio-scientific "low-tech" sector.	The unidimensionality of the indicator of R&D intensity and the concept of sectorial boundaries must be conceived more broadly and systematic.
Hirsch-Kreinsen, 2008b	It discusses the perspectives and innovative capabilities of low-tech companies and how public policies can influence them.	Point to the development of the potential of low-tech industries in high-tech-oriented countries of the EU and the need to look to the industrial innovation chain as a whole.

Reference	Concepts Covered	Future research / Limitations
Ortiz-Villajos, 2017	Discuss alternatives to analyse innovation on British firms active in the nineteenth and twentieth century, also discuss the concept of Schumpeterian form of innovation.	Standard innovation indicators cannot provide a comprehensive view of innovation activity, and the lack of a database for the service sector.
Kearney, McCarthy, & Huizingh, 2019	Discuss similarities and differences between high and low-tech firms regarding their Product Innovation Management and how this philosophy of "one-size fit all" does not apply.	The study was focused on Dutch companies so was limited geographically, and as mentioned unique factors of low-tech sector might have been overlooked.
Rotaba & Beaudry, 2012	This paper discusses the main differences between high-tech and low-tech industry segments using the NSI (National System Innovation) in countries divided in two groups: leading and catching up economies.	It shows that firms in leading economies are more focused in HT while catching up are stronger on LMT and differentiate them as innovators and imitators. Indicates that the current model to compare is outdated. The limitation pointed are regarding the chronological data.
Hirsch-Kreinsen & Schwinge, 2014	The chapter introduces the discussion over Knowledge Intensive Entrepreneurship in the context of low-tech industries covering from characteristics to policy preconditions, as well the reliance and opportunities for innovation.	The authors that related to KIE, the LMT (low and medium technology) have received limited support regarding public policies, awareness and other needs. Overall, an overlooked sector.
Zawislak, Fracasso, & Tello-Gamarra, 2018	This paper relates the concepts of technological intensity and innovation capability to answer if firms can be innovative regardless of their technological intensity.	The paper is a case study focused on 4 Brazilian companies, therefore for future research was ideally to use a larger dataset and combine with a quantitative approach.

Reference	Concepts Covered	Future research / Limitations
Hatzichronoglou, 1997	Describes the methods used to classify OECD countries industrial sectors and manufacturers.	The limitations are described on the paper, as it recognizes that is not the ideal to base solely on R&D, therefore more better methods must be defined.
Galindo-Rueda & Verger, 2016	Provides a new taxonomy of economic activities according with their average level of R&D intensity. The articles update the definition of industry technology levels and allow to compare the relevance of the topic against Portuguese companies.	The report is purely based in R&D intensity of industries, moreover, they are still consistent with previous classifications. Among other possibilities for future research, it pointed out the weak link between the R&D expenditure and innovativeness.

2.5. Critical discussion

The first main challenge was to identify whatever the literature pointed to a lack of research in a specific area, starting with the proposed question: is there innovation on the low-tech sector? This question brings challenges by itself, as to answer it one must first understand the two key concepts of *innovation* and *low-tech sector*. What are they, how they are defined and most important, how those concepts are measured?

2.5.1. Understanding innovation

To understand innovation, one must understand a few key concepts, as defined in the Oslo Manual:

Innovation is more than a new idea or an invention it requires implementation, either by being put into active use or by being made available for use by other parties, firms, individuals or organisations. The economic and social impacts of inventions and ideas depend on the diffusion and uptake of related innovations.

Furthermore, innovation is a dynamic and pervasive activity that occurs in all sectors of an economy; it is not the sole prerogative of the Business enterprise sector. Other types of organisations, as well as individuals, frequently make changes to products or processes and produce, collect, and distribute new knowledge of relevance to innovation. (OECD/Eurostat, 2018, p.44)

Essentially, the foundation for measure innovativeness comes from the management and economics disciplines. While management try to understand how it can change the firm's position in the market and generate new ideas, economics investigates the *why*.

Measurement of innovation is guided by four dimensions: knowledge, novelty, implementation and value creation.

Knowledge is non-rival as the use by one organization does not reduce the amount available to others. It is acquired through cognitive effort, referring to the understanding of information and the ability to use it, for the same reason, it is difficult to transfer. One of the many ways to acquire knowledge is through experimental development or R&D, where the definition and measurement is described in detail in the Frascati Manual (OECD, 2015).

Novelty can be much more subjective, although the boundaries of what can and cannot be measured has shrunk. It relates to potential uses of new ideas, can be determined by comparing with either, previous experiences or alternatives. This leads to the actual implementation of the idea, model, method or prototype. Although the innovation might not be new to the market but might be new to the context.

Innovation implies some form of value creation or preservation (OECD/Eurostat, 2018), therefore the value-related measurements are important to understand the impact.

2.5.2. Understanding the low-tech sector

The clustering of industrial sector into technology intensity groups allowed the construction and harmonization of an international classification (Hatzichronoglou, 1997). From that, industrial sector was classified from high to low technology, referring to the expenditure in R&D (Hirsch-Kreinsen, 2008a).

Hatzichronoglou (1997) claims that, “firms which are technology-intensive innovate more, win new markets, use available resources more productively and generally offer higher remuneration to the people that they employ”(p.4). One can only assume that the opposite is true, and firms that are not technology-intensive are not innovative, are less prone to win markets, uses resources inefficiently and overall a lower remuneration.

2.6. Utilising proposed future research

Every article analysed above suggests, or at least implies for future research based on its contents.

Some of the proposed future research utilised in this dissertation are as follows:

- Hirsch-Kreinsen (2008b) states that is necessary to focus on industrial innovation as a whole and find the potentials of low-tech industries.
- Hirsch-Kreinsen (2008a) implies that the measurement and the unidimensionality of the R&D as indicator made the LMT being overlooked, and the boundaries of the sector have to be conceived more broadly.
- Rotaba and Beaudry (2012) calls for a renewed industrial policy that take into consideration the changes in the global markets.
- Zawislak, Fracasso, and Tello-Gamarra (2018) suggests a survey covering a larger sample of companies and, in addition, a sectorial nalysis to seek other

features that can justify innovation capabilities other than technological intensity.

2.7. The “Low-Tech” innovativeness

Overall, the discussion regarding innovation and low-tech sectors usually ends pointing to more research to be done and the lack of a complete database to compare and generalize any findings. The proxies for innovation and technology level are not there, and a connection is virtually impossible to be made when coming from a large group comparison.

Companies that are innovative are usually linked to high-technology level of industry or to more knowledge intensive industries. However, innovation can occur in multiple ways, from a new product to a new method. The latter is usually linked to low-technology industries as most of the times those innovations are not derived from the usual R&D, e.g., by trial and error, which cannot be confirmed over the usual indicators as they are based solely on R&D expenditures.

It becomes virtually impossible to discuss innovation without getting into the industry level of technology intensity. It is evident that a gap in the literature exists, across all the discussion and documents, the question of how to relate R&D with innovation is repeated, and not fully answered. Moreover, the challenge is identifying a proxy between the technological intensity level of industry and innovativeness of the industry.

3. Methodology

3.1. Introduction

A method is essential to the logical structure of any activity. It ensures the repeatability and facilitates the analysis. In the following section the research questions and design will be presented. In this research, multiple partial methods will be applied, as quoted:

(...) the identification and elimination of contradictions, hypotheses formation, etc. are often called the methods of scientific research (without proper explanations – at least, we have not found such explanations in literature). Meanwhile, such methods as analysis and synthesis, comparison, abstracting and concretizing (actually, the main mental operations) are frequently referred to as the methods of theoretical research.

A similar division takes place for empirical methods of scientific research. There exist partial methods (the analysis of publications, documents and results of activity; an observation; an inquiry (oral and written ones); the method of expert evaluation; testing) and complex or general methods involving a single or several partial methods (an investigation; monitoring; experience study and generalization; a trial; an experiment) (Novikov & Novikov, 2013).

Regarding this research, the empirical operation of analyse the publications of documents and results of activities, followed by theoretical methods of analysis, comparison, generalization and deduction were used.

3.2. Research questions

The research proposal started with a simple question: is there innovation in the Low-Tech sector? However, after the conclusion of the literature review other questions were found to be unanswered. From this first analysis, the following gaps were identified:

- R&D is pointed as not the best indicator for innovation, specifically when used to measure innovations on the Low-Tech sectors.
- Lack of other proxies to measure innovativeness disregarding the industry sectors as the sectorial boundaries seems to be very strict.

- The overall view starts from ‘top-to-bottom’, as the available studies first identify the High-Tech industries and from it, compare to find the ones that does not fit the group.
- The Low-Tech sector is overlooked despite the importance for any country economy and employment.

After identifying these knowledge gaps, we can now focus on the main research question that will give the direction to this research. Although, in order to answer the main question, we define auxiliary questions to provide more insight, as they are inevitable throughout the process.

The main research question is:

Is research and experimental development expenditure (R&D) the correct way to measure the technological level of an economic sector?

The auxiliary questions are:

- Are Portuguese low-tech industries innovative?
- Is Portugal mostly a low-technology country?
- Is the taxonomy really reflecting the Portuguese industries when compared against the OECD index?
- Can data from CIS be used as a proxy to link the technology level in Portuguese firms?
- Can a new approach be proposed on the industry technology level classification?

I do hope to be able to answer, in a satisfactory way, those questions and find proxies to innovation and technology level. Believing a fresh approach can be brought to light, starting from one country with a large data source and offering the possibility to

escalate from the specific to the generic, where the current approach is taken on the other way around.

3.3. Research design

In this research effort, the approach will be based on the Design-science research as it is fundamentally a problem-solving paradigm, and it addresses important unsolved problems in innovative ways (Hevner, March, Park, & Ram, 2004). As we will be focusing on the analysis of an artifact use with reflection and abstraction (Vaishnavi, Kuechler, & and Petter, 2004). The table 6 below shows the broadly definition of artifacts as described in (Hevner et al., 2004).

Table 6. Artifacts definition by Hevner et al. (2004)

Construct	Vocabulary and symbols
Models	Abstractions and representations
Methods	Algorithms and practices
Instantiations	Implement and prototype systems

Design-science research has a set of guidelines as shown on the table below. It requires the creation of an innovative, purposeful artifact, for a specified problem domain. The artifact utility must be demonstrated through evaluation, and novelty by solving an unsolved problem or solving a known problem more efficient or effectively. It must be rigorously defined, formally represented, coherent and internally consistent. The process incorporates or enable a search process where a problem space (environment) is constructed, and the results must be communicated effectively to both technical and managerial audience (Hevner, March, Park, & Ram, 2004).

The actual process of classify the industries has no validation, the process is based on the methodologies described in Revision of the High-Technology Sector and Product Classification (Hatzichronoglou, 1997), based on the foundations laid by International Standard Industrial Classification (ISIC), Standard International Trade Classification

(SITC), Oslo Manual, Frascati Manual and, R&D expenditure data. The framework of those interactions is presented in the Figure 1 below.

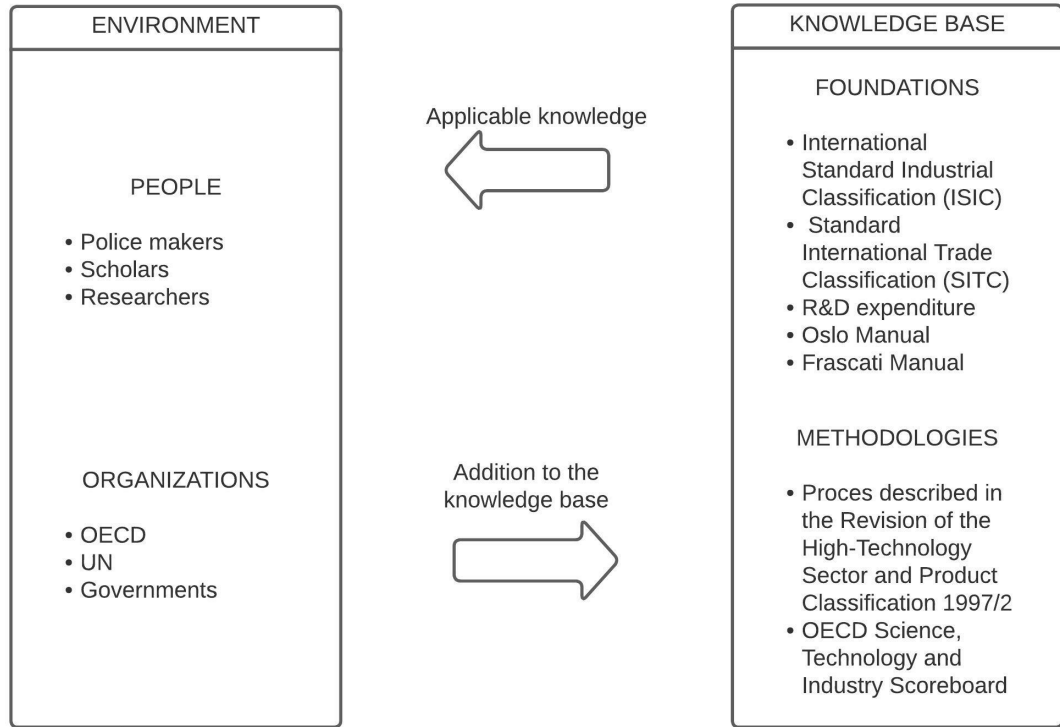


Figure 1. Classification of Industrial Sector by Technology Intensity framework

3.3.1. Design as an Artifact

The goal of this research is to achieve a model that industries can be classified by technology intensity without the dependency to their R&D expenditure. This ‘artifact’ will be structured in a way to compare information from a number of statistical sources and other surveys conducted in Portugal, that are validated as to fairly point out innovation and innovativeness in the industries, against the current method based on R&D. Using a quantitative approach to validate the data provided by both indexers. Aiming to use the responses in the CIS questionnaire to stablish what type of innovation the companies produce and which level of technology they better fit. This research aims to link proxies and reach a definition of the industry technology level while answering the research questions.

3.3.2. Problem Relevance

As per the guidelines, the relevance of the problem must be well demonstrated. In this research, we are discussing a problem that is not on the realm of business *per se*. However, it can influence how business grows and develop. According Pordata², in 2020 49,6% of employed in Portugal were working on sectors that are either low technology or low knowledge intensive and accounting for almost half³ of the companies in the country. Also, R&D requires financing, and despite resources from the state account for around 5% of the investment funds, in 2020 it represents over 100 million euros to R&D. As pointed out by Hirsch-Kreinsen (2008b) the importance of this sector is provided by several empirical findings which emphasize the innovation ability of the low-tech sector also in high-tech countries (cf. Maskell, 1998; Schmierl, 2000; Palmberg, 2001; Tunzelmann and Acha, 2005). Modern society is characterized by the notion that only the increase of research and experimental development institutions and innovation based on high-tech will safeguard jobs and wealth (Hirsch-Kreinsen, 2008a). Hirsch-Kreinsen, also points out the recurrence of this debate, if whether the sector can be sufficiently separated from others. Therefore this problem call for a improvement.

3.3.3. Design evaluation

The evaluation of the design is problem by itself. There is no mention of an evaluation of the data after the publications, in fact the is stated in (Hatzichronoglou, 1997) that the opinions expressed are the sole responsibility of the authors. However, the ISIC Rev.3 does note:

² www.pordata.pt, accessed in 07-06-2022. Last update in 30-03-2022.

³ Own approximation based on Percentual number of companies in Portugal per CAE division

Based on direct R&D intensity, first shown in the Annex of the 2001 edition of OECD's STI Scoreboard using 1991-1999 data. Updated calculations with identical results in the 2003 edition. The cut-off points between 'High', 'Medium-high', 'Medium-low' and 'low technology' were revealed by R&D relative to value-added and gross production statistics. (OECD, 2011).

The evaluation method for assessing the model will be purely descriptive. With the use of information from the knowledge base, relevant research and future data to provide a compelling argument for the artefact utility (Hevner, March, Park, & Ram, 2004).

3.3.4. Research contributions

This research aims to contribute with knowledge base, in the way of contributing with the methodologies on how the classification is applied to the data provided as was pointed before at the problem relevance.

