GLOBALINTO

Deliverable 3.5

MICRO-LEVEL INTANGIBLES MEASURE: THE CASE OF PUBLIC SECTOR & APPLICATION TO SLOVENIA

Due date of deliverable: 2020/07/31 (postponement due to Covid February 1st 2021)

Actual submission date: 29.1.2021

Globalinto Identifier:	WP3
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Work package/task:	WP3 / Task 3.12
Document status:	Final (subject to change in case of possible changes in agreed methodologies in other countries)
Confidentiality:	Public

Summary of changes in the document

1	Document is subject to change and will possibly be amended with any methodological changes based on the development of the Globalinto approach by the end of the project.	
2		
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4		

Prepared using linked employer-employee datasets, provided by the Statistical Office of the Republic of Slovenia. This analysis would not be possible without their expert support, in particular the User relations section of the Data publication and communication division.

REPUBLIC OF SLOVENIA
STATISTICAL OFFICE

This project has received funding from the European Union's Horizon 2020 The mechanisms to promote smart, sustainable and inclusive growth under grant agreement No 822259.

Summary

This paper focuses on the application of the Globalinto methodology and modification of the existing Globalinto methodology for the private (market) sector in order to apply the methodology also to the public sector. So far, little has been done in the field of the empirical analysis of intangibles in the public sector. The SPINTAN project (Carol Corrado et al., 2016) contributed initial guidance relying on modified definition by Corrado et al. (Carol Corrado et al., 2006). This paper proposes identification strategy for the micro-level measurement of intangible capital. The identification strategy proposes three alternative identifications of the public sector (narrow NACE identification, broad NACE identification and the identification based on the legal status), two different lists of occupations (broad and narrow), and two alternative educational characteristics thresholds (tertiary and master or higher level of education) in order to assess the stock of intangible capital in the public sector. By that, the methodology for the public sector extends the definition of intangible capital in the private sector by adding relevant occupations and education fields for the public sector (following also deliverable 7.1). These are among other for example medical doctors, also nurses, of course, depending also on education level.

Estimations show that the stock of organisational capital is the most robust with respect to the possible identification of the public sector; however, the stock of R&D and ICT depends very much on such identification. When investigating the educational and health sub-type of the R&D intangible capital separately, we find that estimations under the narrow definition of public sector produce twice as high estimations of the stock of intangible capital. One important outcome of this empirical exercise is the finding that when investigating the flow of intangible capital (potential increase or decrease) is very robust to the identification of the public sector.

Applying an alternative list of occupations shows that the stock of organizational capital does not change significantly, but again the changes are more profound in the R&D type of intangible capital. Lifting the threshold level of education from tertiary to master or higher degree lowers the estimated stock of intangible capital, especially in educational and health sub-type of the intangible capital. On the contrary, the changes are less evident in the organizational type of intangible capital. Applying the uniform level of education necessary to be recognized as the stock of intangible capital should be therefore further investigated.

The paper investigates empirically the characteristic of intangible capital in Slovenia, by applying the Globalinto methodology, which relies on occupational classification and educational classification of employees into the three different categories of intangible capital, computerised information (ICT), innovative capital (R&D) and economic competencies (OC). The results show that the stock of economic competencies is the least sensitive to the specification of the public sector. On the other hand, the alternative list of occupations is most sensitive to the specifications of the public sector, especially in the case health care occupational sub-major group and the educational. However, the investigation of the flow of intangible capital stock (potential decrease or increase) is robust to the different specifications of the public sector. By adding alternative list of occupations, we show that the innovation capital, especially in the sub-type of educational and health

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innovation capital, represents high stock of intangible capital and should be thus included in the estimations. We also show, that increasing the threshold level of education to estimate the stock of intangible capital gives more reliable estimations.

We would like to stress that at this point in the project, the research on the characteristics of intangibles in the public sector is still an on-going process within this project and consequently this report is an interim report that captures current developments. While data across countries differs, additional approaches may be suggested to either exploit additional possibilities offered by the data or to overcome challenges in countries, where data is harder to obtain or is less complete. Therefore, the deliverable might be amended if the Globalinto team decides to adjust the methodologies.

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1 Introduction

Intangible capital and intangible investments are equally important in the private and public sector. Public sector intangibles are important because

- of their direct impact on the performance or the productivity of the public sector;
- indirect impact of public sector performance on the private sector performance by providing more or less efficient services to the private sector in those industries, where public sector provides such services (for example NACE O/ Public administration, defence, compulsory social security)
- indirect effect on the private sector, because the public sector intangibles impact the quality of intangible capital in the private sector (e.g. NACE P/Education).

So far very little has been done in the process of empirical evaluation of intangible capital in the public sector. The results of the bibliometric analysis in this paper highlight the void in the literature and also stress the seminal contribution of the SPINTAN project (Carol Corrado et al., 2016). However, methodologically, Spintan project relies on a sectoral approach, which differs from the Innodrive and consequently Globalinto methodology. Innodrive methodology relies on the occupational and educational categorization and evaluates the intangible capital in the market sector. The SPINTAN project identified several challenges that are shared also with the GLOBALINTO project. First, is the identification of the public sector and second is the measurement of the stock and investment in the intangible capital in the public sector. The purpose of this paper is therefore twofold. First, to propose different identification strategies for public sector definition and second, to develop micro-level intangible measure for the stock of intangible capital.

Building on the work done by the SPINTAN project, the INNODRIVE project and achievements of the Globalinto project this deliverable proposes micro-level intangible measure for three types of intangible capital: (1) economic competences and organizational capital (OC) such as management and marketing, and information, (2) research and development (R&D) intangible capital and (3) communication capital (ICT). Micro-level intangible measure is proposed by using linked employer-employee data (LEED) for each country separately. The development of the measure follows three steps: the identification of the public sector, the identification of occupations and identification of the field and level of education. In order to assure the application value for all the EU countries, the public sector, the occupations and the education characteristics of an employee are identified using standard classifications (described in detail in Chapter 3). Measure of the intangible capital in the public sector is developed by using three different strategies for the identification of the public sector, two different lists of occupations as well as two different educational characteristics and the combination of them. By that a matrix of 3 by 4 for the different identification strategies is developed. By applying the matrix on the micro-level data for a selected country (Slovenia), we are able to test the robustness of the specifications as well as to infer about the appropriate measure of the intangibles in public sector.

This deliverable is starts with the overview of the existing approaches to measuring intangible capital in public sector, where in particular focuses on the SPINTAN and INNODRIVE approach and offers a bibliometric

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analysis of the investigation of intangible capital in public sector from 2003 until 2020. The third chapter proposes the micro-level measure in public sector (three different alternatives for the identification of public sector, two for the lists of occupations and two for the educational characteristics). The proposed measures are applied in the case of Slovenia. The paper concludes with a discussion of future research challenges.

We would like to stress that at this point in the project, the research on the characteristics of intangibles in the public sector is still an on-going process within this project and consequently this report is an interim report that captures current developments. While data across countries differs, additional approaches may be suggested to either exploit additional possibilities offered by the data or to overcome challenges in countries, where data is harder to obtain or is less complete. Therefore, the deliverable might be amended if the Globalinto team decides to adjust the methodologies.

2 Overview of existing approaches to measuring public sector intangibles

This chapter first discusses the existing approaches in the measurement of intangible capital and presents the void in the literature to stress the importance of the empirical investigation of intangible investments in the public sector.

2.1 Empirical evaluation of intangible capital in the public sector: a literature review

A brief bibliometric analysis reveals that so far very little has been done in the field of empirical evaluation of intangible capital in the public sector. Two bibliographic databases were searched, Scopus and Web of Knowledge. Both databases were explored due to low number of suitable papers in both. WoS covered over 21 thousand journals, books and proceedings (Web of Science Group, 2020), while Scopus covered almost 23 thousand periodicals and over 150 thousand books. For Scopus, the coverage is broader, however both Scopus and WoS have a tendency of overrepresenting English language and a stronger focus on specific disciplines (e.g. Natural Sciences, Engineering and Biomedical Research) (Mongeon and Paul-Hus, 2016). WoS is more focused on the journals with citation index.

The search was done using the keywords "intangible capital" and "public sector". The search of Scopus resulted in 96 hits, while Web of Knowledge collection included 56 hits. Due to the low number of hits, all results were explored and are briefly presented here. Table 1 summarizes both databases Web of Science collection comprised 56 documents with keywords/keywords plus, title words or words in abstract that included "intangible" capital and public sector. The documents were published from 2003 on, the first paper in 2003 and second in 2004 focusing on components of intangible capital. For example, the Carmeli and Tishler (2004) paper focuses on the "independent intangible organizational elements and the interactions among them« in order to assess their impact on organizational performance measures in local government institutions in Israel. They show that organizational performance can be linked to »intangible organizational elements (managerial capabilities, human capital, internal auditing, labour relations, organizational culture, and perceived organizational reputation) «. Guthrie et al. (2001) focus on measuring intellectual capital in different organisations and »the wider social fabric«, focusing also on new accounting approaches towards measuring intangibles within public and private sector organisations. In Scopus database, already in 1983 a paper on the »Adaptive DSS design strategy for a regional socioeconomic balance sheet«(Sharp & Bharath, 1983) suggests introducing a socio-economic balance sheet similar to those of companies, however expanded to include human capital and components of intangible capital (they specifically suggest education and water resources). Also, the authors stress that such a socio-economic balance-sheet would »'add-up' those main factors—tangible and intangible—which contribute, in a positive or negative sense to the total cumulative wealth of the region«. Many papers in fact study private sector

but admit the importance of public sector for its performance, which confirms the importance of the study of intangible capital in the public sector.

Table 1: Summary of documents in Scopus and Web of Science (WoS)

Description	**WOS**	**Scopus**
MAIN INFORMATION ABOUT DATA		
Timespan	2001:2020	1983:2020
Sources (Journals, Books, etc)	51	71
Documents	56	96
Average years from publication	6,27	8,97
Average citations per documents	9,321	14,57
Average citations per year per doc	0,9048	1,091
References	2612	4302
DOCUMENT TYPES (just main presented)		
article	27	64
book	1	4
book chapter	2	4
proceedings/conference paper	22	12
review	3	7
DOCUMENT CONTENTS		
Keywords Plus (ID)	128	357
Author's Keywords (DE)	206	313
AUTHORS		
Authors	128	209
Author Appearances	135	221
Authors of single-authored documents	12	25
Authors of multi-authored documents	116	184
AUTHORS COLLABORATION		
Single-authored documents	12	30
Documents per Author	0,438	0,459
Authors per Document	2,29	2,18
Co-Authors per Documents	2,41	2,3
Collaboration Index	2,64	2,79