3.3.5. Research rigor

In Design-Science, mathematical formalist is often the way to go, however this situation may defy high levels of formalism in order to achieve more relevance. In this case, the mathematical rigor can still be achieve as described under the guidelines of the Frascati Manual and the Oslo Manual. The data used on the knowledge base are well regulated by those documents. Still the connection between the data will be, at some extend, abstracted or assumed.

3.3.6. Design as a Search Process

Often in Design-Science, the search for the optimal design is intractable for realistic problems. A search process to find a solution is what, essentially, what define the design. The representation of the appropriated means, ends and laws are crucial. However, in Design-science, often a simplification is made by decomposing into

simpler sub-problems. Although such simplifications may not be realistic enough to have a significant impact, it may be a start point (Hevner et al., 2004). As noted by (Hevner et al., 2004) and suggested by (Vessey & Glass, 1998) that, “Given the wicked nature of many information system design problems, however, it may not be possible to determine, let alone explicitly describe, the relevant means, ends, or law”. Therefore, the search for the satisfactory solution is *satisficing* (Simon, 1996) and it simply qualifies as *credentialed knowledge* (Meehl, 1986, p. 311).

3.3.7. Communication of research

This research will be presented in the form of a dissertation, where the methodology developed will be detailed and shown in a language that can be understood by either technology or a management-oriented audience.

4. Understanding the data

4.1. Introduction

There is a consensus across the literature that the potentials of low-tech industries are overlooked, and the way the industry is classified may not reflect the reality of an industry as pointed by Hirsch-Kreinsen (2008b) and (2008a), Zawislak et al (2018), and Hatzichronoglou (1997).

The classification that is in place today was first proposed by Hatzichronoglou(1997), at the time the limitations were still regarding the lack of disaggregated sectorial data. Was based on the ISIC Rev.2, and covering manufacturing industries alone, this classification was used to prepare a sectorial list. Based SITC Rev.3, a product approach was also developed to supplement and provide a better tool for analysing international trade. This classification applied on the ISIC Rev. 3 (OECD, 2011).

Galindo-Rueda et al. (2016) builds on the previous classification, and incorporates three main novelties, first the work is based on the ISIC Rev.4, second it extends the

analysis of R&D intensity to economic activities in services and, third it focusses on a measure of R&D performance intensity as the defining criterion that is an indicative of high technology. However, the last one is indicated as an insufficient measure.

Hirsch-Kreinsen et al. (2014) emphasizes that a differentiation between the sectorial and the company level should be made, while at the sectorial level the classification of R&D intensity reflects, the same is not so clear in the company level. As shown by empirical data, that are low levels of R&D in the high-tech sector and vice-versa (Kirner, Kinkel, & Jaeger, 2009).

4.2. Statistical data and industry information

Data about the industries were collected from multiple sources as listed:

Pordata – is the Database of Contemporary Portugal, organized and developed by the Francisco Manuel dos Santos Foundation. It collects, compile, systematize and disseminate data on multiple areas of society, both for Portugal and the European countries. Reported statistics derive from official and certified sources (Pordata, 2022).

INE – the Nacional Institute of Statistics in Portugal (Instituto Nacional de Estatística) produce, independently, official statistical information without bias and following the international methodologies and standards (INE, 2022).

Eurostat – is the key statistics office of the EU, it produces European statistics in partnership with National Statistics Institutes and other national authorities in the EU member states and the, in the European Economic Area (EEA) and Switzerland through the European Statistical System (ESS) (Eurostat, 2022).

OECD / OECD.Stat – provides a unique forum and knowledge hub for data and analysis, exchange of experiences, best-practice sharing and advice on public polices and international standard-setting (OECD, 2022). OECD.Stat includes data and metadata for OECD countries and selected non-members economies.

United Nations (UN) Statistics Division – is committed to the advancement of the global statistical system. It compiles and disseminate global statistics information, develop standards and norms, and support countries' efforts to improve their national statistical system (Division, 2022).

DGEEC – the Directorate-General for Education and Science Statistics (Direção-Geral de Estatísticas da Ciência e Educação) is a central service of the Portuguese administration, whose mission is to guarantee the production and statistical analysis of education and science, technically supporting policy formulation and strategic planning. The results obtained by the educational and scientific and technological systems, in conjunction with other MEdu (Ministry of Education) and MCTES (Ministry of Science, Technology and Higher Education) services (DGEEC, 2022).

4.3. The Classifications

To start we must first understand the relation between the multiple industry classification in use today, the ISIC, NACE and CAE.

ISIC – The International Standard Industrial Classification of All Economic Activities have been utilized by several countries, as the base for developing their national industry classification. It provides comparability between industrial classification of many other countries ensuring as far as possible, detailed level of classification into only one category. The number of countries that have adapted ISIC to their national activity classification has increased (UN Statistics Division, 2008).

NACE – Is the Statistical Classification of Economic Activities in the European Community, the NACE Rev.2 was created based on ISIC Rev.4 and adapted working together with a group of experts. Accordingly with the NACE Rev.2 it links to ISIC as mentioned:

NACE is a derived classification of ISIC: categories at all levels of NACE are defined either to be identical to, or to form subsets of, single ISIC categories. The first level and the second level of ISIC Rev. 4 (sections and divisions) are identical to sections and divisions of NACE Rev. 2. The third and fourth levels (groups and classes) of ISIC Rev. 4 are subdivided in NACE Rev. 2 according to European requirements. However, groups and classes of NACE Rev. 2 can always be aggregated into the groups and classes of ISIC Rev. 4 from which they were derived. The aim of the further breakdowns in NACE Rev. 2, as compared with ISIC Rev. 4, is to obtain a classification more suited to the structures of the European economies. Also the coding systems used in ISIC and NACE are, as far as possible, the same: to distinguish easily between the two, NACE places a dot between the first two digits (division level) and the last two (groups and classes). Since some groups and classes in ISIC Rev. 4 are disaggregated into NACE groups and classes, without introducing additional hierarchical levels, some ISIC codes differ from the corresponding NACE codes. An activity at group or class level may therefore have a numerical code in NACE Rev. 2, which differs from that in ISIC Rev. 4. (Eurostat, 2008, p. 41).

CAE – Is the Portuguese classification of economic activities (Classificação das Atividades Económicas) and in order to ensure the efficacy the statistical comparability at the international level, this system is completely integrated in relation to NACE and ISIC as the coding structure, concept and methodologies are aligned (INE, 2007).

Therefore, the CAE Rev.3 coding follow the same grouping as the ISIC Rev.4 up to the class, using four numbers for classification.

4.4. Understanding the organization

We must understand that changes in the classifications take a considerable amount of time and research to take effect. The current classification was proposed in 1997 by Hatzichronoglou, Galindo-Rueda and Verger proposed changes in 2016. The comparison of the changes proposed with previous classifications, that can be seen in the Table 8 as based in the table made by Galindo-Rueda et al. (2016).

To start the analysis the environment must be limited to find out how many companies are in Portugal, and how they are classified by their economic activity.

Table 7. Comparison of proposed classification by Galindo-Rueda & Verger (2016) with Eurostat and former OECD classification for manufacturing industries

ISIC Rev.4	Proposed classification in ISIC Rev. 4	Eurostat classification in NACE Rev.2	OECD classification in ISIC Rev.34
303 – Air and spacecraft and related machinery	High	High	High
21 - Pharmaceuticals	High	High	High
26 - Computer, electronic and optical products	High	High	High
252 - Weapons and ammunition	Medium-High	Medium-High	Medium-High
29 - Motor vehicles, trailers and semi-trailers	Medium-High	Medium-High	Medium-High
325 - Medical and dental instruments	Medium-High	Medium-High	High
28 - Machinery and equipment n.e.c.	Medium-High	Medium-High	Medium-High
20 - Chemicals and chemical products	Medium-High	Medium-High	Medium-High
27 - Electrical equipment	Medium-High	Medium-High	Medium-High

⁴ The following concordances between ISIC Rev.3 (i3) and ISIC Rev.4 (i4) were used in order to compare both classifications; the allocation of i4 303 was compared to the allocation of i3 353 in the previous classification; i4 21 to i3 2423; i4 26 to i3 30, 32 and 33; i4 252 to i3 29; i4 29 to i3 34; i4 325 to i3 33, 29 and 2423; i4 28 to i3 29; i4 20 to i3 24 except 2423; i4 27 to i3 31; i4 30X to i3 352+359; i4 22 to i3 25; i4 301 to i3 351; i4 32X to i3 36; i4 23 to i3 26; i4 24 to i3 27; i4 13 to i3 17; i4 15 to i3 19; i4 17 to i3 21; i4 10-12 to i3 15-16; i4 14 to i3 18; i4 25X to i3 28; i4 19 to i3 23; i4 31 to i3 36; i4 16 to i3 20; i4 18 to i3 23.

ISIC Rev.4	Proposed classification in ISIC Rev. 4	Eurostat classification in NACE Rev.2	OECD classification in ISIC Rev.34
30X - Railroad, military vehicles and transport n.e.c. (ISIC 302, 304 and 309)	Medium-High	Medium-High	Medium-High
22 - Rubber and plastic products	Medium	Medium-Low	Medium-Low
301 - Building of ships and boats	Medium	Medium-Low	Medium-Low
32X - Other manufacturing except medical and dental instruments (ISIC 32 less 325)	Medium	Low	Low
23 - Other non-metallic mineral products	Medium	Medium-Low	Medium-Low
24 - Basic metals	Medium	Medium-Low	Medium-Low
33 - Repair and installation of machinery and equipment	Medium	Medium-Low	N.A. ⁵
13 - Textiles	Medium-Low	Low	Low
15 - Leather and related products	Medium-Low	Low	Low
17 - Paper and paper products	Medium-Low	Low	Low
10-12 - Food products, beverages and tobacco	Medium-Low	Low	Low
14 - Wearing apparel	Medium-Low	Low	Low
25X - Fabricated metal products except weapons and ammunition (ISIC 25 less 254) ⁶	Medium-Low	Medium-Low	Medium-Low
19 - Coke and refined petroleum products	Medium-Low	Medium-Low	Medium-Low

⁵ ISIC Rev.4 33 has no rough equivalent in ISIC Rev.3

⁶ The original table in (Galindo-Rueda & Verger, 2016) indicates 252, however that is not the correct code for 'Weapons and Ammunition'.

ISIC Rev.4	Proposed classification in ISIC Rev. 4	Eurostat classification in NACE Rev.2	OECD classification in ISIC Rev.34
31 - Furniture	Medium-Low	Low	Low
16 - Wood and products of wood and cork	Medium-Low	Low	Low
18 - Printing and reproduction of recorded media	Medium-Low	Low	Low

Note: As stated before, the classification of NACE Rev.2 and CAE Rev.3 are differentiated only by the separator on a four-digit level. Therefore, can be understand as the same codification.

4.5. Low technology and intensive-knowledge activities

Comparing the number of Portuguese industries against the current classification. In this case the comparison is made using the classification provided by CAE Rev.3, in terms of coding, a more complete classification comparison between NACE Rev.2 and CAE Rev.3 can be found in the Appendix B. From information available at the INE and Pordata database, we were able to construct a table that shows the number of companies in each industry as shows on the Table 9. The timeframe is between 2020 and 2015 which places the latest CIS results in the middle of the interval. The CIS is a biannual survey, and the last survey took place between 2016 and 2018, with results just recently released.

Table 8. Number of companies in Portugal by CAE 2015-2020

Economic Activity CAE Rev.3	2015	2016	2017	2018	2019	2020
A Crop, animal production, forestry and fishing	133427	132844	132928	132887	130350	126907
B Mining and extraction	1066	1045	1062	1022	1020	1023
C Manufacturing industries	66729	66953	67555	68214	6883277	66469

⁷ Data rectified by responsible entity as noted in the original source from INE

Economic Activity	CAE Rev.3	2015	2016	2017	2018	2019	2020
D	Electricity, gas, steam and air conditioning supply	1209	3977	4062	4365	4501	4890
E	Water collection, treatment and supply	1262	1229	1219	1280	1304	1282
F	Construction	77906	78866	81629	85311	90430	92328
G	Wholesale and retail trade and repair of motor vehicles and motorcycles	222034	220359	219190	217831	218440	215033
H	Transport and logistics	21638	21799	22841	25592	31331	34237
I	Accommodation, food and beverages	91826	97562	104826	113191	118031	112347
J	Information and communication activities	15600	16453	17837	19116	21004	21312
K	Financial services and insurance	18324	18104	17743	17135	16676	15256
L	Real state	32154	35787	40792	45510	49830	51940
M	Consulting, research, technical activities and similar	116705	120198	125617	128466	131886	134105
N	Administration activities and support services	154178	163936	176535	181109	188846	176636
O	Public administration and defence; compulsory social security				N.I. ⁸		
P	Education	54626	54647	56577	57895	58407	57503
Q	Human health activities and social work	86978	90728	94740	98006	101008	103397
R	Creative, arts and entertainment activities	30471	32815	35742	36689	38287	37113

⁸ Not informed or not available in the original source.

Economic Activity	CAE Rev.3	2015	2016	2017	2018	2019	2020
S	Other service activities	55273	56904	59541	61680	64823	64478
T	Activities of households as employers of domestic personnel				N.I. ⁸		
U	Activities of extraterritorial organisations and bodies				N.I. ⁸		
Total ⁹		1181406	1214206	1260436	1295299	1335006	1316256

Note(s): The economic activity considered comprehend companies classified in section A to S of CAE Rev.3, with the exception of section K and section O.

Source(s): https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_indicadores&indOcorrCod=0007748&contexto=bd&selTab=tab2&xlang=pt 03-05-2022, <https://www.pordata.pt> in 04-05-2022, last update in 31-03-2022

Comparing the classification against the organization of the economic activities given on the table above, we can now see a better picture of the Portuguese economic environment as shown on the Figure 2, the representation in percentage of companies accordingly their activity in Portugal in the year of 2020.

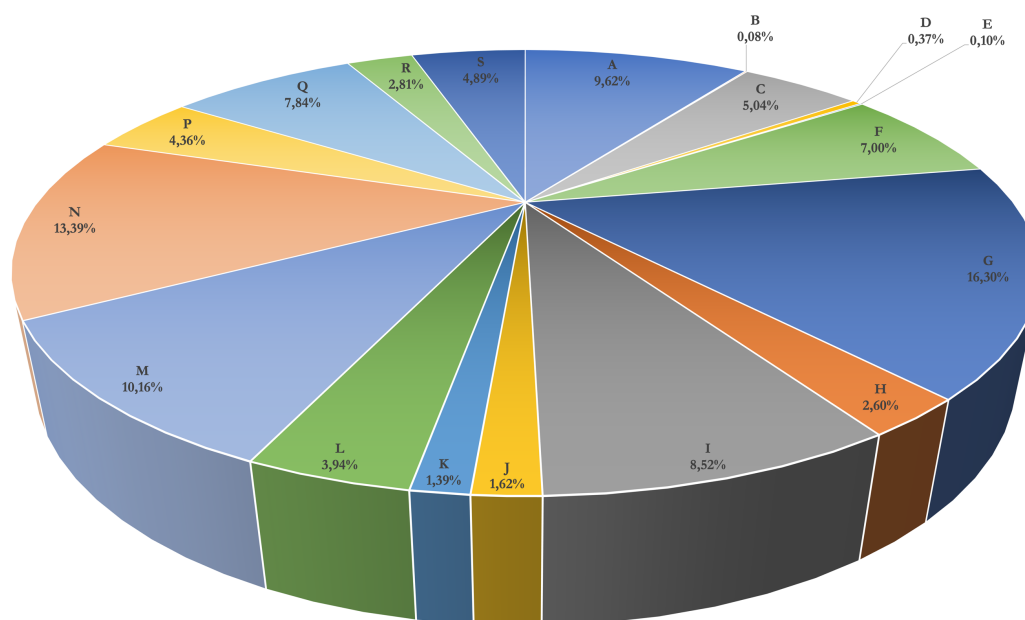


Figure 2. Percentage of Portuguese companies per division of CAE in 2020

⁹ Total companies in Portugal accordingly with INE and Pordata as in 31-03-2022

Based on the number of companies in Portugal and how they are classified accordingly with the NACE Rev.2, the country has just over 5% of the total industries as manufacturing industries and, therefore possible to be classified as shown on the Table 10.

Table 9. Portuguese manufacturer industry classification as NACE Rev.2

Manufacturing Industries	2020	2019	2018	2017	2016	2015
High tech	0,04%	0,04%	0,04%	0,04%	0,04%	0,04%
Mid-High	0,3%	0,3%	0,3%	0,3%	0,3%	0,3%
Mid-Low	1,6%	1,6%	1,6%	1,6%	1,7%	1,7%
Low	3,1%	3,2%	3,3%	3,4%	3,5%	3,6%

Note: calculations based on data from INE and Pordata.

However, when considering the aggregation of services based on NACE Rev.2 as show in the Figures 6, 7 and 8, found on Appendix C. The service sectors are then classified as knowledge-intensive services (KIS) or as less knowledge-intensive services (LKIS) it has more impact. In comparison with the whole of industries in Portugal, the ones classified as knowledge-intensive are over 75% of the total as shown in Table 11.

Table 10. Portuguese Knowledge-based classification as NACE Rev.2

Knowledge based services	2020	2019	2018	2017	2016	2015
KIS	28%	28%	28%	28%	28%	27%
LKIS	50%	50%	50%	49%	49%	49%

Activities can be classified as knowledge-intensive if more than 33% of the total employment in that activity is performed by tertiary educated persons (Eurostat, 2020). Tertiary education is defined as person possessing education levels between ISCED 2011 level 5 to 8. The population is defined as those in the age group having the highest level of education. As a comparison, Portugal values of 2020 was 41,9% for 25-34

years-old and 16,9% for 55-64 years-old. For the same period, OECD countries shows values of 45,6% and 29,1% respectively¹⁰.

Based on this information the assumption that Portugal is mostly a low-technology country is clear, as none of the indicators discussed so far have pointed to a different direction. Almost 50% of the Portuguese industry is composed the sectors A, G, N, M and I of CAE Rev. 3. Where the large part is composed by low-technology industries or low knowledge-intensive services.

4.6. Innovativeness

The question remains, is the fact of being mostly low-tech have such an impact in the innovativeness of the industries in Portugal? Are the low-tech industries not innovative as it is implied?

Innovation and low-technologies industries have been discussed for some time and is well documented in the literature. Hirsch-Kreinsen discuss about the objectives of the inovation in the 'low' and 'mid-low' sector refered as LMT. Firstly discussing the companies that improves their easily immitable product, based in small steps. The product components can be improved regarding material, function or quality but the structure and technological principles remains. Sencondly, those who promote market-induced product innovations. Branding strategies, expasion of service or product related activities, and market niches are the main focus. Thirdly, the process specialist, companies that manufacture simple products and easily imitable. Like the first ones, this third type stands under competition and cost pressure (Hirsch-Kreinsen, 2008b). This discussion, along with Zawislak et al.(2018) statement that, firms can be

¹⁰ OECD, Population with tertiary education, doi: 10.1787/0b8f90e9-en

innovative regardless of their technological intensity classification, points to answer the question about the low-tech industries innovativeness.

Analysing the results from CIS 2020 and CIS 2018, it shows that in Portugal, the number of companies with innovation activities has grow around 48%¹¹, from 32,4% in 2018 to 48% in 2020. The Low-tech sectors does show innovation growth in the last two editions of the survey, as shows in the Table 12 based in the results of CIS 2020. The results shows the values regarding the totality of valid responses fitted into the aggregated activities, i.e. from the 13 509 valid responses, taking into consideration only the ones from sector A, 39,9% of them had innovation activities in the period.

Table 11. Companies with innovation activities – CIS results

Economic Activity¹²	CIS 2020 (2018-2020)	CIS 2018 (2016-2018)
Agriculture and fishing	39,2%	25,9%
Industry and energy	47,4%	37,7%
Construction and real state	39,7%	20,9%
Retail	50,8%	28,4%
Transport and warehousing	45,9%	30,0%
Accommodation and restaurants	44,0%	30,8%
Information and communication	75,5%	57,4%
Financial services	68,4%	45,4%
Other services	51,9%	35,5%
TOTAL	48,0%	32,4%

Note: Data collected from summary of CIS results available at www.dgeec.mec.pt

The results shows that around 40% of industries from the the first 3 sector of the CAE Rev.3 classification had some sort of innovation activities, not only, all the sectors shows some percentage of innovation activity. The Survey of the National Scientific

¹¹ It must be noted the grow took place during pandemic times, and one can infare the positive impact it had in the industry.

¹² Economic activities were aggregated, consider the follow correspondence with CAE Rev.3: Agriculture and fishing to section A; Industry and energy to sections B, C, D and E; Construction and real state to sections F and L; Retail to section G; Transport and warehousing to section H; Accommodation and restaurants to section I; Information and communication to section J; Financial services to section K; Other services to sections M, N, P, Q, R and S.

and Technological Potential or IPCTN (Inquerito ao Potencial Científico e Tecnológico Nacional), provides even more detailed data regarding the expenditure in R&D by technology intensity as show on the table below.

Table 12. Expenditure in R&D accordingly to IPCTN by technology intensity (in millions of EUR)

Technology Intensity	2020	2019	2018	2017	2016	2015
Manufacturing Industry	666,2	623,5	584,3	516,1	483,8	412,6
High	143,1	131,3	155,8	139,2	125,2	107,0
Mid-High	166,5	153,9	137,8	129,0	131,6	110,9
Mid-Low	170,6	160,3	129,3	117,4	109,0	84,5
Low	186,0	177,9	161,4	130,6	118,0	110,2
Services	1 096,3	885,9	792,4	747,9	638,8	591,1
KIS – High technology	497,8	395,8	391,4	348,0	293,7	256,2
KIS - Financial services	147,7	110,9	107,5	136,8	166,5	166,3
KIS – Market services	232,7	203,4	137,6	136,6	73,5	64,5
KIS – Other services	46,9	37,7	30,8	28,7	21,1	19,8
LKIS – Market services	163,3	131,7	120,5	91,1	75,9	70,3
LKIS – Other services	7,9	6,4	4,7	6,9	8,0	13,9
Other	81,1	61,1	47,9	39,4	33,9	32,9
Total	1 843,6	1 570,5	1 424,6	1 303,5	1 156,5	1 036,5

Those tables shows that not only the low-tech sector does innovate, as it also invests heavily as much as the high-tech sector does. However, we must note that the regarding the service sector, the assumptions stand as KIS activities does invest and innovate more but does not disprove that has innovativeness in the LKIS sector.

Analyzing the education level in the industries in Portugal accordingly to the Quadros de Pessoal (GEP, 2020)(Staff Table 2020), we can notice that the require amount of employees in a certain level are not met for KIS sectors and but are met for LKIS, as shown in the Figure x, more detailed table can be add to the Appendix G.

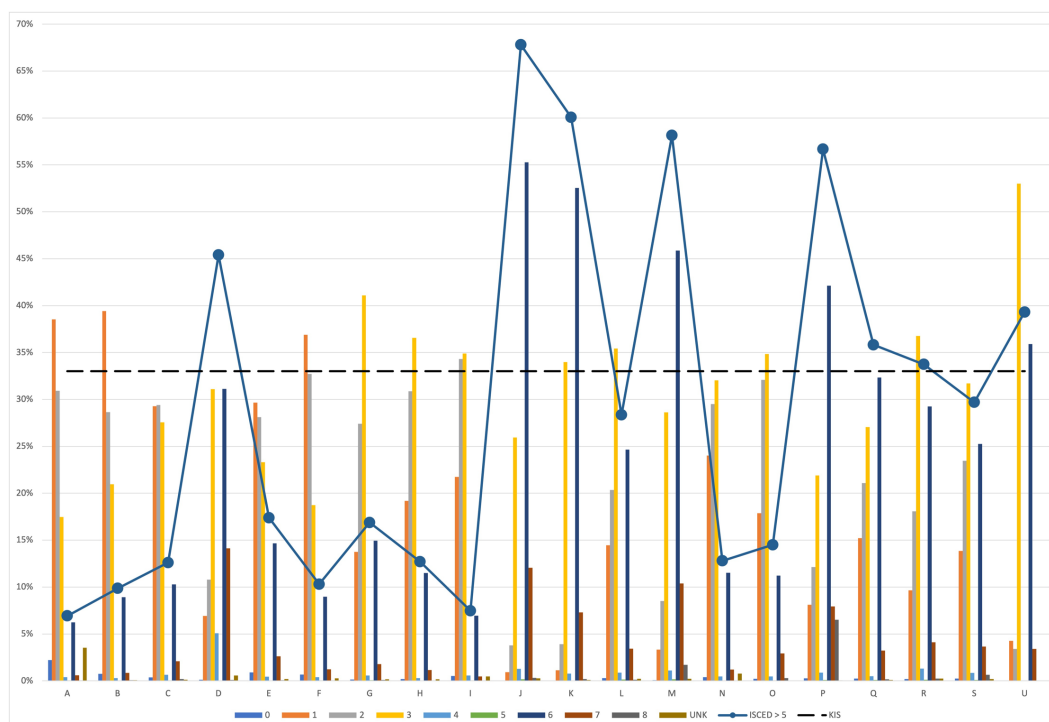


Figure 3. Industries in Portugal, classified by CAE Rev.3 by ISCED education level in 2020

4.7. Taxonomy application

Portuguese industries are indeed innovating, as shows by the data from the CIS and IPCTN. However, the taxonomy used to classify the industries by technology intensity is not mature, despite the time that has been in use so far. We can observe in Portugal high investments in services and manufacturing.

This dynamic might be explained on how Portugal approach innovation. As well concluded by Rotaba et al.(2012) the growth in *catching up*¹³ economies are prominent in both, HT and LMT, sectors but more significance for LMT. While *leading* economies focus on HT, showing that firms on these economies produce modular products and then, outsource components to catching up economies (1). As a result, catching up economies imitate the HT by process innovation, giving a better chance to penetrate

¹³ “‘Catching-up’ relates to the ability of a country to narrow the gap in productivity and income vis-à-vis a leader country” (Fagerberg & Godinho, 2005, p. 514)

LMT in both catching and leading economies (2 and 4). Due to migration of technology, LMT on catching economies are more prone to enter a leading economy LMT market (3) and bring low-cost technology while high quality technology comes from HT in leading economies (5). A rough representation of the dynamic is shown in the Figure 3 below.

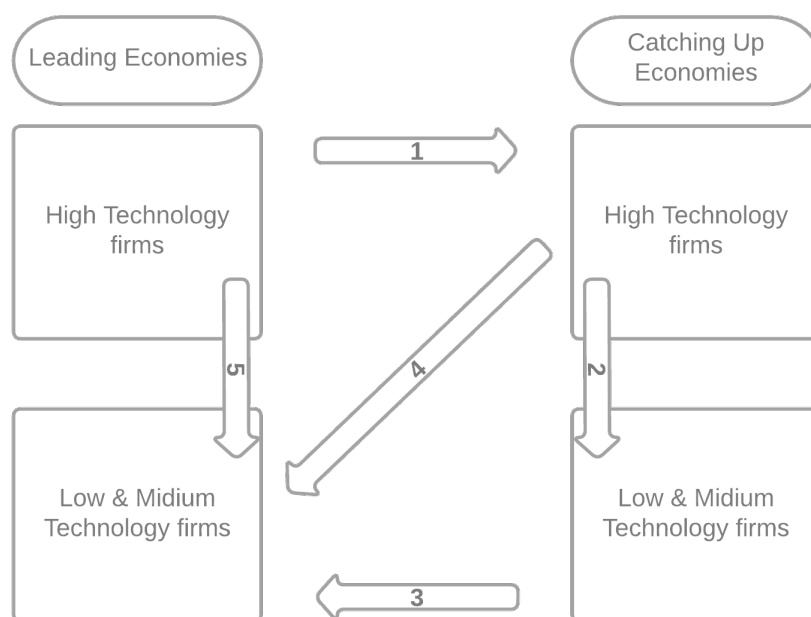


Figure 4. LMT, HT, Leading and Catching Ups dynamics based on Rotaba & Beaudry (2012)

The seminal study by Hatzichronoglou (1997), clustered industries by their internal R&D intensity combined estimates of indirect R&D acquired, later the OECD Science, Technology and Industry Scoreboard (OECD, 2003) update the grouping was to be based solely on R&D intensity. This classification continued to be referred as a technology classification as pointed by Galindo-Rueda, et al. (2016). The R&D intensity indicator is commonly defined as the ratio of the expenditure in it, to an output measure. This measures according to the Frascati Manual (OECD, 2015) are usually the gross value added (GVA) or gross output (GO). Therefore being used at economic level to measure its relative R&D effort, indicated by the ratio of gross domestic expenditure on R&D (GERD) and gross domestic product (GDP), or in the

business sector the GERD is replaced by the business enterprise expenditure on R&D (BERD) or to a more aligned measure of GVA.

The Table 14 shows the R&D intensity in Portugal, as per the definition mentioned before, and when compared against the taxonomy and the cut-off points defined it shows that it does not reflect reality in the case of Portugal. The source tables with more detailed data about the GVA and R&D expenditure can be found on Appendix I.

Table 13. R&D intensity between 2020-2015 in Portugal

CAE	2019	2020	2018	2017	2016	2015	Avg.
Class	R&D/GVA	R&D/GVA	R&D/GVA	R&D/GVA	R&D/GVA	R&D/GVA	
A	0,64%	1,01%	0,54%	0,60%	0,55%	0,32%	0,61%
B	0,29%	0,63%	0,32%	0,59%	0,18%	0,11%	0,31%
C	2,73%	3,15%	2,59%	2,35%	2,38%	2,11%	2,59%
D ¹⁴	0,22%	0,46%	0,28%	0,18%	0,23%	0,23%	0,28%
E	-	-	-	-	-	-	-
F	0,21%	0,27%	0,19%	0,18%	0,12%	0,15%	0,19%
G	0,35%	0,42%	0,28%	0,31%	0,29%	0,29%	0,33%
H	0,45%	0,51%	0,29%	0,24%	0,19%	0,16%	0,32%
I	0,05%	0,06%	0,02%	0,01%	0,01%	0,00%	0,03%
J	-	-	-	-	-	-	-
K	1,08%	1,47%	0,97%	1,18%	1,65%	1,54%	1,34%
L	0,06%	0,04%	0,20%	0,00%	0,00%	0,00%	0,06%
M	-	-	-	-	-	-	-
N	-	-	-	-	-	-	-
O	-	-	-	-	-	-	-
P	0,14%	0,19%	0,10%	0,03%	0,03%	0,07%	0,11%
Q	0,37%	0,50%	0,34%	0,30%	0,24%	0,00%	0,29%
R	-	-	-	-	-	-	-

Notes: Blank values (-) where not provided in the source, therefore no calculation was made.

When looking closer into the industry, we can notice that the gap between theoretical and reality gets larger. However, to expand this affirmation the same analysis must be done in other countries. Moreover, one can assume high-tech sector of Portugal does not invest over 5% in R&D and, are even closer to the low-tech sector as the investments does not reach the 3%.

¹⁴ The section D and E were considered as one according with CAE Rev. 2.1, as noted in the source table.

The CIS provides a large amount of data, that is mostly focused on innovation due to the nature of it. Its use is limited to be used as a proxy, and as forementioned innovation is not the best indication to classify industries by their technology intensity. Although it can provide value information on the knowledge flow, if technology was acquired, imitated or developed.

4.8. Proposing a new model

The current model of classification is established for over a decade now, and despite the mention across the literature that is not ideal, no other classification has come to light.

Hatzichronoglou, provides a interesting approach based on product as stated “While an industry may be very technology-intensive in one country and only slightly technology-intensive in another, it is inconceivable that the same product should be classified as high-tech in some countries and as medium- or low-tech in others. If that were the case, it would imply that the products were different.” (Hatzichronoglou, 1997). Moreover, he indicates that the classification were not detailed enough for products that belongs to different ranges, although having the same name. However, looking at the SITC Rev. 4, the five digits classification has enough disaggregation for this porpouse.

The proposed model would based in the correlation between two main principals:

- Knowledge-Intensity (KI)
- Output product Technology Intensity (PTI)

The KI is well defined and depend only on the level of education related to the amount of employees on the company, if tertiary educated persons represent over 33% of total employed it could be recognised as an Knowledge-Intensive organisation. This is a

stretch from the KIA indicator (Eurostat, 2020) that is used for classify the sectors, although the application remains the same.