Data: Scopus, Web of Knowledge, analysis in R, Biblioshiny

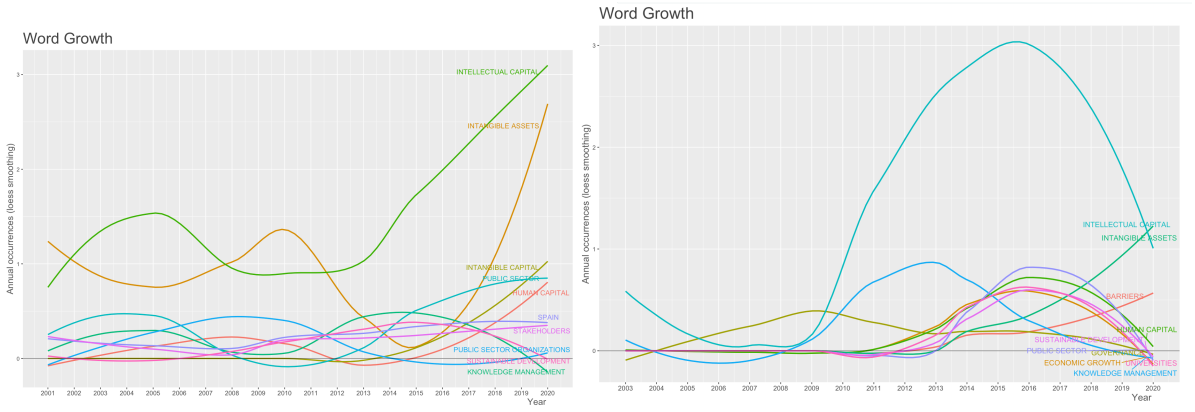
Figure 1 and Figure 2 present the concepts discussed in the literature. The field is dominated still by the indirect effect of public sector on private sector (Abu-Rashed et al., 2005; Messica & Agmon, 2008; Shapiro, 2007), many focus on human and intellectual capital in public sector and certain sectoral applications (Craik, 2005; Das & Raut, 2014; Miller, 2015; Veretennik, 2018), as well as some papers suggest measurement approaches to capturing intangible capital in the public sector (Edvinsson & Bounfour, 2004; Fairchild & de Vuyst, 2005; Ramirez et al., 2013, 2017; Rooney & Dumay, 2016; J.A. Sharp & Bharath, 1983; Sposato & Puntillo, 2012). The literature also directly links the performance of public sector(s) to the intangible capital (human, intellectual or intangible) (Buonomo et al., 2020;

Burgman & Roos, 2004; A. Carmeli & Tishler, 2004; A Carmeli & Tishler, 2004; Cavicchi, 2017; Kamaruddin & Abeysekera, 2013; Mertlova et al., 2015; Rija & Bronzetti, 2011; Selvam et al., 2020; Velibeyoglu & Yigitcanlar, 2010; Wall, 2005). However, the literature is very fragmented, and no unified approach is either used across sectors or countries to allow also the possibility of a comparative analysis. Of course, the literature also comprises of the Corrado seminal contributions (C. Corrado et al., 2017a).

Figure 1: Tree-map Scopus (upper panel, N=96) and WoS (lower panel, N=56)

Data: Scopus, Web of Knowledge, analysis in R, Biblioshiny.

Figure 2: Word dynamics Scopus (left panel, N=96) and WoS (right panel, N=56)



Data: Scopus, Web of Knowledge, analysis in R, Biblioshiny.

With regards to topic, word dynamics (Figure 2) reveals the importance of intellectual and intangible capital (which are closely related) as well as public sector and knowledge management. The interest in the literature increased fast in the past 5 years. However, the fragmented literature at the moment does

not (with the exception of Corrado et al. (2017) work provide solid ground for a unified analytical approach that would allow broader comparisons between sectors, countries as well as measurement of impact.

2.2 The SPINTAN approach

SPINTAN project, led by Corrado team, provided the first systematic and comprehensive approach to measuring intangibles in the public sector, which was methodologically compatible with their definition of intangibles, which was used also for the private sector. This methodology was presented already in detail in Deliverable 7.1. titled "*INTANGIBLE ASSETS IN THE PUBLIC SECTOR: AN EXTENDED DEFINITION AND METHODOLOGICAL GUIDE*". Here, key points are summarized.

The methodology, which was developed within the SPINTAN is based on an intertemporal approach. The methodology was developed for the measurement of the intangible in the non-market sector.

It is first important to clearly define the non-market or the "public sector". According to Corrado et al. (2014, 2016) the non-market sector is defined based on NACE 2 from the Statistical classification of economic activities in the European Community (2008). These activities are (1) public administration and defence (O.84 Public administration and defence; compulsory social security), (2) education (P.85: Education) and (3) human health and social work activities Q.86 Human health activities and Q.87-88 Residential care and social work activities). These sectors are typically non-market sectors. SPINTAN (Corrado et al., 2014, 2016) add also (4) scientific research and development (NACE 72) and (5) arts, entertainment and recreation (R.90-91: Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities and R.92-93: Gambling and betting activities; sports activities and amusement and recreation activities). The rationale behind the inclusion of the later two is based on the large share of non-market activities in these two sectors (Carol Corrado et al., 2014, 2016).

The SPINTAN methodology (Carol Corrado et al., 2014, 2016) introduces also a modified definition of **intangibles in the public sector but provides a clear link of the definition of intangibles in the public sector to the original market sector CHS definition of intangibles** (Carol Corrado et al., 2005). The definition is presented in Table 2.

SPINTAN/CHS methodology is thereby:

(1) consistent with the existing definition of CHS in the private sector but
(2) extends, adjusts the intangibles definition used in the private sector so as to include also all those categories which are relevant for the public sector.

The **SPINTAN/CHS methodology introduces** the **following categories**, which are different or not included in the definition of intangibles for the private sector:

1) **Information, scientific and cultural assets and societal competencies**, which incorporate databases, including open data, available to everybody (from statistical to geospatial data to other public databases);
2) **Cultural and heritage assets**, which are public intangibles, which can derive broader benefits;
3) **Professional/managerial capital**
4) **Human capital**, which is a consequence of schooling

These categories of public intangibles from their private counterparts. In continuing, the differences, as defined by the SPINTAN methodology will be only briefly presented. Namely, the purpose of this deliverable is not to discuss in detail their methodology, but rather present it briefly as well as other used approaches.

Information, scientific and cultural assets are according to SPINTAN methodology extended or amended in the following manner (Carol Corrado et al., 2014, 2016):

- **Information assets**, which are related to the information and content, either prepared/produced or as collected by a public institution as part of the tasks that it undertakes within its regular activities. SPINTAN provides the following examples: geo-spatial, meteorological data, business statistics, etc. The data are stored in public databases, and can be used as an asset. Some data are open, some can be used under specific conditions, while some are not available for wider public use.
- Software is already included in the ESA 2010 and are available for EU countries.
- In the case of R&D in the public sector, the fact that the producer or executor of R&D, who pays for R&D, which is not necessarily the case in publicly funded R&D and represents a challenge in the measurement of public R&D.

Table 2: Market vs. non-market intangible capital

Market sector	Non-market sector
Computerised information	Information, scientific and cultural assets
1 Software	1 Software
2 Databases	2 Databases, including open data
Innovative property	
3 R&D broadly defined to include new product development costs	3 Basic and applied science research, industrial and defence R&D
4 Entertainment and artistic originals	4 Cultural and heritage, including design
5 Design	
6 Mineral exploration	5 Mineral exploration
Economic competencies	Societal competencies/Social infrastructure
7 Brands	6 Brands
8 Organizational capital	7 Organizational capital
8a Managerial capital	7a Professional/managerial capital
8b Purchased organizational services	7b Purchased organizational services
9 Firm-specific human capital (employer provided training)	8 Function-specific human capital (employer provided training)
	9 Schooling-produced human capital

Source: (C. Corrado et al., 2017b)

Innovative property. Cultural assets were added to the definition of public sector intangibles. These include value which stems from cultural goods, which generate value because they have artistic, aesthetic, symbolic and spiritual values. Public investments in cultural assets are therefore added to intangible investments according to the SPINTAN methodology. The "culture" differentiates between cultural and creative industries. The first include market or non-market oriented activities that provide cultural goods and services, which are film, radio, books, arts, etc. Creative industries, on the other hand, have culture as input, and also have a cultural dimension, but produce functional outputs (e.g. graphic design, advertising, architecture, etc.). This includes cultural heritage (museums, historical places, archaeological sites), archives and libraries, visual arts, performing arts, books and press, audio-visual and multimedia and cultural education.

Economic competencies. SPINTAN addresses the issue of **brands in the public sector**. The SPINTAN approach stresses that for public organizations and non-profit organizations (e.g. charities, sports clubs, etc.) typically consistency, focus, trust and partnership are key for brand value (Carol Corrado et al., 2014, 2016).

Organizational capital is defined for the SPINTAN purposes in accordance with the CHS (2005) framework, which defines organizational capital as accumulated knowledge that is built into the organizations through the processes of organizing and changing the production process. The manual stresses several open problems: (1) different workers can carry out tasks that affects the organization and organizational change and that organizational capital is an asset, which is part of an organization and does not depend on a single worker/manager (Carol Corrado et al., 2014, 2016).

SPINTAN also classifies training into several categories: Function-specific human capital (employer provided training) and Schooling-produced human capital. To capture training, several approaches are being suggested, from Continuous Vocational Training data, to Labour Force Survey and linking PIACC to national data.

Overall, the CHS SPINTAN approach, which is in detail described in the manual (Carol Corrado et al., 2014, 2016), provides the first such comprehensive approach to measuring public sector intangibles and highlights a number of issues that also are relevant for the Globalinto approach: from sector definition to data availability, very different types of data and data sources the analysis must rely on as well as country differences in data availability.

2.3 INNODRIVE methodology

The methodology used in Globalinto to evaluate the intangibles in the public sector will follow the innovative approach developed for the purposes of INNODRIVE. The methodology will be upgraded and adapted for the public sector, however, nonetheless, first we briefly present the INNODRIVE approach. The presentation is based on Piekkola (ed.) (2011), in particular the paper " *Firm-level intangible capital in six countries: Finland, Norway, the UK, Germany, the Czech Republic and*

Slovenia" (Piekkola et al., 2011) and the methodological guide prepared by Innodrive team (available at project web-pages).

The methodology used in Globalinto to evaluate the intangibles in the public sector follows and extends the approach developed for the purposes of INNODRIVE. The presentation in this paper is based on Piekkola (ed.) (2011), in particular the paper " *Firm-level intangible capital in six countries: Finland, Norway, the UK, Germany, the Czech Republic and Slovenia*" (Piekkola et al., 2011) and the methodological guide prepared by Innodrive team (available at project web-pages) as well as the Globalinto Deliverable 7.1. titled "*INTANGIBLE ASSETS IN THE PUBLIC SECTOR: AN EXTENDED DEFINITION AND METHODOLOGICAL GUIDE*" (Piekkola et al., 2020). Here, key points are summarized.

Innodrive methodology uses education and occupation data, combined with wages data (Linked employer-employee dataset). The idea, from which the Innodrive methodology stems from is that firms produce three types of goods/capital:

- Information and communications technology (ICT),
- Research and development (R&D), and
- Organisational capital (OC).

The methodology further assumes that firms produce these "types of goods" or capital for their own use. If these are not used in current period, but later, these can be classified in accordance with (Carol Corrado et al., 2005) approach and general definition of investment (goods not consumed today, but in future) as investments (Piekkola et al., 2020). To produce these goods, companies use three types of labour:

- ICT personnel (information and communication experts);
- R&D personnel (technicians, engineers and related occupations);
- OC personnel (management, including owners) and marketing employees.

The key challenges in the analysis addressed primarily the identification of appropriate:

- Industries (NACE codes)
- Occupations related to each category of intangible investment and
- Depreciation rates are also determined (see e.g. (Piekkola et al., 2011, p. 66)).

Occupation selection. Occupation data are used to evaluate the innovative labour input in intangible assets (IA) activities. The selection is presented in continuing.

3 Measuring intangibles in the public sector using LEED data

In order to develop a micro-level intangibles measure applicable for the public sector, the Innodrive methodology is used as a starting point and is adopted by the current methodology being developed and used by the Globalinto project. The strategy to calculate intangible capital in the public sector, already the Deliverable 7.1. titled "*INTANGIBLE ASSETS IN THE PUBLIC SECTOR: AN EXTENDED DEFINITION AND METHODOLOGICAL GUIDE*" provided an estimation strategy. In addition, in order to modify the intangible measures to be suitable for the public sector, this paper proposes alternatives. In order to observe and test the differences among those alternatives, stock of intangible capital in the public sector is estimated using LEED data in the case of Slovenia. By this approach the data is being worked on and several approaches are being examined in order to distil the best and most universal approach.

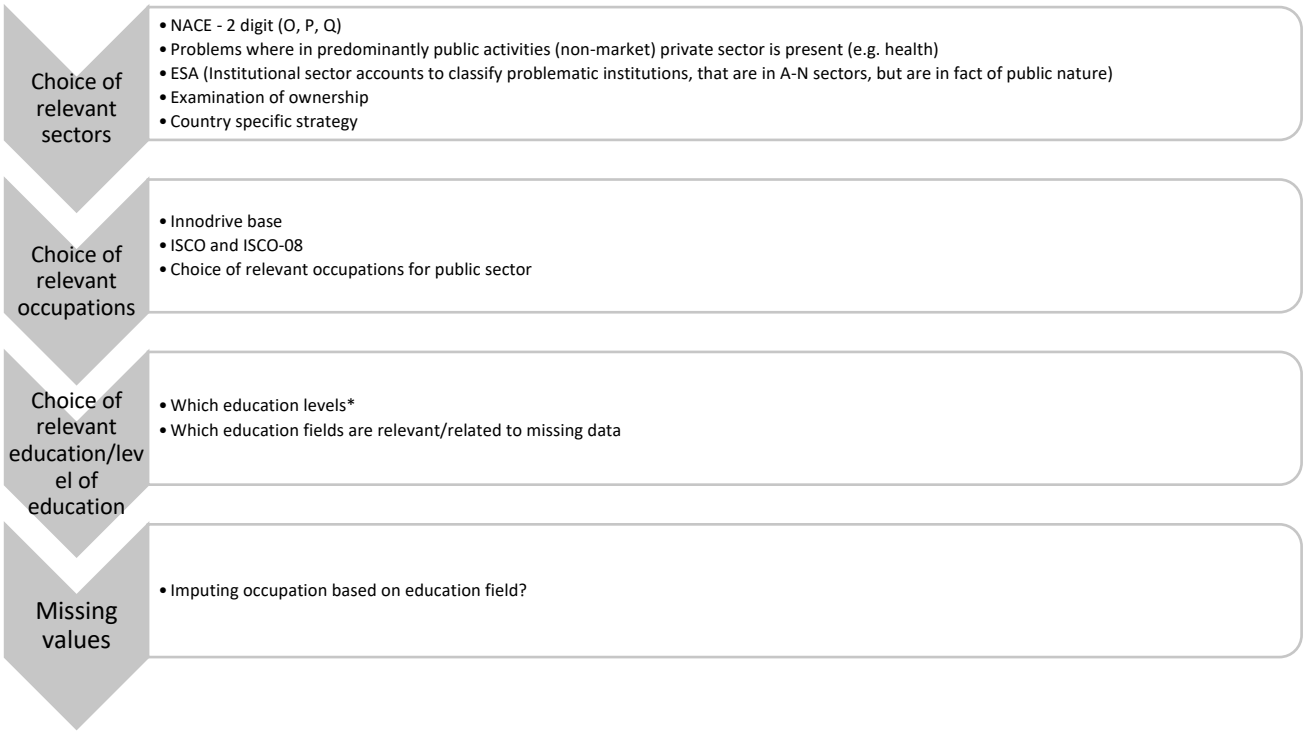
In order to develop the micro-level intangible measure, the next identification strategy is adopted: first the public sector (the relevant sectors) are identified. Second, the identification of the relevant occupations follows and third, relevant education or level of education is identified. Figure 3 provides an overview of the estimation process.

When developing the identification strategy and proposing the intangible measure several different challenges occurred and are primarily are linked to:

- Identification of variation in relevant sectors at 2- 3-digit levels;
- Identification of further sector-specific occupations at 3-digit levels (minor groups of education) and
- Identification of relevant sector-specific fields and levels of educations

Taking into account the challenges, below each of the step is presented in detail.

Figure 3: Identification strategy



* Given that public sector requires multiple task we also emphasise the high education requirement. Therefore we will also consider the alternative of having upper tertiary education requirement in innovation-type work in the public sector. It is also clear that the different sectors may further require the adjustment of intangible workers.

3.1 Definition of public sector / non-market sector

First, the paper focuses on the identification of the public sector. In general, NACE does not differentiate between market and non-market activities, as defined in the SNA/ESA, even if this distinction is an important feature of the SNA/ESA (Eurostat, 2008). Again, the Corrado (2014, 2016) approach that builds on the CHS approach (2005, 2009) use the following sectors:

- M Scientific research and development (NACE 72)
- O Public administration and defence; compulsory social security (NACE 84)
- P Education (NACE 85)
- Q Human health activities (NACE 86) and Residential care and social work activities (NACE 87-88)
- Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities (NACE 90-91)
- Gambling and betting activities; sports activities and amusement and recreation activities (NACE 92-93)

The sectors in question in the Corrado et al. (2014, 2016) approach are not equally relevant also for the European context, in particular not NACE 92-93, only 93 (part of it, as will be discussed). Alternatively,

distinction can be made between non-market and market activities and thus sectors, but such distinction is not precise because an industry can reflect activity carried out by a mix of producers, as is evident with NACE Section R and the larger section of which NACE Section M is a part (Corrado, Haskel & Iasinio, 2017).

The public sector is also defined in the SNA (Chapter 19) as the national, regional, and local governments as well as institutional units controlled by government units. The SNA classify economic activity according to the institutional sectors, not industries. Problems arise in relation to identification of the latter units and further clarification is recommended. A government-controlled entity might be an entity that can be a source of financial gain to the government that controls it because it produces goods and services and sells them at market prices (referred to as corporations in the SNA) or it might be an entity that cannot be a source of financial gain to the government regardless of the prices for which it sells the goods and services it produces (non-profit institutions). Governments exert control over these two types of entities differently (United Nations, 2006).

Next, three different identifications strategies for the public sector are presented. First, the narrow definition that focuses on the non-market services that are considered as the public sector (Chapter 3.1.1). Second, the broad definition of public sector is identified and presented in Chapter 3.1.2. Third, the public sector is identified based on the legal status of the organization and is presented in Chapter 3.1.3.

3.1.1 Narrow NACE identification of the public sector

Non-market services are considered services including NACE2011 Codes O – Public administration and defence, P – Education, Q – Human health and social work activities (Eurostat, 2008). Nace2011 Codes for the identification of public sector in more detail are presented in Table 3.

When applied the identification strategy on the case of Slovenia, we obtain linked employer-employee data for the period from 2005-2017. Number of observations is presented in Table 5. In the observed period of time the number of observations – employees in the narrow defined public sector increased every year from 166 thousand employees in 2005 to around 182 thousand employees in 2017 (16.18 percent increase).

Table 3: NACE-codes for the narrow identification of the public sector

O - Public administration and defence; compulsory social security	O84	Public administration and defence; compulsory social security
	O84.1	Administration of the State and the economic and social policy of the community
	O84.1.1	General public administration activities
	O84.1.2	Regulation of the activities of providing health care, education, cultural services and other social services, excluding social security
	O84.1.3	Regulation of and contribution to more efficient operation of businesses
	O84.2	Provision of services to the community as a whole
	O84.2.1	Foreign affairs
	O84.2.2	Defence activities
	O84.2.3	Justice and judicial activities
	O84.2.4	Public order and safety activities
	O84.2.5	Fire service activities
	O84.3	Compulsory social security activities
	O84.3.0	Compulsory social security activities
P – Education	P85	Education
	P85.1	Pre
	P85.1.0	Pre
	P85.2	Primary education
	P85.2.0	Primary education
	P85.3	Secondary education
	P85.3.1	General secondary education
	P85.3.2	Technical and vocational secondary education
	P85.4	Higher education
	P85.4.1	Post
	P85.4.2	Tertiary education
	P85.5	Other education
	P85.5.1	Sports and recreation education
	P85.5.2	Cultural education
	P85.5.3	Driving school activities
	P85.5.9	Other education n.e.c.
	P85.6	Educational support activities
	P85.6.0	Educational support activities
Q - Human health and social work activities	Q86	Human health activities
	Q86.1	Hospital activities
	Q86.1.0	Hospital activities
	Q86.2	Medical and dental practice activities
	Q86.2.1	General medical practice activities
	Q86.2.2	Specialist medical practice activities
	Q86.2.3	Dental practice activities
	Q86.9	Other human health activities
	Q86.9.0	Other human health activities
	Q87	Residential care activities
	Q87.1	Residential nursing care activities
	Q87.1.0	Residential nursing care activities
	Q87.2	Residential care activities for mental retardation, mental health and substance abuse
	Q87.2.0	Residential care activities for mental retardation, mental health and substance abuse
	Q87.3	Residential care activities for the elderly and disabled
	Q87.3.0	Residential care activities for the elderly and disabled
	Q87.9	Other residential care activities
	Q87.9.0	Other residential care activities
	Q88	Social work activities without accommodation
	Q88.1	Social work activities without accommodation for the elderly and disabled
	Q88.1.0	Social work activities without accommodation for the elderly and disabled
	Q88.9	Other social work activities without accommodation
	Q88.9.1	Child day
	Q88.9.9	Other social work activities without accommodation n.e.c.

*NACE code obtained from Eurostat (Eurostat, 2008).

3.1.2 Broad NACE identification of the public sector

In order to follow Corrado, Haskel & Iasinio (2017) a more broad identification of the public sector is proposed. Again, it relies on the NACE Classification and includes the sectors proposed in Chapter 3.1.1 and summarized in Table 3 and adds additional sectors which are listed Table 4.

Table 4: Additional NACE M, S, R which comprise institutions/organizations of "public nature"

M Professional, scientific and technical activities	M72	Scientific research and development
	M72.1	Research and experimental development on natural sciences and engineering
	M72.1.1	Research and experimental development on biotechnology
	M72.1.9	Other research and experimental development on natural sciences and engineering
	M72.2	Research and experimental development on social sciences and humanities
	M72.2.0	Research and experimental development on social sciences and humanities
R Arts, entertainment and recreation	R90	Creative, arts and entertainment activities
	R90.0	Creative, arts and entertainment activities
	R90.0.1	Performing arts
	R90.0.2	Support activities to performing arts
	R90.0.3	Artistic creation
	R90.0.4	Operation of arts facilities
	R91	Libraries, archives, museums and other cultural activities
	R91.0	Libraries, archives, museums and other cultural activities
	R91.0.1	Library and archives activities
	R91.0.2	Museums activities
	R91.0.3	Operation of historical sites and buildings and similar visitor attractions
	R91.0.4	Botanical and zoological gardens and nature reserves activities
	R93.1.1	Operation of sports facilities
S Other services activities	S94	Activities of membership organisations
	S94.1	Activities of business, employers and professional membership organisations
	S94.1.1	Activities of business and employers membership organisations
	S94.1.2	Activities of professional membership organisations
	S94.2	Activities of trade unions
	S94.2.0	Activities of trade unions
	S94.9	Activities of other membership organisations
	S94.9.1	Activities of religious organisations
	S94.9.2	Activities of political organisations
	S94.9.9	Activities of other membership organisations n.e.c.

*NACE code obtained from Eurostat (Eurostat, 2008).

The number of observation following the more broad definition of the public sector for Slovenia is presented in Table 5. By applying the more broad definition, the number of observations (employees in the public sector) increases by on average 9 percent.

3.1.3 Identification of public sector based on the legal status

As pointed out in the Deliverable 7.1. titled "INTANGIBLE ASSETS IN THE PUBLIC SECTOR: AN EXTENDED DEFINITION AND METHODOLOGICAL GUIDE" Section O, and problems with P, Q and mixture of private sector and non-market sector in P and Q. Public administration and defence; compulsory social security NACE does not make any distinction regarding the institutional sector (as defined in the SNA and ESA) in which the institutional unit is classified. Moreover, there is no NACE category that describes all activities carried out by the government as such. Consequently, not all government bodies are automatically classified in Section O "Public administration and defence; compulsory social security". Units carrying out activities at national, regional or local levels that are specifically attributable to other areas of NACE are classified in the appropriate section. For example, a secondary school administered by the central or local government is allocated to group 85.3 (Section P)

or a public hospital is allocated to class 86.10 (Section Q). On the other hand, not only government bodies are classified in section O: private units performing typical "public administration activities" are also classified here. This mixture of public and private in the two most relevant sectors (P and Q) but also in some other (M – research activities and public research institutes for example).