The PTI will require more work, as during the course of this research, no direct indicators exist to provide such information. This indicator would build in the technological intensity required for that product to be made. Based on empirical knowledge, I propose to have this indicator supported by the cost of production and the value-added of the final product. The cost of production is the cost incurred to produce a specific quantity of the forementioned product or service, from raw material to labor. This would give a quantitative value for the output of and specific activity, company or service. Indicating how much the process cost and providing a linkage between the use of technology and knowledge applied to the production. Whilst, the value added, that is the economic value that a company add to its product and explain why they can sell for a price above the cost, could indicate differences between same products across companies and countries. Together, those could indicate the level of technology involved in the process of bringing that item to the market.

Although exceptions may exist, we can assume that higher is the production cost more processes are involved, and therefore more technology and knowledge is demanded. while the same can be assumed from value-added, as it usually indicates a product that has been through a number of processes to increase his value.

All those indicators are available for any level, from a single company to the whole industry, allowing to test the classification on every level. From that we could conclude the technological intensity of an industry or company and act upon accordingly.

5. Conclusions

Talk about innovation and technology is never easy, those terms are the definition of change. As technology has changed much faster in the recent years. What was once new becomes old in a matter of months, sometimes days. While innovation is the main

engine behind the ageing of a technology. They work as clockwork, technology pushing innovation and, innovation pulling technology.

Measure science and technology was never an easy task. However, we have achieved parts that allows to measure innovativeness, knowledge, and the level of readiness of a new technology. This dissertation aims to understand how and if the technology intensity classification is well fit for to measure the reality of the companies. Doing so after an empirical research based on scientific publications from multiple authors from where the ideas and concepts discussed were drawn upon.

This research started with one main question and another auxiliary question came along to provide even more clarity to the main answer, and in the end a new approach to classify the level of technology intensity came to light, along with limitations and propositions for future research.

Portuguese low-tech industries are indeed innovative, and more than that they do invest heavily as their counterparts in the high-tech sector. However, when looking at the knowledge-intensive services (KIS), we can see the exact description provided by Hatzichronoglou (1997) where high levels are indeed more innovative. The research does also indicate that Portugal is mostly a low-technology country, where almost 50% of the companies are part of either low-tech or low knowledge-intensive activities.

Regarding the taxonomy, a conclusion is devided. At the same time that all the data indicates that it does not reflect when confronted with a reality of a country, doing a analisys based on a single country opens up to discussion if the indicators are correct. However, the indicators used to group the industries are based in innovativiness and in regards of Portugal, the use of CIS does not replace those indicators. Moreover, the CIS and the IPCTN if combined can provide a large ammount of information about any company. Here I firmly believe that this type of data collection and report are absorbed by other countries for a larger database.

The last question was if a new approach could be proposed, and I do think the first step was taken. Much more data must be collected and tested in order to really test the feasibility of the proposed model. Nevertheless, a new model was proposed and hopefully will be an asset to our knowledge base.

In conclusion, R&D is not the correct way to measure the technological level of an industry sector, it is a shallow indicator of innovativeness of an industry and does not indicate accurately how intensive the technology is applied to output of an industry.

For the future, more research must be carried on other countries, and would recommend to start with the Iberic peninsula as could give a base of comparison between countries in the same region. The model presented is a rough draft of what can it become, a research to gather the necessary data across the companies would provide a test and possible adjusts for the implamentation.

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Appendices

Tables and other information that provided support for the ideas presented in this document are found in this chapter.

Most of the tables and figures presented in here are of my own making based in data from public sources, the sources are mentioned in the main text of this document.

Appendix A

PROCESS FLOW DIAGRAM OF PAPERS ELIGIBILITY.

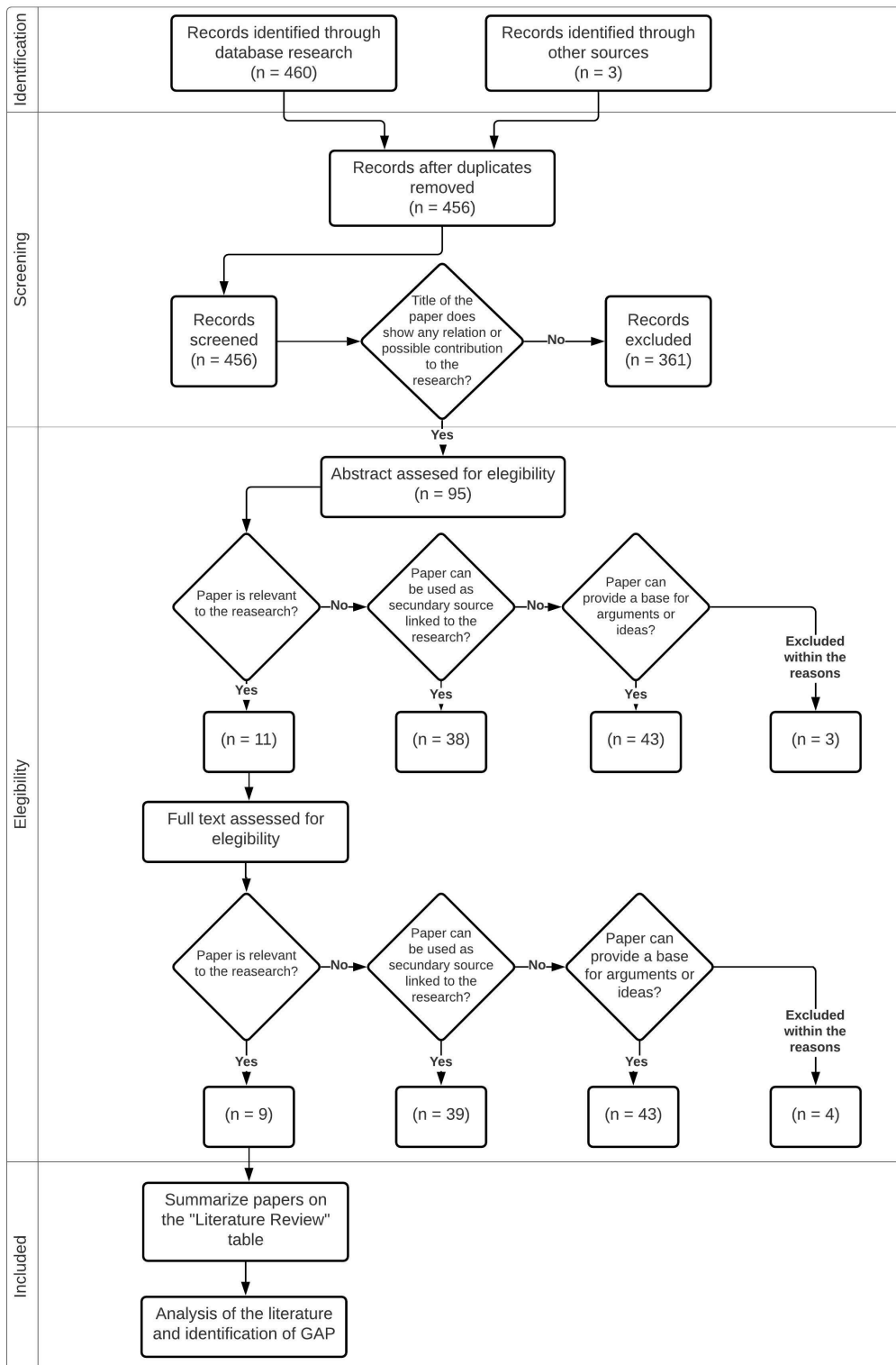


Figure 5. PRISMA flow diagram for papers eligibility

Appendix B

COMPARISON BETWEEN CAE REV.3 AND NACE REV.2.

Table 14. Comparison between CAE Rev.3 and NACE Rev.2.

DIVISION	CAE Rev.3	NACE Rev.2
01	Agricultura, produção animal, caça e atividades dos serviços relacionados	Crop and animal production, hunting and related service activities
02	Silvicultura e exploração florestal	Forestry and logging
03	Pesca e aquicultura	Fishing and aquaculture
05	Extração de hulha e lenhite	Mining of coal and lignite
06	Extração de petróleo bruto e gás natural	Extraction of crude petroleum and natural gas
07	Extração e preparação de minérios metálicos	Mining of metal ores
08	Outras indústrias extrativas	Other mining and quarrying
09	Atividades dos serviços relacionados com as indústrias extrativas	Mining support service activities
10	Indústrias alimentares	Manufacture of food products
11	Indústria das bebidas	Manufacture of beverages
12	Indústria do tabaco	Manufacture of tobacco products
13	Fabricação de têxteis	Manufacture of textiles
14	Indústria do vestuário	Manufacture of wearing apparel
15	Indústria do couro e dos produtos do couro	Manufacture of leather and related products
16	Indústrias da madeira e da cortiça e suas obras, exceto mobiliário; Fabricação de obras de cestaria e de espartaria	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
17	Fabricação de pasta, de papel, de cartão e seus artigos	Manufacture of paper and paper products
18	Impressão e reprodução de suportes gravados	Printing and reproduction of recorded media
19	Fabricação de coque, produtos petrolíferos refinados e de aglomerados de combustíveis	Manufacture of coke and refined petroleum products
20	Fabricação de produtos químicos e de fibras sintéticas ou artificiais, exceto produtos farmacêuticos	Manufacture of chemicals and chemical products
21	Fabricação de produtos farmacêuticos de base e de preparações farmacêuticas	Manufacture of basic pharmaceutical products and pharmaceutical preparations
22	Fabricação de artigos de borracha e de matérias plásticas	Manufacture of rubber and plastic products
23	Fabricação de outros produtos minerais não metálicos	Manufacture of other non-metallic mineral products
24	Indústrias metalúrgicas de base	Manufacture of basic metals
25	Fabricação de produtos metálicos, exceto máquinas e equipamentos	Manufacture of fabricated metal products, except machinery and equipment

DIVISION	CAE Rev.3	NACE Rev.2
26	Fabricação de equipamentos informáticos, equipamento para comunicações e produtos eletrónicos e óticos	Manufacture of computer, electronic and optical products
27	Fabricação de equipamento elétrico	Manufacture of electrical equipment
28	Fabricação de máquinas e de equipamentos, n.e.	Manufacture of machinery and equipment n.e.c.
29	Fabricação de veículos automóveis, reboques, semi-reboques e componentes para veículos automóveis	Manufacture of motor vehicles, trailers and semi-trailers
30	Fabricação de outro equipamento de transporte	Manufacture of other transport equipment
31	Fabrico de mobiliário e de colchões	Manufacture of furniture
32	Outras indústrias transformadoras	Other manufacturing
33	Reparação, manutenção e instalação de máquinas e equipamentos	Repair and installation of machinery and equipment
35	Electricidade, gás, vapor, água quente e fria e ar frio	Electricity, gas, steam and air conditioning supply
36	Captação, tratamento e distribuição de água	Water collection, treatment and supply
37	Recolha, drenagem e tratamento de águas residuais	Sewerage
38	Recolha, tratamento e eliminação de resíduos; valorização de materiais	Waste collection, treatment and disposal activities; materials recovery
39	Descontaminação e atividades similares	Remediation activities and other waste management services
41	Promoção imobiliária (desenvolvimento de projetos de edifícios); construção de edifícios	Construction of buildings
42	Engenharia civil	Civil engineering
43	Atividades especializadas de construção	Specialised construction activities
45	Comércio, manutenção e reparação, de veículos automóveis e motociclos	Wholesale and retail trade and repair of motor vehicles and motorcycles
46	Comércio por grosso (inclui agentes), exceto de veículos automóveis e motociclos	Wholesale trade, except of motor vehicles and motorcycles
47	Comércio a retalho, exceto de veículos automóveis e motociclos	Retail trade, except of motor vehicles and motorcycles
49	Transportes terrestres e transportes por oleodutos ou gasodutos	Land transport and transport via pipelines
50	Transportes por água	Water transport
51	Transportes aéreos	Air transport
52	Armazenagem e atividades auxiliares dos transportes (inclui manuseamento)	Warehousing and support activities for transportation
53	Atividades postais e de courier	Postal and courier activities
55	Alojamento	Accommodation
56	Restauração e similares	Food and beverage service activities
58	Atividades de edição	Publishing activities

DIVISION	CAE Rev.3	NACE Rev.2
59	Atividades cinematográficas, de vídeo, de produção de programas de televisão, de gravação de som e de edição de música	Motion picture, video and television programme production, sound recording and music publishing activities
60	Atividades de rádio e de televisão	Programming and broadcasting activities
61	Telecomunicações	Telecommunications
62	Consultoria e programação informática e atividades relacionadas	Computer programming, consultancy and related activities
63	Atividades dos serviços de informação	Information service activities
64	Atividades de serviços financeiros, excepto seguros e fundos de pensões	Financial service activities, except insurance and pension funding
65	Seguros, resseguros e fundos de pensões, excepto segurança social obrigatória	Insurance, reinsurance and pension funding, except compulsory social security
66	Atividades auxiliares de serviços financeiros e dos seguros	Activities auxiliary to financial services and insurance activities
68	Atividades imobiliárias	Real estate activities
69	Atividades jurídicas e de contabilidade	Legal and accounting activities
70	Atividades das sedes sociais e de consultoria para a gestão	Activities of head offices; management consultancy activities
71	Atividades de arquitetura, de engenharia e técnicas afins; atividades de ensaios e de análises técnicas	Architectural and engineering activities; technical testing and analysis
72	Atividades de investigação científica e de desenvolvimento	Scientific research and development
73	Publicidade, estudos de mercado e sondagens de opinião	Advertising and market research
74	Outras atividades de consultoria, científicas, técnicas e similares	Other professional, scientific and technical activities
75	Atividades veterinárias	Veterinary activities
77	Atividades de aluguer	Rental and leasing activities
78	Atividades de emprego	Employment activities
79	Agências de viagem, operadores turísticos, outros serviços de reservas e atividades relacionadas	Travel agency, tour operator reservation service and related activities
80	Atividades de investigação e segurança	Security and investigation activities
81	Atividades relacionadas com edifícios, plantação e manutenção de jardins	Services to buildings and landscape activities
82	Atividades de serviços administrativos e de apoio prestados às empresas	Office administrative, office support and other business support activities
84	Administração Pública e Defesa; Segurança Social Obrigatória	Public administration and defence; compulsory social security
85	Educação	Education
86	Atividades de saúde humana	Human health activities
87	Atividades de apoio social com alojamento	Residential care activities
88	Atividades de apoio social sem alojamento	Social work activities without accommodation

DIVISION	CAE Rev.3	NACE Rev.2
90	Atividades de teatro, de música, de dança e outras atividades artísticas e literárias	Creative, arts and entertainment activities
91	Atividades das bibliotecas, arquivos, museus e outras atividades culturais	Libraries, archives, museums and other cultural activities
92	Lotarias e outros jogos de aposta	Gambling and betting activities
93	Atividades desportivas, de diversão e recreativas	eSports activities and amusement and recreation activities
94	Atividades das organizações associativas	Activities of membership organisations
95	Reparação de computadores e de bens de uso pessoal e doméstico	Repair of computers and personal and household goods
96	Outras atividades de serviços pessoais	Other personal service activities
97	Atividades das famílias empregadoras de pessoal doméstico	Activities of households as employers of domestic personnel
98	Atividades de produção de bens e serviços pelas famílias para uso próprio	Undifferentiated goods-and services-producing activities of private households for own use
99	Atividades dos organismos internacionais e outras instituições extra-territoriais	Activities of extraterritorial organisations and bodies

Appendix C

HIGH-TECH AGGREGATION BASED ON NACE REV.2

Manufacturing Industries	NACE Rev. 2 codes – 2-digit level	
High-technology	21	Manufacture of basic pharmaceutical products and pharmaceutical preparations;
	26	Manufacture of computer, electronic and optical products
Medium-high-technology	20	Manufacture of chemicals and chemical products;
	27 to 30	Manufacture of electrical equipment; Manufacture of machinery and equipment n.e.c. ; Manufacture of motor vehicles, trailers and semi-trailers; Manufacture of other transport equipment
Medium-low-technology	19	Manufacture of coke and refined petroleum products;
	22 to 25	Manufacture of rubber and plastic products; Manufacture of other non-metallic mineral products; Manufacture of basic metals; Manufacture of fabricated metals products, excepts machinery and equipment;
	33	Repair and installation of machinery and equipment
Low technology	10 to 18	Manufacture of food products, beverages, tobacco products, textile, wearing apparel, leather and related products, wood and of products of wood, paper and paper products, printing and reproduction of recorded media;
	31 to 32	Manufacture of furniture; Other manufacturing

Figure 6. Aggregation of manufacturing industries by technology intensity

Knowledge based services	NACE Rev. 2 codes – 2-digit level	
Knowledge-intensive services (KIS)	50 to 51	Water transport; Air transport;
	58 to 63	Publishing activities; Motion picture, video and television programme production, sound recording and music publish activities; Programming and broadcasting activities; Telecommunications; computer programming, consultancy and related activities; Information service activities (section J);
	64 to 66	Financial and insurance activities (section K);
	69 to 75	Legal and accounting activities; Activities of head offices, management consultancy activities; Architectural and engineering activities, technical testing and analysis; Scientific research and development; Advertising and market research; Other professional, scientific and technical activities; Veterinary activities (section M);
	78	Employment activities;
	80	Security and investigation activities;
	84 to 93	Public administration and defence, compulsory social security (section O); Education (section P), Human health and social work activities (section Q); Arts, entertainment and recreation (section R).
Knowledge-intensive market services (excluding high-tech and financial services)	50 to 51	Water transport; Air transport;
	69 to 71	Legal and accounting activities; Activities of head offices, management consultancy activities; Architectural and engineering activities, technical testing and analysis;
	73 to 74	Advertising and market research; Other professional, scientific and technical activities;
	78	Employment activities;
	80	Security and investigation activities;
High-tech knowledge-intensive services	59 to 63	Motion picture, video and television programme production, sound recording and music publish activities; Programming and broadcasting activities; Telecommunications; computer programming, consultancy and related activities; Information service activities;
	72	Scientific research and development;
Knowledge-intensive financial services	64 to 66	Financial and insurance activities (section K).
Other knowledge-intensive services	58	Publishing activities;
	75	Veterinary activities;
	84 to 93	Public administration and defence, compulsory social security (section O); Education (section P), Human health and social work activities (section Q); Arts, entertainment and recreation (section R).