In the SNA definition of control over the institutions is stressed that it shall be aligned more closely with the financial accounting definition of control in the IPSASs and current practices. The main recommendations are for classification for SNA are public sector boundaries (indicators of control of corporations, indicators of control of non-market non-profit institutions (NPIs). SNA proposes distinction between market/non-market productions based on the concept of economically significant prices. Non-market production present general government (GG) and non-profit institutions serving households (NPISH). The market production thus includes private enterprises and government enterprises. The distinction between private and public sector is however different, where the public sector comprises of the general government and governmental enterprises. In particular:

- **General government** consists of all institutional units which are under public control and which cover less than 50% of production costs by market sales. Those are units that are included in public finances – central government budget, local government budgets and social security funds; also public institutes, public agencies and public funds if they cover less than 50% of production costs by market sales, and also some other units.
- **Public corporations** are corporations under control by units of the general government sector. The basic criterion for determining control is owning more than half of the voting shares, meaning that a unit is under public control if general government or corporations under public control are the majority equity holder in that unit. Other criteria are: control of the board or other management body, control of appointment and discharging of key staff, control of sub-boards in the corporation, the option of buying the majority equity, the control of prevailing buyer, control concerning borrowing, etc. (STAT, 2020).

In this context, a consideration of other classifications is also relevant. **Standard Classification of Institutional Sectors** (SCIS, in accordance with ESA) identifies as the public sector the following:

- general government (S.13)
- public corporations: public non-financial corporations (S.11001),
- central bank (S.121),
- public deposit-taking corporations except the central bank (S.12201),
- public money market funds (MMF) (S.12301),
- public non-MMF investment funds (S.12401),
- public other financial intermediaries, except insurance corporations and pension funds (S.12501),
- public financial auxiliaries (S.12601),
- public captive financial institutions and money lenders (S.12701),

- public insurance corporations (IC) (S.12801), public pension funds (PF) (S.12901).

In addition as also Corrado et. al (2017) also points certain other industries not listed, e.g., those that receive government funds for the conduct of R&D, are indeed of interest, but such industries tend to have little nonmarket production other than own-produced intangible assets. In order to bridge this gap an alternative is proposed that originates from the legal status of the institution.

For example, **in Slovenia**, the Agency of the Republic of Slovenia for Public Legal Records and Related Services (AJPES) collects annual reports based on the legal status of the institution. Based on the legal status the institutions can be divided into two groups: private institutions and public institutions. Public institutions are legal entities under public law: governmental budgets beneficiaries (state or municipal), direct and indirect users of the budget and persons governed by the public law.

- Direct budget users are: state and municipal bodies and organizations, including municipal administration, established by law, municipal ordinance or other legal act, the narrower part of municipalities that are legal entities.
- Indirect budget users are e.g. public institutes, public agencies… persons of public law founded by the state or a municipality, the like the Health Insurance Institute of Slovenia, the Pension and Disability Insurance Institute of Slovenia.

Table 5 shows the number of observations in the period 2005-2017 by the three different propositions for Slovenian data. Identification of the public sector based on NACE Codes O, P, Q is the most narrow identification and therefore has the smallest number of observations. When including also NACE Codes M, S, R as defined in Table 4, of course the number of observations increases. When identifying the public sector using the legal status, the largest number of observations is included.

Table 5: Number of observations by different identification of public sector, 2005-2017, Slovenia

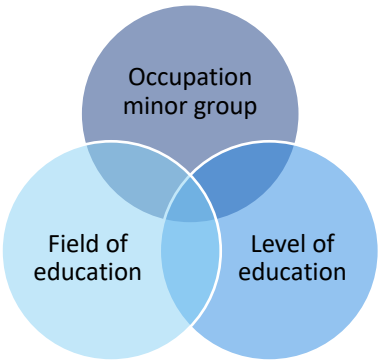
Year	Public sector by NACE Codes: O,P,Q	Public sector by NACE codes: O,P,Q, selected M,S,R*	Public sector by legal status
2005	156.969	169.057	301.076
2006	158.726	171.234	310.909
2007	160.228	173.363	316.956
2008	163.336	177.349	327.355
2009	166.162	180.363	326.113
2010	169.000	183.930	322.663
2011	171.324	187.156	321.906
2012	170.128	185.991	314.849
2013	170.089	186.219	315.093
2014	171.339	187.736	317.905
2015	173.355	189.739	318.722
2016	178.399	195.023	326.909
2017	182.365	199.571	330.839

Note: * Specific identification of sub-sectors identified as public sector is in Table 4.
Data: (Statistical Office of the Republic of Slovenia, 2020), own calculations.

3.2 Occupation and education selection

Occupations are selected in Globalinto project in two manners: the broad and narrow selection. In this deliverable we focus on the broad selection where there are three categories of intangible capital identified: (1) Organizational intangible capital, (2) R&D intangible capital, and (3) ICT intangible capital. Based on microdata, for each of the type of the intangible capital the individuals are identified that have both an appropriate occupation and level and field of education. This means that stock of intangible capital is identified based on three dimensions: (1) occupation, (2) field of education, (3) level of education. The rationale behind also identifying the appropriate field and level of education originates from the extensive research on the mismatch of education-occupation of individuals that shows that in case the level and/or filed of education are not appropriate, the individual exhibits lower productivity (see for example Salas-Velasco, 2018). Therefore, all three dimensions need to be of appropriate value to identify and individual of having intangible capital. Figure 4 represents the identification strategy based on the three dimensions. Only the intersection of the three overlapping dimensions is considered as the intangible capital. When having less than required level of education, an individual is not identified as part of the stock of intangible capital. Same goes for the field of education. More detailed data is presented below.

Figure 4: Micro-level dimensions for the identification of the stock of intangible capital



Source: (Piekkola et al., 2020), own presentation.

Occupations are identified based on the International Standard Classification of Occupations 2008 (ISCO-08) and therefore applicable and comparable across countries. Level and field of education is identified based on the International Standard Classification of Education (ISCED-F 2013)[1] (UNESCO, 2015). Level of education is also identified based on the International Standard Classification of

[1] 2016 was the first year of implementation of the revised classification of fields of education and training - ISCED-F 2013 in EU data collections: in administrative data collections on education systems (UOE) it concerned school year 2014/15 and in household surveys reference year 2016 (Eurostat, 2021). The ISCED-F 2013 can be translated to previously used ISCED 1997 and vice versa.

Education (ISCED 2011). First, in Table 6 the identified occupations with the ISCO classification code by each type of intangible capital are presented, second, the field and level of education follow.

Table 6: Globalinto classification of occupations by type of intangible capital, broad measure

ISCO Code	Description
ORGANISATIONAL INTAGIBLE CAPITAL	
112	Managing directors and chief executives
121	Business services and administration managers
122	Sales, marketing and development managers
131	Production managers in agriculture, forestry and fisheries
132	Manufacturing, mining, construction, and distribution managers
134	Professional services managers
241	Finance professionals
242	Administration professionals
243	Sales, marketing and public relations professionals
261	Legal professionals
331	Financial and mathematical associate professionals
332	Sales and purchasing agents and brokers
333	Business services agents
2631	Economists
R&D INTANGIBLE CAPITAL	
211	Physical and earth science professionals
212	Mathematicians, actuaries and statisticians
213	Life science professionals
214	Engineering professionals (excluding electrotechnology)
215	Electrotechnology engineers
221	Medical doctors
222	Nursing and midwifery professionals
226	Other health professionals
311	Physical and engineering science technicians
314	Life science technicians and related associate professionals
321	Medical and pharmaceutical technicians
1223	Research and development managers
ICT INTANGIBLE CAPITAL	
251	Software and applications developers and analysts
252	Database and network professionals
351	Information and communications technology operations and user support technicians
352	Telecommunications and broadcasting technicians

Source: (Piekkola et al., 2020)

ISCO code 121 - Business services and administration managers in Table 6 includes finance managers, human resource managers, policy and planning managers and business services and administration managers. In addition, ISCO code 134 includes child care services managers, health services managers, aged care services managers, social welfare managers, education managers, financial and insurance

services branch managers, cultural and arts managers, professional services managers not elsewhere classified. ISCO code 211 includes physicists and astronomers, meteorologists, chemists, geologists and geophysicists and the ISCO code 251 includes software and applications developers and analysts, systems analysts, software developers, web and multimedia developers, applications programmers, software and applications developers and analysts not elsewhere classified.

The Innodrive and Spintan projects suggested that in health and science sectors large part of experts should be considered as contributing to R&D in professions such as ISCO 22 (221 Medical doctors and 222 Nursing and midwifery) and ISCO 31 Science and engineering science technicians or ISCO 32 (321 Medical and pharmaceutical technicians). Globalinto continues with addition of experts 3 such as ISCO 311 Physical and engineering science technicians and ISCO 33 Business and administration associate professional (specifically ISCO 331 Financial and mathematical associate professionals, ISCO 332 Sales and purchasing agents and brokers, ISCO 333 Business services agents). ISCO 31 Science and engineering associate and ISCO 32 Health associate professionals (321) belong to R&D type of intangible capital, while ISCO 33 to organisational type of intangible capital. Including also technicians and associate professions as professionals in the public sector would imply that the share of as innovation-type work is almost twice higher than without these additions.

Field of education. The appropriate field of education is identified using ISCED-F 2013 classification and the fields by type of intangible capital are presented in Table 7. More specifically, ISCED-F 2013 Social sciences, journalism and information (03) includes Economics, Political sciences and civics, Psychology, Sociology and cultural studies, Journalism and reporting, Library, information and archival studies, interdisciplinary programmes involving broad field. Business, administration and law (04) field of study includes education in the fields of accounting and taxation, finance, banking and insurance, management and administration, marketing and advertising, secretarial and office work, wholesale and retail sales, work skills, law and interdisciplinary programmes involving broad field.

The field of education Natural sciences, mathematics and statistics (05) includes education in the next fields: biology, biochemistry, environment, environmental sciences, natural environments and wildlife, physical sciences, chemistry, earth sciences, physics, mathematics, statistics, interdisciplinary programmes involving broad field. The filed Information and Communication Technologies (06) comprises of the next sub-fields: computer use, database and network design and administration, software and applications development and analysis and interdisciplinary programmes involving broad field.

Table 7: ISCED-F 2013 fields of education by type of intangible capital

ISCED-F 2013 Code	Description
ORGANISATIONAL INTAGIBLE CAPITAL	
03	Social sciences, journalism and information
04	Business, administration and law
R&D INTANGIBLE CAPITAL	
05	Natural sciences, mathematics and statistics
ICT INTANGIBLE CAPITAL	
06	Information and Communication Technologies

Source: (Piekkola et al., 2020)

Level of education. The Globalinto identifies the tertiary level of education as the third dimension for the identification of the intangible capital based on LEEDs data. Based on ISCED 2011 tertiary level of education builds on secondary education, providing learning activities in specialised fields of education. It aims at learning at a high level of complexity and specialisation. Tertiary education includes what is commonly understood as academic education but also includes advanced vocational or professional education (UNESCO, 2012). In detail, tertiary level of education includes ISCED 5: Short-cycle tertiary education, ISCED 6: Bachelor's or equivalent level, ISCED 7: Master's or equivalent level and ISCED 8: Doctoral or equivalent level.