Figure 7. Aggregation of intensive knowledge services industries

Knowledge based services	NACE Rev. 2 codes – 2-digit level	
Less knowledge-intensive services (LKIS)	45 to 47	Wholesale and retail trade; Repair of motor vehicles and motorcycles (section G);
	49	Land transport and transport via pipelines;
	52 to 53	Warehousing and support activities for transportation; Postal and courier activities;
	55 to 56	Accommodation and food service activities (section I);
	68	Real estate activities (section L);
	77	Rental and leasing activities;
	79	Travel agency, tour operator reservation service and related activities;
	81	Services to buildings and landscape activities;
	82	Office administrative, office support and other business support activities;
	94 to 96	Activities of membership organisation; Repair of computers and personal and household goods; Other personal service activities (section S);
	97 to 99	Activities of households as employers of domestic personnel; Undifferentiated goods- and services-producing activities of private households for own use (section T); Activities of extraterritorial organisations and bodies (section U).
Less knowledge-intensive market services	45 to 47	Wholesale and retail trade; Repair of motor vehicles and motorcycles (section G);
	49	Land transport and transport via pipelines;
	52	Warehousing and support activities for transportation;
	55 to 56	Accommodation and food service activities (section I);
	68	Real estate activities (section L);
	77	Rental and leasing activities;
	79	Travel agency, tour operator reservation service and related activities;
	81	Services to buildings and landscape activities;
	82	Office administrative, office support and other business support activities;
Other less knowledge-intensive services	95	Repair of computers and personal and household goods;
	53	Postal and courier activities;
	94	Activities of membership organisation;
	96	Other personal service activities;
	97 to 99	Activities of households as employers of domestic personnel; Undifferentiated goods- and services-producing activities of private households for own use (section T); Activities of extraterritorial organisations and bodies (section U).

Figure 8. Aggregation of less intensive knowledge services industries

Appendix D

PORTUGUESE INDUSTRIES CAE REV.3 CLASSIFICATION ACCORDINGLY TO EUROSTAT AGGREGATION OF MANUFACTURING AND SERVICES

Table 15. Aggregation of companies by Eurostat classification

Div.	Description	Mfg ¹⁵	Eurostat Aggregation				
			K.Svc ¹⁶	NHT ¹⁷	HT ¹⁸	Fin ¹⁹	Other ²⁰
01	Agricultura, produção animal, caça e atividades dos serviços relacionados						
02	Silvicultura e exploração florestal						
03	Pesca e aquicultura						
05	Extração de hulha e lenhite						
06	Extração de petróleo bruto e gás natural						
07	Extração e preparação de minérios metálicos						
08	Outras indústrias extrativas						
09	Atividades dos serviços relacionados com as indústrias extrativas						
10	Indústrias alimentares	Low					
11	Indústria das bebidas	Low					
12	Indústria do tabaco	Low					
13	Fabricação de têxteis	Low					
14	Indústria do vestuário	Low					
15	Indústria do couro e dos produtos do couro	Low					
16	Indústrias da madeira e da cortiça e suas obras, exceto mobiliário; Fabricação de obras de cestaria e de espartaria	Low					
17	Fabricação de pasta, de papel, de cartão e seus artigos	Low					
18	Impressão e reprodução de suportes gravados	Low					
182	Reprodução de suportes gravados	Med-low					
19	Fabricação de coque, produtos petrolíferos refinados e de aglomerados de combustíveis	Med-low					

¹⁵ Manufacturing Industries

¹⁶ Knowledge Services (All)

¹⁷ Market services (excluding high-tech and financial services)

¹⁸ High-tech knowledge-intensive services

¹⁹ Knowledge-intensive financial services

²⁰ Other knowledge-intensive services

CAE Rev. 3		Eurostat Aggregation				
Div.	Description	Mfg ¹⁵	K.Svc ¹⁶	NHT ¹⁷	HT ¹⁸	Fin ¹⁹ Other ²⁰
20	Fabricação de produtos químicos e de fibras sintéticas ou artificiais, exceto produtos farmacêuticos	Med-high				
21	Fabricação de produtos farmacêuticos de base e de preparações farmacêuticas	High				
22	Fabricação de artigos de borracha e de matérias plásticas	Med-low				
23	Fabricação de outros produtos minerais não metálicos	Med-low				
24	Indústrias metalúrgicas de base	Med-low				
25	Fabricação de produtos metálicos, exceto máquinas e equipamentos	Med-low				
254	Fabricação de armas e munições	Med-high				
26	Fabricação de equipamentos informáticos, equipamento para comunicações e produtos eletrónicos e óticos	High				
27	Fabricação de equipamento elétrico	Med-high				
28	Fabricação de máquinas e de equipamentos, n.e.	Med-high				
29	Fabricação de veículos automóveis, reboques, semi-reboques e componentes para veículos automóveis	Med-high				
30	Fabricação de outro equipamento de transporte	Med-high				
301	Construção naval	Med-low				
302	Fabricação de material circulante para caminhos-de-ferro					
303	Fabricação de aeronaves, de veículos espaciais e equipamento relacionado	High				
304	Fabricação de veículos militares de combate					
309	Fabricação de equipamento de transporte, n.e.					
31	Fabrico de mobiliário e de colchões	Low				
32	Outras indústrias transformadoras	Low				
325	Fabricação de instrumentos e material médico-cirúrgico					
33	Reparação, manutenção e instalação de máquinas e equipamentos	Med-low				
35	Eletricidade, gás, vapor, água quente e fria e ar frio					
36	Captação, tratamento e distribuição de água					
37	Recolha, drenagem e tratamento de águas residuais					
38	Recolha, tratamento e eliminação de resíduos; valorização de materiais					
39	Descontaminação e atividades similares					

CAE Rev. 3		Eurostat Aggregation					
Div.	Description	Mfg ¹⁵	K.Svc ¹⁶	NHT ¹⁷	HT ¹⁸	Fin ¹⁹	Other ²⁰
41	Promoção imobiliária (desenvolvimento de projetos de edifícios); construção de edifícios						
42	Engenharia civil						
421	Construção de estradas, pontes, túneis, pistas de aeroportos e vias férreas						
43	Atividades especializadas de construção						
45	Comércio, manutenção e reparação, de veículos automóveis e motociclos		LKIS	LKIS	LKIS	LKIS	
46	Comércio por grosso (inclui agentes), exceto de veículos automóveis e motociclos		LKIS	LKIS	LKIS	LKIS	
47	Comércio a retalho, exceto de veículos automóveis e motociclos		LKIS	LKIS	LKIS	LKIS	
49	Transportes terrestres e transportes por oleodutos ou gasodutos		LKIS	LKIS	LKIS	LKIS	
50	Transportes por água		KIS	KIS			
51	Transportes aéreos		KIS	KIS			
52	Armazenagem e atividades auxiliares dos transportes (inclui manuseamento)		LKIS	LKIS	LKIS	LKIS	
53	Atividades postais e de courier		LKIS				LKIS
55	Alojamento		LKIS	LKIS	LKIS	LKIS	
56	Restauração e similares		LKIS	LKIS	LKIS	LKIS	
58	Atividades de edição		KIS				KIS
59	Atividades cinematográficas, de vídeo, de produção de programas de televisão, de gravação de som e de edição de música		KIS		KIS		
60	Atividades de rádio e de televisão		KIS		KIS		
61	Telecomunicações		KIS		KIS		
62	Consultoria e programação informática e atividades relacionadas		KIS		KIS		
63	Atividades dos serviços de informação		KIS		KIS		
64	Actividades de serviços financeiros, excepto seguros e fundos de		KIS			KIS	
65	Seguros, resseguros e fundos de pensões, excepto segurança social		KIS			KIS	
66	Actividades auxiliares de serviços financeiros e dos seguros		KIS			KIS	
68	Atividades imobiliárias		LKIS	LKIS	LKIS	LKIS	
69	Atividades jurídicas e de contabilidade		KIS	KIS			
70	Atividades das sedes sociais e de consultoria para a gestão		KIS	KIS			
71	Atividades de arquitetura, de engenharia e técnicas afins;		KIS	KIS			

CAE Rev. 3		Eurostat Aggregation					
Div.	Description	Mfg ¹⁵	K.Svc ¹⁶	NHT ¹⁷	HT ¹⁸	Fin ¹⁹	Other ²⁰
	atividades de ensaios e de análises técnicas						
72	Atividades de investigação científica e de desenvolvimento		KIS		KIS		
73	Publicidade, estudos de mercado e sondagens de opinião		KIS	KIS			
74	Outras atividades de consultoria, científicas, técnicas e similares		KIS	KIS			
75	Atividades veterinárias		KIS				KIS
77	Atividades de aluguer		LKIS	LKIS	LKIS	LKIS	
78	Atividades de emprego		KIS	KIS			
79	Agências de viagem, operadores turísticos, outros serviços de reservas e atividades relacionadas		LKIS	LKIS	LKIS	LKIS	
80	Atividades de investigação e segurança		KIS	KIS			
81	Atividades relacionadas com edifícios, plantação e manutenção de jardins		LKIS	LKIS	LKIS	LKIS	
82	Atividades de serviços administrativos e de apoio prestados às empresas		LKIS	LKIS	LKIS	LKIS	
84	Administração Pública e Defesa; Segurança Social Obrigatória		KIS				KIS
85	Educação		KIS				KIS
86	Atividades de saúde humana		KIS				KIS
87	Atividades de apoio social com alojamento		KIS				KIS
88	Atividades de apoio social sem alojamento		KIS				KIS
90	Atividades de teatro, de música, de dança e outras atividades artísticas e literárias		KIS				KIS
91	Atividades das bibliotecas, arquivos, museus e outras atividades culturais		KIS				KIS
92	Lotarias e outros jogos de aposta		KIS				KIS
93	Atividades desportivas, de diversão e recreativas		KIS				KIS
94	Atividades das organizações associativas		LKIS				LKIS
95	Reparação de computadores e de bens de uso pessoal e doméstico		LKIS	LKIS	LKIS	LKIS	
96	Outras atividades de serviços pessoais		LKIS				LKIS
97	Actividades das famílias empregadoras de pessoal doméstico		LKIS				LKIS
98	Actividades de produção de bens e serviços pelas famílias para uso próprio		LKIS				LKIS

CAE Rev. 3			Eurostat Aggregation				
Div.	Description	Mfg ¹⁵	K.Svc ¹⁶	NHT ¹⁷	HT ¹⁸	Fin ¹⁹	Other ²⁰
99	Actividades dos organismos internacionais e outras instituições extra-territoriais		LKIS				LKIS

Appendix E

NUMBER OF COMPANIES IN PORTUGAL GROUPED BY CAE DIVISIONS

Table 16. Companies grouped by CAE classification

Div.	Description	2020	2019	2018	2017	2016	2015
01	Agricultura, produção animal, caça e atividades dos serviços relacionados	114 343	117 774	119 791	119 587	119 747	120 945
02	Silvicultura e exploração florestal	7 922	7 809	8 297	8 545	8 239	7 646
03	Pesca e aquicultura	4 642	4 767	4 799	4 796	4 858	4 836
05	Extração de hulha e lenhite						
06	Extração de petróleo bruto e gás natural						
07	Extração e preparação de minérios metálicos	31	30	27	25	24	23
08	Outras indústrias extrativas	950	957	960	1 006	998	1 021
09	Atividades dos serviços relacionados com as indústrias extrativas	42	33	35	31	23	22
10	Indústrias alimentares	8 883	9 566	9 445	9 327	9 296	9 337
11	Indústria das bebidas	1 967	2 023	1 981	1 885	1 793	1 754
12	Indústria do tabaco	6	5	6	6	6	5
13	Fabricação de têxteis	3 463	3 578	3 542	3 509	3 517	3 480
14	Indústria do vestuário	8 480	8 747	8 754	8 821	8 710	8 594
15	Indústria do couro e dos produtos do couro	2 856	3 087	3 187	3 266	3 234	3 182
16	Indústrias da madeira e da cortiça e suas obras, exceto mobiliário; Fabricação de obras de cestaria e de espartaria	4 892	5 070	5 031	4 991	5 047	5 208
17	Fabricação de pasta, de papel, de cartão e seus artigos	557	560	580	575	571	572
18	Impressão e reprodução de suportes gravados	2 287	2 412	2 396	2 403	2 453	2 500
182	Reprodução de suportes gravados	0	0	0	0	0	0
19	Fabricação de coque, produtos petrolíferos refinados e de aglomerados de combustíveis	17	20	22	17	15	18
20	Fabricação de produtos químicos e de fibras sintéticas ou artificiais, exceto produtos farmacêuticos	835	836	829	843	791	779
21	Fabricação de produtos farmacêuticos de base e de preparações farmacêuticas	186	167	151	149	141	134
22	Fabricação de artigos de borracha e de matérias plásticas	1 103	1 094	1 078	1 084	1 072	1 074

Div.	Description	2020	2019	2018	2017	2016	2015
23	Fabricação de outros produtos minerais não metálicos	3 650	3 819	3 802	3 840	3 831	3 918
24	Indústrias metalúrgicas de base	298	315	314	316	331	335
25	Fabricação de produtos metálicos, exceto máquinas e equipamentos	11 741	11 927	11 817	11 553	11 508	11 437
254	Fabricação de armas e munições	0	0	0	0	0	0
26	Fabricação de equipamentos informáticos, equipamento para comunicações e produtos eletrónicos e óticos	306	316	321	329	325	334
27	Fabricação de equipamento elétrico	556	574	588	599	605	608
28	Fabricação de máquinas e de equipamentos, n.e.	1 489	1 527	1 525	1 560	1 551	1 523
29	Fabricação de veículos automóveis, reboques, semi-reboques e componentes para veículos automóveis	691	689	709	697	685	684
30	Fabricação de outro equipamento de transporte	257	245	236	228	211	206
301	Construção naval	0	0	0	0	0	0
302	Fabricação de material circulante para caminhos-de-ferro	0	0	0	0	0	0
303	Fabricação de aeronaves, de veículos espaciais e equipamento relacionado	0	0	0	0	0	0
304	Fabricação de veículos militares de combate	0	0	0	0	0	0
309	Fabricação de equipamento de transporte, n.e.	0	0	0	0	0	0
31	Fabrico de mobiliário e de colchões	4 366	4 479	4 438	4 421	4 414	4 446
32	Outras indústrias transformadoras	3 253	3 395	3 322	3 205	3 097	3 018
325	Fabricação de instrumentos e material médico-cirúrgico	0	0	0	0	0	0
33	Reparação, manutenção e instalação de máquinas e equipamentos	4 330	4 381	4 140	3 931	3 749	3 583
35	Eletricidade, gás, vapor, água quente e fria e ar frio	4 890	4 501	4 365	4 062	3 977	1 209
36	Captação, tratamento e distribuição de água	162	163	150	147	148	151
37	Recolha, drenagem e tratamento de águas residuais	67	66	70	68	63	64
38	Recolha, tratamento e eliminação de resíduos; valorização de materiais	1 036	1 059	1 045	991	1 002	1 028
39	Descontaminação e atividades similares	17	16	15	13	16	19
41	Promoção imobiliária (desenvolvimento de projetos	44 042	43 002	40 565	38 984	37 874	37 704

Div.	Description	2020	2019	2018	2017	2016	2015
	de edifícios); construção de edifícios						
42	Engenharia civil	3 031	2 990	2 881	2 893	2 850	2 885
421	Construção de estradas, pontes, túneis, pistas de aeroportos e vias férreas	0	0	0	0	0	0
43	Atividades especializadas de construção	45 255	44 438	41 865	39 752	38 142	37 317
45	Comércio, manutenção e reparação, de veículos automóveis e motociclos	31 559	31 007	30 210	29 391	28 760	28 244
46	Comércio por grosso (inclui agentes), exceto de veículos automóveis e motociclos	59 047	59 279	58 511	58 528	58 332	58 818
47	Comércio a retalho, exceto de veículos automóveis e motociclos	124 427	128 154	129 110	131 271	133 267	134 972
49	Transportes terrestres e transportes por oleodutos ou gasodutos	26 510	25 576	21 351	19 324	18 713	18 603
50	Transportes por água	322	329	300	390	262	258
51	Transportes aéreos	97	102	91	86	78	70
52	Armazenagem e atividades auxiliares dos transportes(inclui manuseamento)	2 606	2 494	2 415	2 471	2 307	2 303
53	Atividades postais e de courier	4 702	2 830	1 435	570	439	404
55	Alojamento	38 374	41 860	37 408	28 831	21 861	16 394
56	Restauração e similares	73 973	76 171	75 783	75 995	75 701	75 432
58	Atividades de edição	1 793	1 787	1 741	1 706	1 719	1 673
59	Atividades cinematográficas, de vídeo, de produção de programas de televisão, de gravação de som e de edição de música	3 481	3 398	3 106	2 939	2 629	2 416
60	Atividades de rádio e de televisão	370	373	372	356	335	351
61	Telecomunicações	790	794	762	751	731	723
62	Consultoria e programação informática e atividades relacionadas	13 482	13 256	11 867	10 975	10 031	9 480
63	Atividades dos serviços de informação	1 396	1 396	1 268	1 110	1 008	957
64	Actividades de serviços financeiros, excepto seguros e fundos de	15 256	16 676	17 135	17 743	18 104	18 324
65	Seguros, resseguros e fundos de pensões, excepto segurança social	0	0	0	0	0	0
66	Actividades auxiliares de serviços financeiros e dos seguros	0	0	0	0	0	0
68	Atividades imobiliárias	51 940	49 830	45 510	40 792	35 787	32 154

Div.	Description	2020	2019	2018	2017	2016	2015
69	Atividades jurídicas e de contabilidade	53 766	53 260	53 046	52 468	51 706	51 054
70	Atividades das sedes sociais e de consultoria para a gestão	24 862	24 089	22 929	21 480	19 671	18 632
71	Atividades de arquitetura, de engenharia e técnicas afins; atividades de ensaios e de análises técnicas	27 867	27 958	27 569	27 858	26 764	26 152
72	Atividades de investigação científica e de desenvolvimento	1 686	1 588	1 606	1 668	1 603	1 606
73	Publicidade, estudos de mercado e sondagens de opinião	5 260	4 989	4 547	4 298	4 098	4 002
74	Outras atividades de consultoria, científicas, técnicas e similares	18 101	17 484	16 304	15 431	14 034	12 992
75	Atividades veterinárias	2 563	2 518	2 465	2 414	2 322	2 267
77	Atividades de aluguer	3 512	3 622	3 454	3 204	3 097	3 027
78	Atividades de emprego	728	693	636	590	595	579
79	Agências de viagem, operadores turísticos, outros serviços de reservas e atividades relacionadas	4 301	4 652	4 379	4 000	3 598	3 216
80	Atividades de investigação e segurança	640	587	562	578	538	520
81	Atividades relacionadas com edifícios, plantação e manutenção de jardins	9 391	8 610	7 606	6 825	6 161	5 652
82	Atividades de serviços administrativos e de apoio prestados às empresas	158 064	170 682	164 472	161 338	149 947	141 184
84	Administração Pública e Defesa; Segurança Social Obrigatória	0	0	0	0	0	0
85	Educação	57 503	58 407	57 895	56 577	54 647	54 626
86	Atividades de saúde humana	98 201	95 828	92 916	89 833	85 878	82 209
87	Atividades de apoio social com alojamento	2 490	2 419	2 350	2 215	2 164	2 072
88	Atividades de apoio social sem alojamento	2 706	2 761	2 740	2 692	2 686	2 697
90	Atividades de teatro, de música, de dança e outras atividades artísticas e literárias	23 359	24 611	23 660	23 889	22 691	21 589
91	Atividades das bibliotecas, arquivos, museus e outras atividades culturais	270	243	234	232	195	167
92	Lotarias e outros jogos de aposta	366	364	352	339	317	281
93	Atividades desportivas, de diversão e recreativas	13 118	13 069	12 443	11 282	9 612	8 434
94	Atividades das organizações associativas	1 245	1 227	1 220	1 207	1 198	1 217

Div.	Description	2020	2019	2018	2017	2016	2015
95	Reparação de computadores e de bens de uso pessoal e doméstico	4 690	4 848	4 841	4 914	4 864	4 876
96	Outras atividades de serviços pessoais	58 543	58 748	55 619	53 420	50 842	49 180
97	Actividades das famílias empregadoras de pessoal doméstico	0	0	0	0	0	0
98	Actividades de produção de bens e serviços pelas famílias para uso próprio	0	0	0	0	0	0
99	Actividades dos organismos internacionais e outras instituições extra-territoriais	0	0	0	0	0	0
Totals		1 316 256	1 335 006	1 295 299	1 260 436	1 214 206	1 181 406

Appendix F

PERCENTUAL NUMBER OF COMPANIES IN PORTUGAL PER CAE DIVISION.

Table 17. Companies per CAE in percentage of total

Div.	Description	2020	2019	2018	2017	2016	2015
01	Agricultura, produção animal, caça e atividades dos serviços relacionados	8,6870%	8,8220%	9,2481%	9,4877%	9,8622%	10,2374%
02	Silvicultura e exploração florestal	0,6019%	0,5849%	0,6405%	0,6779%	0,6786%	0,6472%
03	Pesca e aquicultura	0,3527%	0,3571%	0,3705%	0,3805%	0,4001%	0,4093%
05	Extração de hulha e lenhite						
06	Extração de petróleo bruto e gás natural						
07	Extração e preparação de minérios metálicos	0,0024%	0,0022%	0,0021%	0,0020%	0,0020%	0,0019%
08	Outras indústrias extrativas	0,0722%	0,0717%	0,0741%	0,0798%	0,0822%	0,0864%
09	Atividades dos serviços relacionados com as indústrias extrativas	0,0032%	0,0025%	0,0027%	0,0025%	0,0019%	0,0019%
10	Indústrias alimentares	0,6749%	0,7166%	0,7292%	0,7400%	0,7656%	0,7903%
11	Indústria das bebidas	0,1494%	0,1515%	0,1529%	0,1496%	0,1477%	0,1485%
12	Indústria do tabaco	0,0005%	0,0004%	0,0005%	0,0005%	0,0005%	0,0004%
13	Fabricação de têxteis	0,2631%	0,2680%	0,2735%	0,2784%	0,2897%	0,2946%
14	Indústria do vestuário	0,6443%	0,6552%	0,6758%	0,6998%	0,7173%	0,7274%
15	Indústria do couro e dos produtos do couro	0,2170%	0,2312%	0,2460%	0,2591%	0,2663%	0,2693%
16	Indústrias da madeira e da cortiça e suas obras, exceto mobiliário; Fabricação de obras de cestaria e de espartaria	0,3717%	0,3798%	0,3884%	0,3960%	0,4157%	0,4408%
17	Fabricação de pasta, de papel, de cartão e seus artigos	0,0423%	0,0419%	0,0448%	0,0456%	0,0470%	0,0484%
18	Impressão e reprodução de suportes gravados	0,1738%	0,1807%	0,1850%	0,1906%	0,2020%	0,2116%
182	Reprodução de suportes gravados	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
19	Fabricação de coque, produtos petrolíferos refinados e de aglomerados de combustíveis	0,0013%	0,0015%	0,0017%	0,0013%	0,0012%	0,0015%
20	Fabricação de produtos químicos e de fibras sintéticas ou artificiais, exceto produtos farmacêuticos	0,0634%	0,0626%	0,0640%	0,0669%	0,0651%	0,0659%
21	Fabricação de produtos farmacêuticos de base e de preparações farmacêuticas	0,0141%	0,0125%	0,0117%	0,0118%	0,0116%	0,0113%
22	Fabricação de artigos de borracha e de matérias plásticas	0,0838%	0,0819%	0,0832%	0,0860%	0,0883%	0,0909%
23	Fabricação de outros produtos minerais não metálicos	0,2773%	0,2861%	0,2935%	0,3047%	0,3155%	0,3316%
24	Indústrias metalúrgicas de base	0,0226%	0,0236%	0,0242%	0,0251%	0,0273%	0,0284%
25	Fabricação de produtos metálicos, exceto máquinas e equipamentos	0,8920%	0,8934%	0,9123%	0,9166%	0,9478%	0,9681%
254	Fabricação de armas e munições	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
26	Fabricação de equipamentos informáticos, equipamento para comunicações e produtos eletrónicos e óticos	0,0232%	0,0237%	0,0248%	0,0261%	0,0268%	0,0283%
27	Fabricação de equipamento elétrico	0,0422%	0,0430%	0,0454%	0,0475%	0,0498%	0,0515%

Div.	Description	2020	2019	2018	2017	2016	2015
28	Fabricação de máquinas e de equipamentos, n.e.	0,1131%	0,1144%	0,1177%	0,1238%	0,1277%	0,1289%
29	Fabricação de veículos automóveis, reboques, semi-reboques e componentes para veículos automóveis	0,0525%	0,0516%	0,0547%	0,0553%	0,0564%	0,0579%
30	Fabricação de outro equipamento de transporte	0,0195%	0,0184%	0,0182%	0,0181%	0,0174%	0,0174%
301	Construção naval	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
302	Fabricação de material circulante para caminhos-de-ferro	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
303	Fabricação de aeronaves, de veículos espaciais e equipamento relacionado	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
304	Fabricação de veículos militares de combate	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
309	Fabricação de equipamento de transporte, n.e.	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
31	Fabrico de mobiliário e de colchões	0,3317%	0,3355%	0,3426%	0,3508%	0,3635%	0,3763%
32	Outras indústrias transformadoras	0,2471%	0,2543%	0,2565%	0,2543%	0,2551%	0,2555%
325	Fabricação de instrumentos e material médico-cirúrgico	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
33	Reparação, manutenção e instalação de máquinas e equipamentos	0,3290%	0,3282%	0,3196%	0,3119%	0,3088%	0,3033%
35	Eletricidade, gás, vapor, água quente e fria e ar frio	0,3715%	0,3372%	0,3370%	0,3223%	0,3275%	0,1023%
36	Captção, tratamento e distribuição de água	0,0123%	0,0122%	0,0116%	0,0117%	0,0122%	0,0128%
37	Recolha, drenagem e tratamento de águas residuais	0,0051%	0,0049%	0,0054%	0,0054%	0,0052%	0,0054%
38	Recolha, tratamento e eliminação de resíduos; valorização de materiais	0,0787%	0,0793%	0,0807%	0,0786%	0,0825%	0,0870%
39	Descontaminação e atividades similares	0,0013%	0,0012%	0,0012%	0,0010%	0,0013%	0,0016%
41	Promoção imobiliária (desenvolvimento de projetos de edifícios); construção de edifícios	3,3460%	3,2211%	3,1317%	3,0929%	3,1192%	3,1915%
42	Engenharia civil	0,2303%	0,2240%	0,2224%	0,2295%	0,2347%	0,2442%
421	Construção de estradas, pontes, túneis, pistas de aeroportos e vias férreas	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
43	Atividades especializadas de construção	3,4382%	3,3287%	3,2321%	3,1538%	3,1413%	3,1587%
45	Comércio, manutenção e reparação, de veículos automóveis e motociclos	2,3976%	2,3226%	2,3323%	2,3318%	2,3686%	2,3907%
46	Comércio por grosso (inclui agentes), exceto de veículos automóveis e motociclos	4,4860%	4,4404%	4,5172%	4,6435%	4,8041%	4,9786%
47	Comércio a retalho, exceto de veículos automóveis e motociclos	9,4531%	9,5995%	9,9676%	10,4147%	10,9756%	11,4247%
49	Transportes terrestres e transportes por oleodutos ou gasodutos	2,0140%	1,9158%	1,6483%	1,5331%	1,5412%	1,5746%
50	Transportes por água	0,0245%	0,0246%	0,0232%	0,0309%	0,0216%	0,0218%
51	Transportes aéreos	0,0074%	0,0076%	0,0070%	0,0068%	0,0064%	0,0059%
52	Armazenagem e atividades auxiliares dos transportes(inclui manuseamento)	0,1980%	0,1868%	0,1864%	0,1960%	0,1900%	0,1949%
53	Atividades postais e de courier	0,3572%	0,2120%	0,1108%	0,0452%	0,0362%	0,0342%
55	Alojamento	2,9154%	3,1356%	2,8880%	2,2874%	1,8004%	1,3877%
56	Restauração e similares	5,6200%	5,7057%	5,8506%	6,0293%	6,2346%	6,3849%
58	Atividades de edição	0,1362%	0,1339%	0,1344%	0,1353%	0,1416%	0,1416%