Estimations. The stock of intangible capital using the above mentioned identification strategy is estimated for Slovenia.2 At the same the stock is estimated for the three alternative identifications of public sector. This is done to test the robustness of the identification of the public sector described in Chapter 3.1. Figure 7 shows the share of employees holding the three identified stocks of intangible capital: (a) organizational, (b) R&D and (c) ICT by each possible identification of the public sector: based on the (1) narrow NACE identification, (2) broad NACE identification and (3) legal status. Complementary, the shares by type of intangible capital and identification of the public sector are presented in Appendix 1.

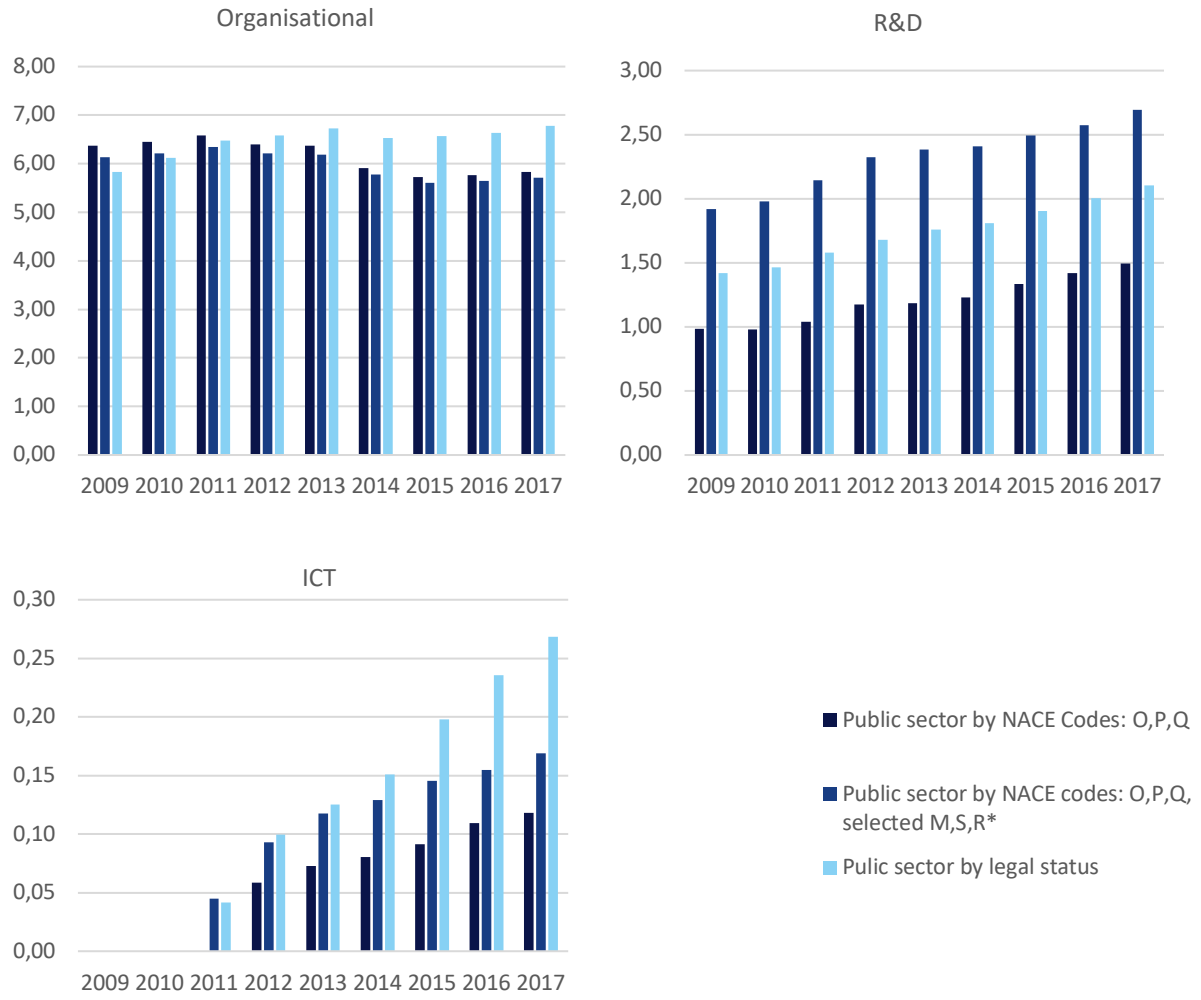
Estimations of the stock of organisational capital are the most robust with respect to the possible identification of the public sector, especially for the narrow and broad NACE identification of the public sector. The estimates when using the broad identification are on average 0.18 percentage point below the narrow identification. Applying the identification based on the legal status, the estimates are in the first two years of the observation period below the other two identifications, however already in 2011 they are above and are less volatile – are increasing by a very small rate. On the other hand, the stock

[2] The purpose of this study is not to comment of the size of the estimates of the intangible capital in public sector in Slovenia, but to use Slovenian data as an example to investigate possible measurements of intangible capital in public sector and to test the robustness of the alternatives.

of the organisational intangible capital decreased when applying the narrow and broad NACE identification of the public sector.

On the contrary, the stock of both R&D and ICT type of intangible capital is very sensitive to the specification of the public sector. The stock of R&D intangible capital is the highest when applying the broad NACE identification of the public sector and the stock of ICT type of intangible capital is the highest when applying the identification of public sector based on the legal status. However irrespective to the identification strategy, the stock of both R&D and ICT intangible capital is increasing in the observed period (CAGR of the stock of R&D capital is 0.4 – 0.5). Based on that, we can conclude that investigating the change in the stock of intangible capital in public sector is less sensitive to the identification of the public sector than is the absolute stock.

Figure 5: Share of stock of intangible capital, by type of intangible capital, by identification of public sector, 2009-2017, Slovenia, (in %)

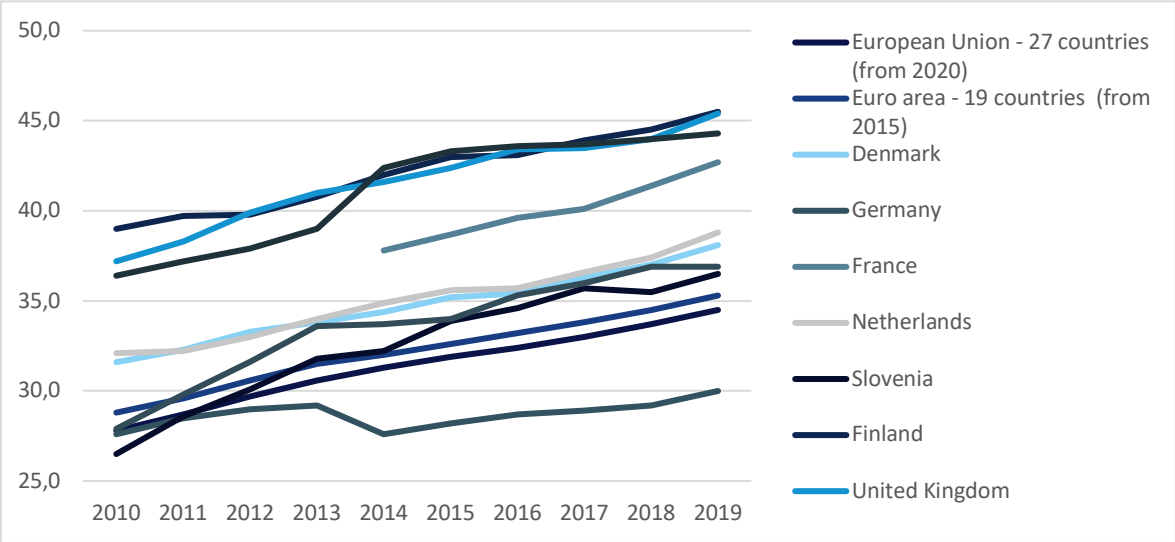


Notes: * Specific identification of sub-sectors identified as public sector is in Table 4. Data for ICT intangible capital in 2009 and 2010 is missing due to low number of observation that can not be reported.
Data: (Statistical Office of the Republic of Slovenia, 2020), own calculations.

3.2.1 Alternative level of education

The proposition of the alternative (higher) level of education was motived by the increase in tertiary education attainment and the share of employees completed the tertiary education. In the last two decades, most of the European countries exhibited increase in tertiary education attainment (Eurostat, 2020). Consequently, the share of employees with tertiary education has increased. Figure 6 shows the percentage of total employment for employed aged 20 to 64 years with tertiary education for selected EU member countries and EU and Euro area average (Eurostat, 2020). On average the percentage of total employment with tertiary education in 27 European Union member countries increased by 6.7 percentage points from 27.8% in 2010 to 34.5% in 2019. The increase in the total employment with tertiary education was especially evident in Slovenia and Greece, where the share of total employed with tertiary education increased by 10 and 9 percentage point, respectively.

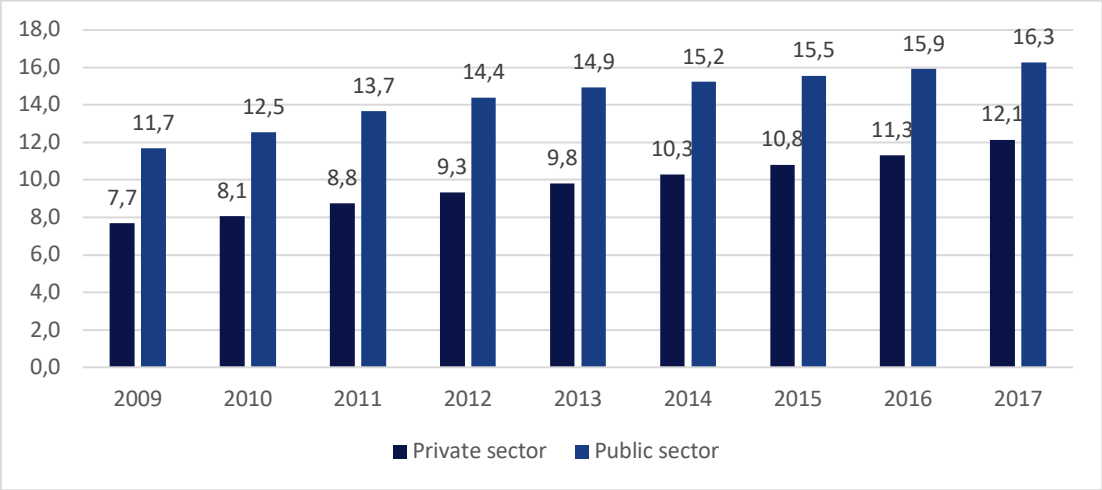
Figure 6: Percentage of total employment, from 20 to 64 years with tertiary education



Source: Eurostat (2020)(Eurostat, 2021).

There are also differences in the share of employed with tertiary education with respect to the sector. Figure 7 shows the share of total employment with tertiary education for Slovenia. Although the share of tertiary educated employees increased with a higher growth rate in the private sector, the share of tertiary educated employees is still on average 4.6 percentage point higher.

Figure 7: The share of total employment with tertiary education, by sector, Slovenia (in %)

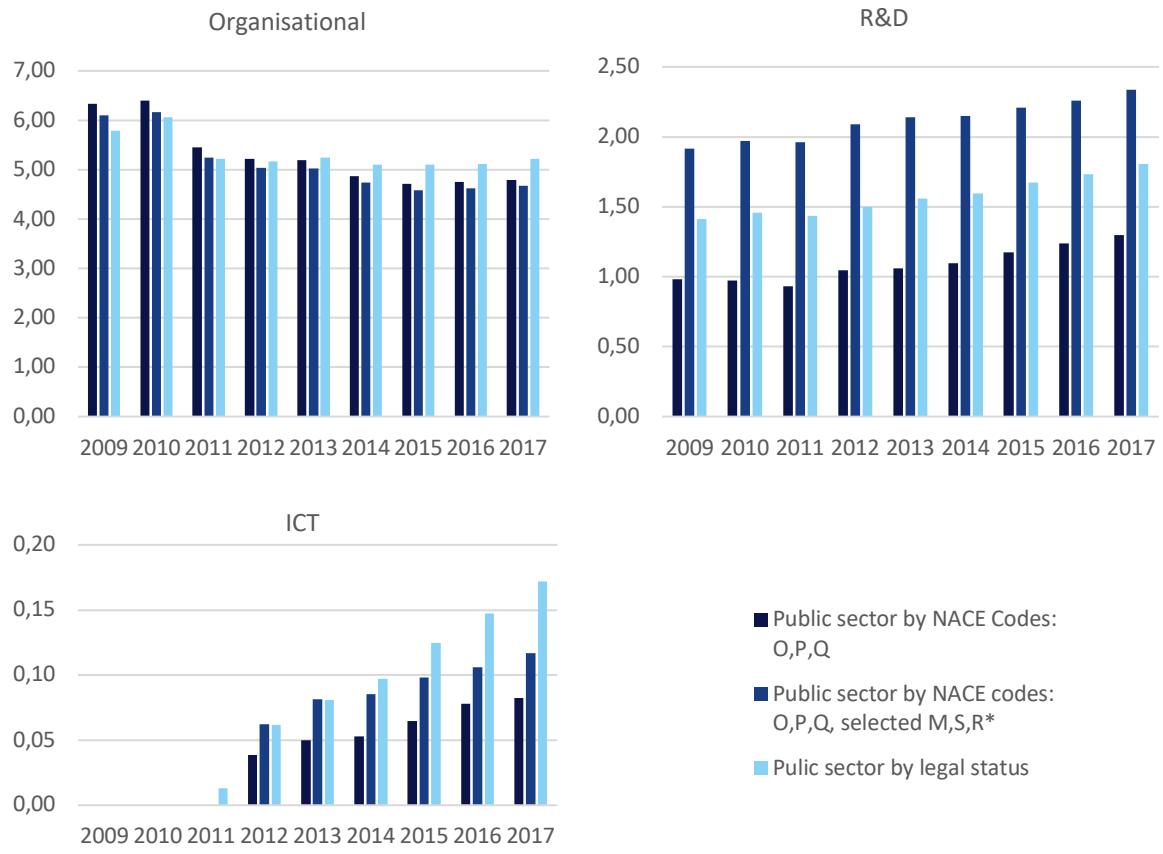


Data: (Statistical Office of the Republic of Slovenia, 2020), own calculations.

Public sector requirements of conducting multiple task and the increase in tertiary education attainment and share of employees that obtained tertiary education motivated the proposition to increase the threshold level of education to be considered as intangible capital from tertiary to master or higher degree. Based on ISCED 2011 classification the proposed alternative includes only ISCED 7: master's or equivalent level and ISCED 8: Doctoral or equivalent level.

Estimations. By applying a more narrow identification of the stock of intangible capital in public sector, we of course observe smaller stock of intangible capital in each of its types. Share of stock of alternative identification of intangible capital (including higher level of education), by type of intangible capital and by three different strategies of identification of public sector for Slovenia is presented in Figure 8 and in Appendix 2.

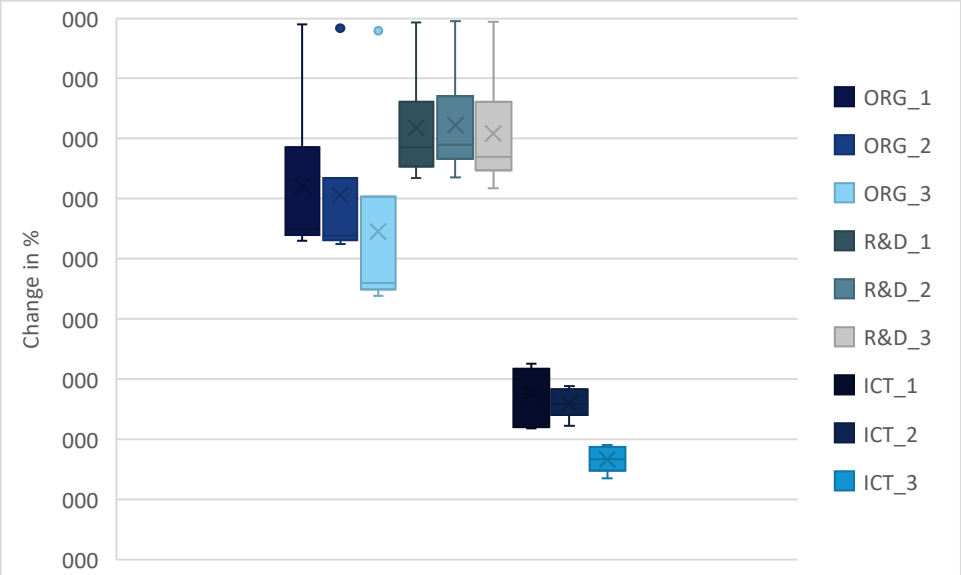
Figure 8: Share of stock of alternative identification of intangible capital (including higher level of education), by type of intangible capital, by identification of public sector, 2009-2017, Slovenia, (in %)



Notes: * Specific identification of sub-sectors identified as public sector is in Table 4. Data for ICT intangible capital in 2009 and 2010 is missing due to low number of observation that can not be reported.
Data: (Statistical Office of the Republic of Slovenia, 2020), own calculations.

When applying a narrow NACE identification of the public sector, we on average observe -0.85 percentage point lower stock of organizational capital, which translates to on average 14 percent decrease. The stock of R&D intangible capital on average decreases for -0.12 percentage points or 9 percent, but the decrease in ICT is more substantial, since it decreases by -0.3 percentage points or by 31 percent. When applying the identification of public sector based on the legal status, the decrease in the stock of intangible capital is on average 22 percent, 12 percent and 37 percent for the organizational, R&D and ICT intangible capital, respectively.

Figure 9: Differences between alternative level of education and tertiary education by type of intangible capital and identification of public sector, Slovenia, 2009-2017, in %



Notes: The figure presents first and third quartile, the median divides the box. The whiskers are error bars. _1 represents narrow NACE identification of the public sector (see Chapter 3.1.1), _2 represents the broad NACE identification of the public sector (see Chapter 3.1.2), _3 represents identification of the public sector based on the legal status (see Chapter 3.1.3). Calculations for ICT include only observations from 2012-2017.
Data: (Statistical Office of the Republic of Slovenia, 2020), own calculations.

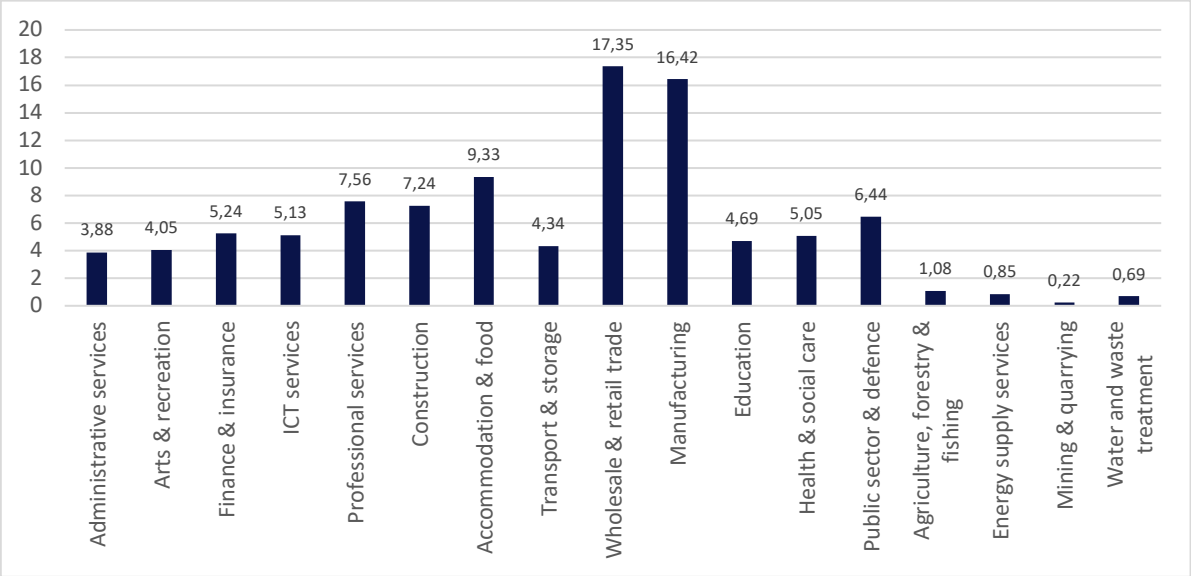
On the other hand, when raising the necessary level of education for identification of stock of intangible capital in the private sector, we observe substantial differences. On average the stock organisational capital in the private sector decreases by 28 percent, the stock of R&D intangible capital by 25 percent and the stock of ICT intangible capital by 56 percent.

3.2.2 Alternative list of occupations

The proposition of the alternative list of occupations is based on the variation of occupational groups among sectors and the structure of the ISCO (described below). There is variation of the occupational groups as defined in ISCO among different sectors. For example data from Cedefop (2020) shows that in the occupational group of managers (01) 17.38 % and 16.42 % of all managers employed in 2019 in the EU were employed in the sector of wholesale & retail trade and manufacturing, respectively. In the narrow definition of the public sector (including non-market services: education, health and social care, and public sector and defence) 16.18% of all managers is employed, compared to 25.86% employed in the business services (see also Figure 10). More detailed analysis on the case of Slovenia shows, that the sectors education, health and social care, and public sector and defence the occupations such as senior

government officials (ISCO 1112), education managers (ISCO 1345), legislators (ISCO 1111) are the most common occupations in these sectors, but not in the business services (SORS, 2020).

Figure 10: Employment of *Managers in EU in 2019 by economy sectors*



Source: Cedefop (2020).

The second rational behind the alternative list of the occupations is the ISCO classification. The structure of ISCO comprises of major, sub-major, minor and unit groups. For example, both senior government officials and legislators are classified in the ISCO 111 minor group of legislators and senior government officials and together with the second minor group: managing directors and chief executives (ISCO 112) comprises sub-major group of Chief executives, senior officials and legislators (ISCO 11). On a higher level, Chief executives, senior officials and legislators (ISCO 11) with Administration and Commercial managers (ISCO 12) and Production and specialized service managers (ISCO 13) comprise a major group of managers (ISCO 1) (See Table 8).

Table 8: An example of ISCO major, sub-major, minor and unit occupation groups

ISCO CODE	Level of classification	Description
1	1	Managers
11	2	Chief executives, senior officials and legislators
111	3	Legislators and senior officials
112	3	Managing directors and chief executives
12	2	Administrative and commercial managers
121	3	Business services and administration managers
122	3	Sales, marketing and development managers
13	2	Production and specialised services managers
131	3	Production managers in agriculture, forestry and fisheries
132	3	Manufacturing, mining, construction, and distribution managers
133	3	Information and communications technology service managers
134	3	Professional services managers

Source: (International Labour Organization, 2012)

Except for the ISCO 111 Legislators and senior officials and Information and Communications Technology Services Managers (ISCO 133 that is included in the R&D intangible capital), all other minor occupational groups are identified as intangible capital. Therefore based on that we propose to expand the relevant occupations as a measure of intangible capital. Next, the 143 Sports, recreation and cultural centre managers are also added to the list of occupations for identification of organisational capital. The rational behind it is similar to inclusion Legislators and senor officials. The Sports, recreation and cultural centre managers are included in the major of managers and are specifically more common in the non-market sectors. Table 9 presents the additional minor occupation groups.