Div.	Description	2020	2019	2018	2017	2016	2015
59	Atividades cinematográficas, de vídeo, de produção de programas de televisão, de gravação de som e de edição de música	0,2645%	0,2545%	0,2398%	0,2332%	0,2165%	0,2045%
60	Atividades de rádio e de televisão	0,0281%	0,0279%	0,0287%	0,0282%	0,0276%	0,0297%
61	Telecomunicações	0,0600%	0,0595%	0,0588%	0,0596%	0,0602%	0,0612%
62	Consultoria e programação informática e atividades relacionadas	1,0243%	0,9930%	0,9162%	0,8707%	0,8261%	0,8024%
63	Atividades dos serviços de informação	0,1061%	0,1046%	0,0979%	0,0881%	0,0830%	0,0810%
64	Actividades de serviços financeiros, excepto seguros e fundos de	1,1590%	1,2491%	1,3229%	1,4077%	1,4910%	1,5510%
65	Seguros, resseguros e fundos de pensões, excepto segurança social	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
66	Actividades auxiliares de serviços financeiros e dos seguros	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
68	Atividades imobiliárias	3,9460%	3,7326%	3,5135%	3,2363%	2,9474%	2,7217%
69	Atividades jurídicas e de contabilidade	4,0848%	3,9895%	4,0953%	4,1627%	4,2584%	4,3215%
70	Atividades das sedes sociais e de consultoria para a gestão	1,8888%	1,8044%	1,7702%	1,7042%	1,6201%	1,5771%
71	Atividades de arquitetura, de engenharia e técnicas afins; atividades de ensaios e de análises técnicas	2,1171%	2,0942%	2,1284%	2,2102%	2,2042%	2,2136%
72	Atividades de investigação científica e de desenvolvimento	0,1281%	0,1190%	0,1240%	0,1323%	0,1320%	0,1359%
73	Publicidade, estudos de mercado e sondagens de opinião	0,3996%	0,3737%	0,3510%	0,3410%	0,3375%	0,3387%
74	Outras atividades de consultoria, científicas, técnicas e similares	1,3752%	1,3097%	1,2587%	1,2243%	1,1558%	1,0997%
75	Atividades veterinárias	0,1947%	0,1886%	0,1903%	0,1915%	0,1912%	0,1919%
77	Atividades de aluguer	0,2668%	0,2713%	0,2667%	0,2542%	0,2551%	0,2562%
78	Atividades de emprego	0,0553%	0,0519%	0,0491%	0,0468%	0,0490%	0,0490%
79	Agências de viagem, operadores turísticos, outros serviços de reservas e atividades relacionadas	0,3268%	0,3485%	0,3381%	0,3174%	0,2963%	0,2722%
80	Atividades de investigação e segurança	0,0486%	0,0440%	0,0434%	0,0459%	0,0443%	0,0440%
81	Atividades relacionadas com edifícios, plantação e manutenção de jardins	0,7135%	0,6449%	0,5872%	0,5415%	0,5074%	0,4784%
82	Atividades de serviços administrativos e de apoio prestados às empresas	12,0086%	12,7851%	12,6976%	12,8002%	12,3494%	11,9505%
84	Administração Pública e Defesa; Segurança Social Obrigatória	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
85	Educação	4,3687%	4,3750%	4,4696%	4,4887%	4,5006%	4,6238%
86	Atividades de saúde humana	7,4606%	7,1781%	7,1733%	7,1271%	7,0728%	6,9586%
87	Atividades de apoio social com alojamento	0,1892%	0,1812%	0,1814%	0,1757%	0,1782%	0,1754%
88	Atividades de apoio social sem alojamento	0,2056%	0,2068%	0,2115%	0,2136%	0,2212%	0,2283%
90	Atividades de teatro, de música, de dança e outras atividades artísticas e literárias	1,7747%	1,8435%	1,8266%	1,8953%	1,8688%	1,8274%
91	Atividades das bibliotecas, arquivos, museus e outras atividades culturais	0,0205%	0,0182%	0,0181%	0,0184%	0,0161%	0,0141%
92	Lotarias e outros jogos de aposta	0,0278%	0,0273%	0,0272%	0,0269%	0,0261%	0,0238%
93	Atividades desportivas, de diversão e recreativas	0,9966%	0,9789%	0,9606%	0,8951%	0,7916%	0,7139%
94	Atividades das organizações associativas	0,0946%	0,0919%	0,0942%	0,0958%	0,0987%	0,1030%
95	Reparação de computadores e de bens de uso pessoal e doméstico	0,3563%	0,3631%	0,3737%	0,3899%	0,4006%	0,4127%

Div.	Description	2020	2019	2018	2017	2016	2015
96	Outras atividades de serviços pessoais	4,4477%	4,4006%	4,2939%	4,2382%	4,1873%	4,1628%
97	Actividades das famílias empregadoras de pessoal doméstico	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
98	Actividades de produção de bens e serviços pelas famílias para uso próprio	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
99	Actividades dos organismos internacionais e outras instituições extra-territoriais	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
	Totals	100%	100%	100%	100%	100%	100%

Appendix G

NUMBER OF EMPLOYED PERSONAL BY ISCED 2011 LEVEL OF EDUCATION PER CAE SECTOR.

Table 18. Number of employed personal grouped by level of education

CAE Rev.3			ISCED 2011 Levels ²¹									
			0	1	2	3	4	5	6	7	8	UNK ²²
A			1546	26949	21618	12210	272	37	4356	428	27	2480
	01	02	1463	23876	20145	11547	264	34	4123	387	26	2475
		03	83	3073	1473	663	8	3	233	41	1	5
B			61	3165	2300	1683	23	2	716	69	5	5
C			2246	180006	180785	169389	3969	270	63209	12880	1134	786
10	11	12	575	25522	27213	23443	388	40	9694	1231	51	192
13	14	15	555	65478	43691	29594	468	19	6429	842	40	44
		16	145	8836	6757	4779	95	6	1967	398	14	31
		17	57	4424	6838	8271	231	7	3264	482	17	17
		19	25	1963	2930	4371	59	5	3289	661	53	63
		21	4	632	1194	3339	95	1	2995	977	123	24
		22	64	5696	8772	10261	269	13	3604	735	15	92
		23	218	12484	10558	9661	169	4	3542	485	21	66
		24	240	21751	27669	24397	660	56	8098	1659	49	60
26	27	28	47	8497	13574	18017	574	47	9129	3372	635	71
	29	30	65	7414	13886	16522	547	34	5364	1104	18	62
		31	111	11439	8789	6098	93	8	1775	285	9	10
		32	14	2628	3517	3905	113	19	1679	253	16	8
		33	126	3242	5397	6731	208	11	2380	396	73	46
D			8	462	720	2075	339	2	2077	942	7	39
E			231	7624	7227	5991	116	6	3772	675	19	50
F			1587	85705	76026	43537	954	110	20856	2853	127	626
		41	1271	62159	44623	22533	493	73	14312	2073	98	451
		43	316	23546	31403	21004	461	37	6544	780	29	175
G			788	72253	144079	216040	3030	338	78535	9433	440	880
		45	100	13971	21979	24036	496	24	6366	530	20	51
		46	243	24876	40336	55083	1098	132	31517	4032	304	269
		47	445	33406	81764	136921	1436	182	40652	4871	116	560

²¹ ISCED 0: Early childhood education ('less than primary' for educational attainment); ISCED 1: Primary education; ISCED 2: Lower secondary education; ISCED 3: Upper secondary education; ISCED 4: Post-secondary non-tertiary education; ISCED 5: Short-cycle tertiary education; ISCED 6: Bachelor's or equivalent level; ISCED 7: Master's or equivalent level; ISCED 8: Doctoral or equivalent level.

²² Unknown level of education of the employee.

ISCED 2011 Levels ²¹												
CAE Rev.3			0	1	2	3	4	5	6	7	8	UNK ²²
H			272	28074	45185	53487	444	25	16812	1707	43	265
49	50	51	268	26590	41331	46541	434	24	15080	1490	38	264
		53	4	1484	3854	6946	10	1	1732	217	5	1
I			1105	46538	73477	74714	1233	83	14872	1032	27	998
J			4	958	3879	26622	1321	163	56748	12366	319	275
58	59	60	1	336	1235	4878	123	22	8452	951	32	11
		61	0	288	1005	4376	112	1	6070	314	6	25
		63	3	334	1639	17368	1086	140	42226	11101	281	239
K			23	854	2944	25610	586	22	39607	5497	153	80
L			77	3614	5081	8847	219	38	6158	856	31	53
M			84	4482	11443	38484	1472	236	61656	13969	2288	294
N			1142	68663	84341	91603	1389	51	32975	3488	67	2200
O			27	2203	3955	4294	57	7	1382	361	38	3
P			169	4852	7251	13090	520	64	25191	4745	3897	28
Q			716	42597	59083	75753	1409	233	90590	9027	476	231
		86	139	7451	16744	36219	615	102	57823	5538	361	97
		88	577	35146	42339	39534	794	131	32767	3489	115	134
R			54	2535	4748	9657	343	30	7686	1083	62	65
S			140	7935	13434	18156	487	60	14469	2095	379	111
U			0	5	4	62	0	0	42	4	0	0
Sum. ²³			10280	589474	747580	891304	18183	1777	541709	83510	9539	9469

Note:

Table based on Quadros de Pessoal 2020 – Quadro 36 (GEP, 2020)

Table cover only Portugal continental.

²³ Sum of values for the referred level of education.

Appendix H

PERCENTAGE OF EMPLOYED PERSONAL BY ISCED 2011 LEVEL OF EDUCATION PER CAE SECTOR AND INDICATOR OF KNOWLEDGE INTENSITY.

Table 19. Percentage of employed personal per CAE per level of education

CAE Rev.3			ISCED 2011 Levels										SUM
			0	1	2	3	4	5	6	7	8	UNK	O ve r 5 ²⁴
A			2,21%	38,54%	30,92%	17,46%	0,39%	0,05%	6,23%	0,61%	0,04%	3,55%	7%
	01	02	2,27%	37,11%	31,31%	17,95%	0,41%	0,05%	6,41%	0,60%	0,04%	3,85%	7%
		03	1,49%	55,04%	26,38%	11,88%	0,14%	0,05%	4,17%	0,73%	0,02%	0,09%	5%
B			0,76%	39,42%	28,65%	20,96%	0,29%	0,02%	8,92%	0,86%	0,06%	0,06%	10%
C			0,37%	29,28%	29,41%	27,56%	0,65%	0,04%	10,28%	2,10%	0,18%	0,13%	13%
10	11	12	0,65%	28,89%	30,80%	26,53%	0,44%	0,05%	10,97%	1,39%	0,06%	0,22%	12%
13	14	15	0,38%	44,49%	29,69%	20,11%	0,32%	0,01%	4,37%	0,57%	0,03%	0,03%	5%
		16	0,63%	38,37%	29,34%	20,75%	0,41%	0,03%	8,54%	1,73%	0,06%	0,13%	10%
		17	0,24%	18,74%	28,96%	35,03%	0,98%	0,03%	13,83%	2,04%	0,07%	0,07%	16%
		19	0,19%	14,63%	21,83%	32,57%	0,44%	0,04%	24,51%	4,93%	0,39%	0,47%	30%
		21	0,04%	6,73%	12,72%	35,58%	1,01%	0,01%	31,92%	10,41%	1,31%	0,26%	44%
		22	0,22%	19,29%	29,71%	34,76%	0,91%	0,04%	12,21%	2,49%	0,05%	0,31%	15%
		23	0,59%	33,55%	28,38%	25,96%	0,45%	0,01%	9,52%	1,30%	0,06%	0,18%	11%
		24	0,28%	25,70%	32,69%	28,82%	0,78%	0,07%	9,57%	1,96%	0,06%	0,07%	12%
26	27	28	0,09%	15,75%	25,15%	33,39%	1,06%	0,09%	16,92%	6,25%	1,18%	0,13%	24%
	29	30	0,14%	16,47%	30,85%	36,70%	1,22%	0,08%	11,92%	2,45%	0,04%	0,14%	14%
		31	0,39%	39,97%	30,71%	21,31%	0,32%	0,03%	6,20%	1,00%	0,03%	0,03%	7%
		32	0,12%	21,63%	28,94%	32,13%	0,93%	0,16%	13,82%	2,08%	0,13%	0,07%	16%
		33	0,68%	17,42%	29,00%	36,17%	1,12%	0,06%	12,79%	2,13%	0,39%	0,25%	15%
D			0,12%	6,93%	10,79%	31,10%	5,08%	0,03%	31,13%	14,12%	0,10%	0,58%	45%
E			0,90%	29,65%	28,11%	23,30%	0,45%	0,02%	14,67%	2,63%	0,07%	0,19%	17%
F			0,68%	36,88%	32,72%	18,74%	0,41%	0,05%	8,97%	1,23%	0,05%	0,27%	10%
	41		0,86%	41,97%	30,13%	15,22%	0,33%	0,05%	9,66%	1,40%	0,07%	0,30%	11%
	43		0,37%	27,93%	37,25%	24,92%	0,55%	0,04%	7,76%	0,93%	0,03%	0,21%	9%
G			0,15%	13,74%	27,40%	41,09%	0,58%	0,06%	14,94%	1,79%	0,08%	0,17%	17%
	45		0,15%	20,68%	32,53%	35,57%	0,73%	0,04%	9,42%	0,78%	0,03%	0,08%	10%
	46		0,15%	15,76%	25,55%	34,89%	0,70%	0,08%	19,96%	2,55%	0,19%	0,17%	23%

²⁴ Sum of the values from levels 5 to 8 ISCED that are the definition for a knowledge intensive activity (Eurostat, 2020).

ISCED 2011 Levels													
CAE Rev.3												SUM	
			0	1	2	3	4	5	6	7	8	UNK	O ve r 524
	47		0,15%	11,12%	27,22%	45,59%	0,48%	0,06%	13,53%	1,62%	0,04%	0,19%	15%
H			0,19%	19,19%	30,88%	36,56%	0,30%	0,02%	11,49%	1,17%	0,03%	0,18%	13%
49	50	51	0,20%	20,13%	31,30%	35,24%	0,33%	0,02%	11,42%	1,13%	0,03%	0,20%	13%
		53	0,03%	10,41%	27,04%	48,73%	0,07%	0,01%	12,15%	1,52%	0,04%	0,01%	14%
I			0,52%	21,74%	34,32%	34,90%	0,58%	0,04%	6,95%	0,48%	0,01%	0,47%	7%
J			0,00%	0,93%	3,78%	25,93%	1,29%	0,16%	55,28%	12,05%	0,31%	0,27%	68%
58	59	60	0,01%	2,09%	7,70%	30,41%	0,77%	0,14%	52,69%	5,93%	0,20%	0,07%	59%
		61	0,00%	2,36%	8,24%	35,88%	0,92%	0,01%	49,77%	2,57%	0,05%	0,20%	52%
		63	0,00%	0,45%	2,20%	23,34%	1,46%	0,19%	56,74%	14,92%	0,38%	0,32%	72%
K			0,03%	1,13%	3,91%	33,98%	0,78%	0,03%	52,55%	7,29%	0,20%	0,11%	60%
L			0,31%	14,47%	20,35%	35,42%	0,88%	0,15%	24,66%	3,43%	0,12%	0,21%	28%
M			0,06%	3,33%	8,51%	28,63%	1,10%	0,18%	45,87%	10,39%	1,70%	0,22%	58%
N			0,40%	24,01%	29,50%	32,04%	0,49%	0,02%	11,53%	1,22%	0,02%	0,77%	13%
O			0,22%	17,87%	32,08%	34,83%	0,46%	0,06%	11,21%	2,93%	0,31%	0,02%	15%
P			0,28%	8,11%	12,12%	21,89%	0,87%	0,11%	42,12%	7,93%	6,52%	0,05%	57%
Q			0,26%	15,21%	21,09%	27,04%	0,50%	0,08%	32,34%	3,22%	0,17%	0,08%	36%
		86	0,11%	5,96%	13,39%	28,95%	0,49%	0,08%	46,23%	4,43%	0,29%	0,08%	51%
		88	0,37%	22,67%	27,31%	25,50%	0,51%	0,08%	21,14%	2,25%	0,07%	0,09%	24%
R			0,21%	9,65%	18,08%	36,77%	1,31%	0,11%	29,27%	4,12%	0,24%	0,25%	34%
S			0,24%	13,86%	23,46%	31,70%	0,85%	0,10%	25,27%	3,66%	0,66%	0,19%	30%
U			0,00%	4,27%	3,42%	52,99%	0,00%	0,00%	35,90%	3,42%	0,00%	0,00%	39%

Note: Table based on Quadros de Pessoal 2020 – Quadro 36 (GEP, 2020). Table covering only Portugal continental.