In the sub-major group of Professionals (ISCO 2) the Piekkola (2020) recognizes Finance professionals (ISCO 241), Administration professionals (ISCO 241), Administration professionals (ISCO 242), Sales, marketing and public relations professionals (ISCO 243) and Legal professionals (ISCO 261) as occupations for identification of the organisational capital. In the same ISCO sub-major group is also a sub-major group of Teaching professionals (ISCO 23). These are nor included in the organizational capital, neither are identified as professionals for identification of R&D intangible capital. But at the same time, are members of the same sub-major group. Therefore, the new proposition of this deliverable is to include an additional type of education intangible capital, which is especially relevant for the public sector. In fact, the teacher quality (measured by the education and years of education for example) is one of the proxies measuring the school quality that increases the human capital of students and can also in that way indirectly contribute to the future productivity of students (Bedi and Edwards (2002), Homlund (2008). Strayer (2002) for example used share of teachers with a graduate degree as one of the proxies of school quality and finds that high school quality has a positive and significant effect

on the probability of college attendance and that college choice affects post-school earnings. In addition, the results of Card and Krueger (1992) indicate that rates of return on an additional year of education are higher for individuals from US states with better-educated teachers.

In the sub-major occupational group of Teaching professionals (23) there are 4 minor occupational groups: University and higher education teachers (ISCO 231), Vocational education teachers (ISCO 232), Primary school and early childhood teachers (ISCO 234), Other teaching professionals (ISCO 235). In order to take into account the field of education dimension for the identification of the intangible capital, an individual needs to have education in the field of education (ISCED 11 code for education is 11). An additional type and the corresponding occupations for identification of the intangible capital are also listed in Table 9.

Another sub-major group otherwise classified as part of the R&D capital are Health professionals (ISCED 22). Since they are mostly employed in the Health and social care sector that is considered as non-market service and thus considered as public sector, the alternative sub-type of intangible capital is proposed which is Health intangible capital. The other dimension for the identification of intangible capital is the field of education that for the Health professionals needs to be in the field of Health and welfare (ISCED 2011 code 9). In order to include the entire major group also sub-major group of traditional and complementary medicine professionals (ISCO 223) and veterinarians (ISCO 225) have been added. The health intangible capital can be viewed as a subgroup of the R&D intangible capital in order to disentangle the changes in the stock of R&D capital in the public sector.

Table 9: ISCO codes for Organisational Capital

Minor ISCO Code	Description
ORGANISATIONAL INTAGIBLE CAPITAL	
111	Legislators and senior officials
112	Managing directors and chief executives
121	Business services and administration managers
122	Sales, marketing and development managers
131	Production managers in agriculture, forestry and fisheries
132	Manufacturing, mining, construction, and distribution managers
134	Professional services managers
143	Sports, recreation and cultural centre managers
241	Finance professionals
242	Administration professionals
243	Sales, marketing and public relations professionals
261	Legal professionals
331	Financial and mathematical associate professionals
332	Sales and purchasing agents and brokers
333	Business services agents
2631	Economists
R&D INTANGIBLE CAPITAL	
211	Physical and earth science professionals
212	Mathematicians, actuaries and statisticians
213	Life science professionals
214	Engineering professionals (excluding electrotechnology)
215	Electrotechnology engineers
311	Physical and engineering science technicians
314	Life science technicians and related associate professionals
321	Medical and pharmaceutical technicians
1223	Research and development managers
ICT INTANGIBLE CAPITAL	
251	Software and applications developers and analysts
252	Database and network professionals
351	Information and communications technology operations and user support technicians
352	Telecommunications and broadcasting technicians
Education intangible capital	
231	University and higher education teachers
232	Vocational education teachers
234	Primary school and early childhood teachers
235	Other teaching professionals
Health intangible capital	
221	Medical doctors
222	Nursing and midwifery professionals
223	Traditional and complementary medicine professionals
225	Veterinarians
226	Other health professionals

Source: ILO (https://www.ilo.org/public/english/bureau/stat/isco/isco08/), Innodrive

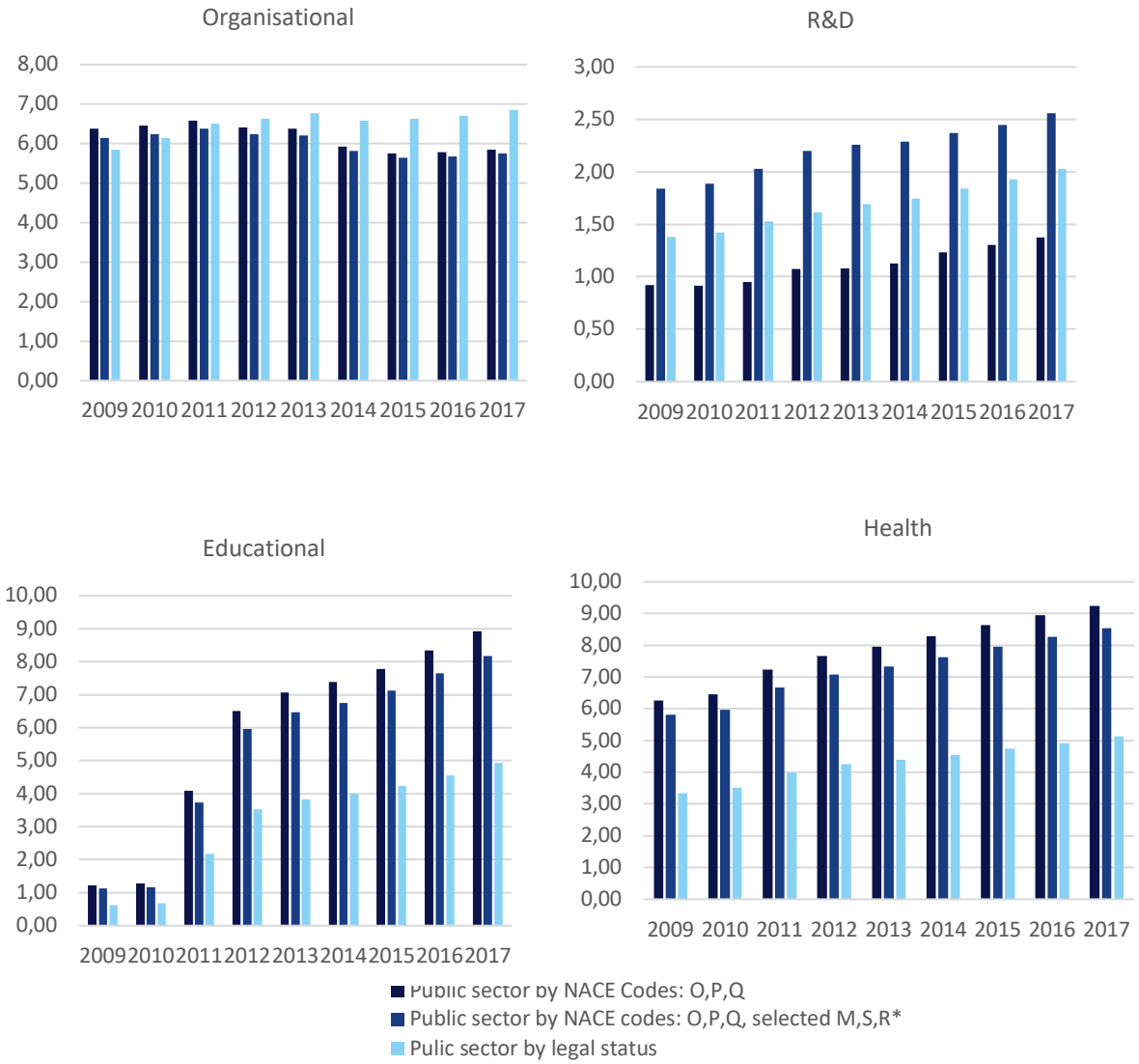
Estimations. Figure 11 presents the share of employees having each type of intangible capital by different public sector identifications for Slovenia in the period from 2009 to 2017. In general, with the proposed alternative specification of the occupations that are recognized as a stock of organizational capital, the average change is non-existent (average change is 0.002 with standard deviation of 0.001). Therefore, including the legislators (ISCO 111) and sports, recreation and cultural centre managers (ISCO 143) in the list of occupations for the organisational capital does not alter the estimated stock of this type of intangible capital significantly.

Excluding the medical doctors (ISCO 221), nursing and midwifery professionals (ISCO 222) as well as other health professionals (ISCO 226), the stock of R&D intangible capital decreases. The stock of R&D capital is also presented in Figure 11. The value of estimated stock of R&D capital is the highest in case of the broad NACE identification of the public sector, followed by the identification based on the legal status and the smallest in case of the narrow NACE identification of public sector. When comparing estimated stock of R&D capital in Chapter 3.2, with the stock identified by the alternative list of occupations, the average decrease in the stock of R&D intangible capital is 7.91 percent in the narrow NACE definition of the public sector (with standard deviation equal to 0.92), 5.11 percent in the broad NACE definition of the public sector (with standard deviation equal to 0.16) and 3.64 percent (with standard deviation equal to 0.44) in case of the identification of public sector based on the legal status. Irrespective of the identification of public sector, the stock of R&D capital has increased by on average 4 percent yearly. Again, the increase in the stock of R&D capital is not sensitive to the identification of the sector, however the value of the stock is.

The alternative list of occupations adds an additional group of health care professionals. Three of the sub major occupation groups listed were excluded from the R&D list of occupations and added to this new type of intangible capital (ISCO 221 - medical doctors, ISCO 222 - Nursing and midwifery professionals and 226 - other health professionals) and two sub-major groups have been added (ISCO 223 - traditional and complementary medicine professionals, ISCO 225 – veterinarians). The stock of health intangible capital is very sensitive to the identification of public sector. Manly due to the prevailing sector where employees of the selected major occupational group are employed. The absolute number of the employees does not vary with respect to the identification of the public sector, however the total number of observation does significantly. Therefore, the stock of identified health capital is the highest in the narrow NACE identification of the public sector, and the smallest in case of the identification of the public sector based on the legal status. The compound annual growth rate of the stock of health intangible capital equals in all the specification of the public sector and is 3.2 percent.

The stock of educational capital identified by including an alternative list of occupational sub-major groups is also presented in Figure 11. Again the stock is very sensitive to the identification of the public sector, since the majority of employees with educational sub-major group of occupations is actually employed in the NACE P sector (Education).

Figure 11: Share of employees having each type of intangible capital by different public sector identifications, Slovenia, 2009-2017, (in %)



Notes: * Specific identification of sub-sectors identified as public sector is in Table 4. Data for ICT intangible capital are the same as in Figure 5 and therefore not included here.

Data: (Statistical Office of the Republic of Slovenia, 2020), own calculations.