Appendix I

R&D COST AND GROSS VALUE ADDED (GVA) IN PORTUGAL BETWEEN 2020-2015 SOURCES FOR THE RATIO CALCULATION OF R&D INTENSITY (IN PORTUGUESE)

Table 20. Expenditure in R&D in Portugal by CAE classification

CAE (Rev.3)	2020	2019	2018	2017	2016	2015
A	21 206,6	13 515,9	10 563,3	11 267,4	9 030,7	4 996,5
01 - Agricultura, produção animal, caça e atividades dos serviços relacionados	16 548,7	10 150,9	7 332,2	5 703,7	4 772,0	2 719,1
02 - Silvicultura e exploração florestal	2 850,1	2 061,1	1 811,9	4 916,1	3 931,6	1 281,1
03 - Pesca e aquicultura	1 807,7	1 303,8	1 419,2	647,6	327,0	996,3
B	2 755,1	1 350,7	1 542,4	2 733,6	714,0	422,1
05 - Extração de hulha e lenhite	//	//				
06 - Extração de petróleo bruto e gás natural	//	//				
07 - Extração e preparação de minérios metálicos	..	..	..	..	..	..
08 - Outras indústrias extrativas	2 755,1	1 350,7	1 542,4	2 733,6	714,0	422,1
09 - Atividades dos serviços relacionados com as indústrias extrativas	..	..	..	..	..	..
C	666 166,8	623 483,4	581 079,3	512 919,2	480 633,7	406 680,0
10 - Indústrias alimentares	45 106,5	41 209,7	33 992,2	28 462,6	28 813,8	26 824,4
11 - Indústria das bebidas	19 558,8	22 716,2	33 516,6	22 042,0	20 085,7	18 252,9
12 - Indústria do tabaco	//	//				
13 - Fabricação de têxteis	23 459,1	20 356,8	17 212,1	15 682,0	16 307,7	15 602,8
14 - Indústria do vestuário	13 352,1	9 381,4	5 689,3	4 957,5	4 191,4	3 259,3
15 - Indústria do couro e dos produtos do couro	10 227,4	11 447,0	9 437,4	9 081,7	7 979,8	8 044,8
16 - Indústrias da madeira e da cortiça e suas obras, exceto mobiliário; fabricação de obras de cestaria e de espartaria	24 190,2	21 323,3	17 919,3	15 420,0	10 645,1	10 737,8
17 - Fabricação de pasta, de papel, cartão e seus artigos	21 761,4	26 748,9	19 745,6	13 633,1	11 194,7	9 813,3
18 - Impressão e reprodução de suportes gravados	17 452,6	13 875,9	13 149,1	12 500,0	11 786,7	11 657,2
19 - Fabricação de coque, de produtos petrolíferos refinados e de aglomerados de combustíveis	7 006,8	6 977,5	..	..	..	..

CAE (Rev.3)	2020	2019	2018	2017	2016	2015
20 - Fabricação de produtos químicos e de fibras sintéticas ou artificiais, exceto produtos farmacêuticos	36 742,7	33 656,7	33 816,2	29 696,8	32 101,8	26 715,7
21 - Fabricação de produtos farmacêuticos de base e de preparações farmacêuticas	90 431,5	90 969,7	116 797,1	99 960,1	88 044,1	74 548,6
22 - Fabricação de artigos de borracha e de matérias plásticas	46 130,7	40 971,4	38 687,8	33 369,5	36 029,5	22 643,5
23 - Fabricação de outros produtos minerais não metálicos	40 989,3	50 237,2	36 188,5	30 050,2	21 027,8	24 187,1
24 - Indústrias metalúrgicas de base	11 601,9	15 106,7	11 678,5	12 053,9	10 366,6	7 537,9
25 - Fabricação de produtos metálicos, exceto máquinas e equipamentos	45 609,1	37 174,6	31 491,1	32 325,3	26 843,9	22 530,6
26 - Fabricação de equipamentos informáticos, equipamento para comunicações e produtos eletrônicos e óticos	50 214,7	37 085,1	35 781,4	36 693,0	36 629,9	31 067,9
27 - Fabricação de equipamento elétrico	39 507,9	39 320,2	34 285,8	31 400,5	30 324,2	26 345,8
28 - Fabricação de máquinas e de equipamentos, n.e.	40 153,1	31 851,9	30 263,3	26 660,4	25 144,8	21 303,4
29 - Fabricação de veículos automóveis, reboques, semirreboques e componentes para veículos automóveis	42 385,7	42 614,9	34 338,8	36 634,7	39 068,5	32 413,1
30 - Fabricação de outro equipamento de transporte	7 788,4	7 579,9	8 047,3	7 067,8	9 028,6	4 108,4
31 - Fabricação de mobiliário e de colchões	7 143,5	6 518,2	6 205,0	4 831,6	3 029,9	3 627,1
32 - Outras indústrias transformadoras	6 738,3	6 641,2	5 505,6	4 729,0	4 493,4	..
33 - Reparação, manutenção e instalação de máquinas e equipamentos	18 615,1	9 719,1	7 331,3	5 667,6	7 495,9	5 458,2
D	12 064,7	12 061,0	8 104,6	4 054,6	7 850,2	7 037,0
35 - Eletricidade, gás, vapor, água quente e fria e ar frio	12 064,7	12 061,0	8 104,6	4 054,6	7 850,2	7 037,0
E	14 153,6	10 485,7	7 070,4	5 253,0	5 511,5	5 553,4

CAE (Rev.3)	2020	2019	2018	2017	2016	2015
36 - Captação, tratamento e distribuição de água	3 396,4	3 594,3	1 914,0	1 766,8	1 764,4	1 372,9
37 - Recolha, drenagem e tratamento de águas residuais	2 623,0	1 806,8	1 647,0	620,8	293,5	1 404,6
38 - Recolha, tratamento e eliminação de resíduos; valorização de materiais	8 134,2	5 084,7	3 509,3	2 865,4	3 453,6	2 775,9
39 - Descontaminação e atividades similares	..	..	..	..	..	..
F	21 068,3	15 593,2	12 452,8	10 682,5	6 230,3	8 058,3
41 - Promoção imobiliária (desenvolvimento de projetos de edifícios); construção de edifícios	5 964,4	4 051,1	4 314,8	3 478,9	1 022,1	687,7
42 - Engenharia Civil	10 894,5	6 574,8	5 078,0	5 578,5	2 999,7	4 805,4
43 - Atividades especializadas de construção	4 209,3	4 967,3	3 060,0	1 625,1	2 208,5	2 565,2
G	79 820,0	70 221,3	53 623,4	55 181,1	47 954,0	46 023,9
45 - Comércio, manutenção e reparação, de veículos automóveis e motociclos	2 139,2	2 305,6	491,0	493,6	776,4	274,6
46 - Comércio por grosso (inclui agentes), exceto de veículos automóveis e motociclos	77 680,7	67 915,8	53 132,4	54 687,4	47 177,6	45 749,3
H	26 049,3	35 344,0	21 500,0	17 013,8	12 312,6	10 120,8
47 - Comércio a retalho, exceto de veículos automóveis e motociclos	16 194,6	11 236,4	7 313,9	6 486,3	4 354,2	4 202,6
49 - Transportes terrestres e transportes por oleodutos ou gasodutos	2 842,1	2 455,2	2 016,7	1 712,6	1 367,5	1 431,1
50 - Transportes por água	..	//				
51 - Transportes aéreos	863,0	9 498,3	2 321,0	..	..	..
52 - Armazenagem e atividades auxiliares dos transportes (inclui manuseamento)	6 149,7	12 153,9	9 848,3	8 814,8	6 590,9	4 487,1
53 - Atividades postais e de courier	..	..	..	..	..	..
I	2 024,1	3 275,1	1 467,1	460,5	392,0	0,0
55 - Alojamento	1 549,9	2 660,4	814,0	460,5	392,0	..
56 - Restauração e similares	474,2	614,7	653,0	..	..	..
J	402 503,5	306 436,7	301 236,3	258 781,9	213 460,8	182 727,4
58 - Atividades de edição	22 341,4	17 588,8	14 789,2	16 205,4	11 682,9	11 899,3
59 - Atividades cinematográficas, de vídeo, de produção de programas de	444,9	481,4	352,3	293,1	316,8	..

CAE (Rev.3)	2020	2019	2018	2017	2016	2015
televisão, de gravação de som e de edição de música						
60 - Atividades de rádio e de televisão	401,2	..	..		..	..
61 - Telecomunicações	43 871,6	47 378,3	74 188,8	71 628,7	58 815,1	45 961,9
62 - Consultoria e programação informática e atividades relacionadas	286 159,4	205 363,5	181 579,7	147 035,6	133 049,4	117 349,9
63 - Atividades dos serviços de informação	49 285,1	35 624,7	30 326,4	23 619,2	9 596,6	7 516,4
K	147 702,5	110 921,0	107 162,1	136 756,9	166 474,6	166 314,8
64 - Atividades de serviços financeiros, exceto seguros e fundos de pensões	127 804,1	99 021,3	97 005,4	127 009,6	136 664,7	130 576,4
65 - Seguros, resseguros e fundos de pensões, exceto segurança social obrigatória	18 434,6	11 025,4	10 156,7	8 899,9	28 935,8	35 217,4
66 - Atividades auxiliares de serviços financeiros e dos seguros	1 463,7	874,3	..	847,4	874,1	521,0
L	1 227,1	1 811,4	5 418,4	0,0	0,0	0,0
68 - Atividades imobiliárias	1 227,1	1 811,4	5 418,4	..	..	..
M	348 752,0	299 604,4	240 301,9	234 851,4	165 240,2	148 253,8
69 - Atividades jurídicas e de contabilidade	1 879,6	1 101,9	502,2	..	..	..
70 - Atividades das sedes sociais e de consultoria para a gestão	123 176,2	102 045,9	69 472,8	57 214,8	15 345,1	12 753,6
71 - Atividades de arquitetura, de engenharia e técnicas afins; atividades de ensaios e de análises técnicas	74 524,9	66 693,2	51 190,3	57 353,2	47 983,5	42 198,0
72 - Atividades de investigação científica e de desenvolvimento	117 666,5	106 897,4	104 903,3	105 399,7	91 857,4	85 112,3
73 - Publicidade, estudos de mercado e sondagens de opinião	4 468,7	3 178,7	1 523,2	1 687,9	910,0	819,3
74 - Outras atividades de consultoria, científicas, técnicas e similares	26 159,0	19 222,5	12 351,8	12 916,2	8 844,4	7 370,6
75 - Atividades veterinárias	877,1	464,7	358,2	279,6	299,8	..
N	53 507,2	27 544,5	36 699,4	14 448,0	13 027,7	12 180,2
77 - Atividades de aluguer	1 617,2	860,7	591,9	447,9	388,0	300,3
78 - Atividades de emprego	//	..			..	

CAE (Rev.3)	2020	2019	2018	2017	2016	2015
79 - Agências de viagem, operadores turísticos, outros serviços de reservas e atividades relacionadas	996,2	563,9	610,6	282,4	304,5	..
80 - Atividades de investigação e segurança	1 483,7	319,9	189,9	..	..	..
81 - Atividades relacionadas com edifícios, plantaço e manutenção de jardins	810,3	138,7	..	..		
82 - Atividades de serviços administrativos e de apoio prestados às empresas	48 599,8	25 661,3	35 307,0	13 717,6	12 335,2	11 879,9
O	0,0	0,0	0,0	0,0	0,0	0,0
84 - Administração Pública e Defesa; Segurança Social Obrigatória				..		
P	1 836,9	1 439,5	1 007,4	266,9	217,7	589,0
85 - Educação	1 836,9	1 439,5	1 007,4	266,9	217,7	589,0
Q	17 570,1	14 312,8	12 222,3	10 160,1	7 621,1	0,0
86 - Atividades de saúde humana	17 570,1	14 261,0	12 121,3	10 160,1	7 621,1	..
87 - Atividades de apoio social com alojamento	//	//				
88 - Atividades de apoio social sem alojamento	..	51,8	101,0	..	..	..
R	12 480,8	12 090,2	9 717,3	10 357,5	5 811,0	11 153,3
90 - Atividades de teatro, de música, de dança e outras atividades artísticas e literárias	670,7	639,6	422,7	378,1	549,5	331,4
91 - Atividades das bibliotecas, arquivos, museus e outras atividades culturais	795,6	734,8	..	..		
92 - Lotarias e outros jogos de aposta	//	//				
93 - Atividades desportivas, de diversão e recreativas	2 788,8	2 552,2	1 555,9	1 315,0	..	1 298,3
94 - Atividades das organizações associativas	5 179,3	4 845,9	3 644,6	5 025,9	5 261,5	9 523,7
95 - Reparação de computadores e de bens de uso pessoal e doméstico	3 046,5	3 317,7	4 094,1	3 638,6	..	..
96 - Outras atividades de serviços pessoais	..	..	..	..	..	..
Total	1 843 559,2	1 570 510,1	1 424 577,6	1 303 484,0	1 156 466,1	1 036 532,3

Note: Values given in thousands of euros

Table 21. GVA of companies: total and by economic sector – Millions of Euros

Sectores de actividade económica ²⁵		Anos	2015	2016	2017	2018	2019	2020
		Total	€ 91378,40	€ 95497,80	€104268,70	€109703,60	€114706,10	€104220,20
A	Agricultura, produção animal, caça, silvicultura e pesca	€	1562,70	€ 1654,80	€ 1884,50	€ 1955,10	€ 2122,00	€ 2098,50
B	Indústrias extractivas	€	393,80	€ 403,30	€ 461,80	€ 478,90	€ 469,50	€ 434,70
C	Indústrias transformadoras	€	19239,20	€ 20159,40	€ 21853,90	€ 22471,90	€ 22864,90	€ 21135,50
D+	Electricidade, gás e água	€	5565,80	€ 5864,80	€ 5164,00	€ 5415,90	€ 5584,40	€ 5660,00
E								
F	Construção	€	5402,90	€ 5365,80	€ 5951,40	€ 6708,20	€ 7585,50	€ 7782,10
G	Comércio por grosso e a retalho (...)	€	15652,20	€ 16581,90	€ 17866,10	€ 19019,20	€ 19853,50	€ 18912,00
H	Transporte e armazenagem	€	6365,20	€ 6628,60	€ 7169,80	€ 7534,30	€ 7794,10	€ 5148,20
I	Alojamento, restauração e similares	€	3912,50	€ 4749,60	€ 5798,90	€ 6329,20	€ 6907,80	€ 3183,80
K	Actividades financeiras e de seguros	€	10830,80	€ 10087,40	€ 11578,50	€ 11051,00	€ 10288,40	€ 10033,70
L	Actividades imobiliárias	€	1590,40	€ 1897,40	€ 2369,80	€ 2683,50	€ 3241,40	€ 2877,10
P	Educação	€	844,80	€ 848,80	€ 901,10	€ 977,10	€ 1031,40	€ 948,10
Q	Actividades de saúde humana e apoio social	€	3032,30	€ 3165,30	€ 3437,40	€ 3622,10	€ 3906,60	€ 3494,30
	Outros sectores	€	16986,00	€ 18090,70	€ 19831,30	€ 21457,10	€ 23056,60	€ 22512,20

Fontes de Dados: INE - Inquérito Anual às Empresas (até 2003) | Sistema de Contas Integradas das Empresas (a partir de 2004)

Fonte: PORDATA

Última actualização: 2022-03-30

Valores apresentados a preços de mercado.

Estão contidas no universo empresarial descrito as empresas públicas com actividades mercantis.

Entre 1996 e 2003, os valores apresentados incluem as secções A a N da CAE Rev.2.1, com excepção das secções J e L.

Até 2004 os valores apresentados incluem as sociedades e os empresários em nome individual.

A partir de 2004 (inclusive) os valores apresentados incluem as secções A a S da CAE Rev.3, com excepção da secção O; além das sociedades e empresários em nome individual passam também a estar incluídos os trabalhadores independentes.

A designação dos sectores de actividade económica apresentados está de acordo com a Classificação das Actividades Económicas (CAE) Rev.3, excepto para a actividade económica "Produção e distribuição de electricidade, gás e água" que está de acordo com a CAE Rev.2.1. Nos casos onde existiram alterações de nomenclatura entre as diferentes revisões da CAE, esclarece-se que os dados apresentados seguem os seguintes critérios:

Na categoria "Agricultura, produção animal, caça, floresta e pesca" consideraram-se a secção A da Rev.3 e as secções A e B da Rev.2.1.

Na categoria "Electricidade, gás e água" considerou-se as secções D e E da Rev.3 e a secção E da Rev.2.1.

Na categoria "Comércio por grosso e a retalho;..." considerou-se a secção G da Rev.3 e a secção G da Rev.2.1.

Na categoria "Transportes e armazenagem" considerou-se a secção H da Rev.3 e a secção I da Rev.2.1.

Na categoria "Alojamento, restauração e similares" considerou-se a secção I da Rev.3 e a secção H da Rev.2.1.

Na categoria "Actividades financeiras e de seguros" considerou-se a secção K da Rev.3 e a secção J da Rev.2.1.

Na categoria "Actividades imobiliárias" considerou-se a secção L da Rev.3 e a secção K da Rev.2.1.

²⁵ CAE Rev. 3 sectors

Na categoria “Actividades de saúde humana e apoio social” consideron-se a secção Q da Rev.3 e a secção N da Rev.2.1.

Até 1999 (inclusive) os valores foram convertidos em Euros a partir da unidade milhar de milhão de Escudos (milhões de Contos).