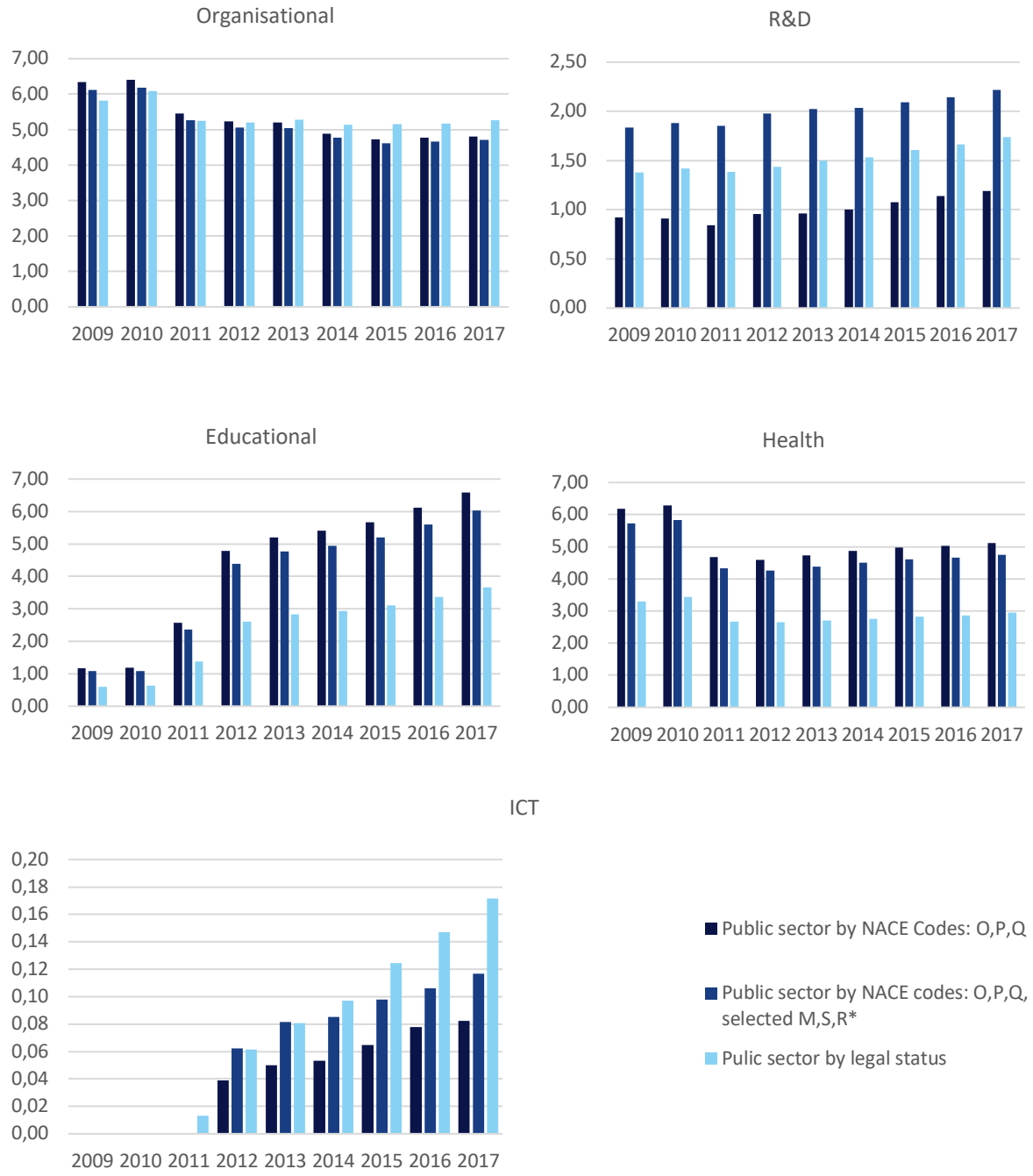
Therefore, the stock of intangible capital is on average 5.8 percent of all employees in the public sector when NACE narrow definition is used, 5.35 percent when NACE broad definition is used and 3.17 percent when identification of public sector is based on the legal status, respectively. On the contrary, the increase in the stock of this type of capital in the observed period is equal, irrespective of the specification of the public sector and the increase is equal to on average 5.4 percent each year.

3.2.3 Combinations of alternatives

The last alternative combines the additional specification of the occupations presented in Chapter 3.2.2. as well as the increased threshold level of education to be considered as intangible capital. At the same time all the three identifications of the public sector are considered. Therefore, this chapter focuses on the combination of all the alternatives proposed to measure stock of intangible capital in the public sector (applies the 3 by 4 matrix). In particular, the chapter differs from Chapter 3.2.2 by applying an alternative / higher threshold level of education – instead of using tertiary level of education; it uses master or higher level of education.

The stock of each type of the intangible capital over the observed years is presented in Figure 12 and the Appendix 3, where also the difference between the stock of intangible capital identified by using an alternative list of education and the combination of all alternatives is calculated. There is a clear trend of the increase in the difference between applying tertiary education as a threshold level of education and applying the master or higher level of education. In other words, due to the overall increase in the average level of education of the employed workers, also the number and share of the employed with tertiary education has increased. In order to disentangle the increase in the stock of intangible capital which was due to the occupations and due to the level of education, the threshold is increased. This is especially evident educational and health sub-major groups of occupations.

Figure 12: Share of employees having each type of intangible capital by different public sector identifications, using alternative level of education, Slovenia, 2009-2017, (in %)

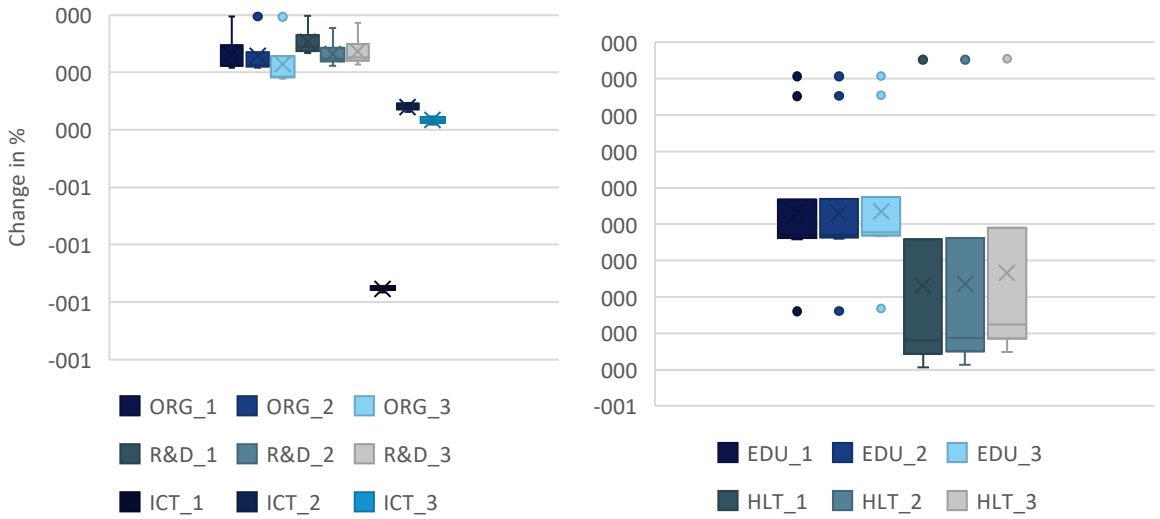


Notes: * Specific identification of sub-sectors identified as public sector is in Table 4. Data for ICT intangible capital in 2009 and 2010 is missing due to low number of observation that can not be reported.

Data: (Statistical Office of the Republic of Slovenia, 2020), own calculations.

Figure 13 presents the differences between alternative level of education and tertiary education (as specified in the Chapter 3.2.1), alternative identification of occupations (as specified in 3.2.2), by identification of public sector. The highest difference is observed in the educational and health sub-type of intangible capital and is therefore the most sensitive to the increased threshold of level of education.

Figure 13: Differences between alternative level of education and tertiary education, alternative identification of occupations, by identification of public sector, Slovenia, 2009-2017, in %



Notes: The figure presents first and third quartile, the median divides the box. The whiskers are error bars. _1 represents narrow NACE identification of the public sector (see Chapter 3.1.1), _2 represents the broad NACE identification of the public sector (see Chapter 3.1.2), _3 represents identification of the public sector based on the legal status (see Chapter 3.1.3). Calculations for ICT include only observations from 2012-2017.
Data: (Statistical Office of the Republic of Slovenia, 2020), own calculations.

4 Discussion and conclusion

The objective of this paper is the proposition of micro-level intangible measurement in public sector. The paper focuses on the development of micro-level measurement of the stock of three types of the intangible capital: organizational, R&D and ICT. It proposes to use linked employer-employee data and a three step identification strategy: identification of public sector, identification of occupations for which individuals possess intangible capital and then it identifies the level and field of education. The identification strategy relies on the use of standard classifications in order to be applicable to all EU countries. The identification of the public sector builds on the NACE classification, the identification of the occupations on ISCO classification and the identification of relevant field and level of education on ISCED-F 2013 and ISCED 2011, respectively.

In this paper 3 different identification strategies of the public sector are proposed, 2 different lists of occupations and 2 different levels of education are proposed. All are applied on one example country in order to test for the robustness and sensitivity of each identification strategy.

Estimations show that the stock of organisational capital is the most robust with respect to the possible identification of the public sector; however the stock of R&D and ICT depends very much on such identification. When investigating the educational and health sub-type of the R&D intangible capital separately, we find that estimations under the narrow definition of public sector produce twice as high estimations of the stock of intangible capital. One important outcome of this empirical exercise is the finding that when investigating the flow of intangible capital (potential increase or decrease) is very robust to the identification of the public sector.

Applying an alternative list of occupations shows that the stock of organizational capital does not change significantly, but again the changes are more profound in the R&D type of intangible capital. Lifting the threshold level of education from tertiary to master or higher degree lowers the estimated stock of intangible capital, especially in educational and health sub-type of the intangible capital. On the contrary, the changes are less evident in the organizational type of intangible capital. Applying the uniform level of education necessary to be recognized as the stock of intangible capital should be therefore further investigated.The limitation of this deliverable remains that applying the micro-level intangible measures in public sector can be difficult in the absence of appropriate data. This can also hold that in some countries the classifications of either industries, occupations and/or education are not aligned with the standard classifications. However, in case of country specific classifications, like also in Slovenia, there exist at least approximate translation tables in order to assure the international comparisons. The data on the legal status can be omitted in some LEED databases and thus presents another limitation of the proposed approach. Overall, the major limitation is of course the identification of public sector, since the activities (mostly non-market) differ among countries.

The purpose of this exercise was to apply the Globalinto methodology, which is used to estimate the intangible capital in the private sector, to the public sector. This deliverable presents the estimates

according to several variants and several "definitions" of intangible capital as well as public sector (by ownership or industry). In the next stage, the income data will be added to provide deeper understanding of the actual investments in the intangible capital in the public sector.

There are several other important research opportunities ahead, especially in terms of comparing the dynamics and the structure of intangible investments in the private and public sectors and explore the consequences on their productivity (where this is possible to estimate due administered wages and budget allocations). In addition, it will be important to compare intangible investments in public sector also between countries, especially in view of the differences in the governance quality.

5 Literature and sources

Abu-Rashed, J., Bertaux, N., & Okunoye, A. (2005). Knowledge management and economic development in developing countries: An examination of the main enablers. *Global Business and Economics Review*, *7*(1), 85–99. https://doi.org/10.1504/GBER.2005.006922

Buonomo, I., Benevene, P., Barbieri, B., & Cortini, M. (2020). Intangible Assets and Performance in Nonprofit Organizations:A Systematic Literature Review. *Frontiers in Psychology*, *11*. https://doi.org/10.3389/fpsyg.2020.00729

Burgman, R., & Roos, G. (2004). Measuring, managing and delivering value performance in the public sector. *International Journal of Learning and Intellectual Capital*, *1*(2), 132–149. https://doi.org/10.1504/IJLIC.2004.005068

Carmeli, A., & Tishler, A. (2004). The relationships between intangible organizational elements and organizational performance. *Strategic Management Journal*, *25*(13), 1257–1278. https://doi.org/10.1002/smj.428

Carmeli, A, & Tishler, A. (2004). The relationships between intangible organizational elements and organizational performance. In *STRATEGIC MANAGEMENT JOURNAL* (Vol. 25, Issue 13, pp. 1257–1278). WILEY. https://doi.org/10.1002/smj.428

Carmeli, Abraham, & Tishler, A. (2004). The relationships between intangible organizational elements and organizational performance. *Strategic Management Journal*, *25*(13), 1257–1278. https://doi.org/10.1002/smj.428

Cavicchi, C. (2017). Healthcare sustainability and the role of intellectual capital Evidence from an Italian Regional Health Service. In *JOURNAL OF INTELLECTUAL CAPITAL* (Vol. 18, Issues 3, SI, pp. 544–563). EMERALD GROUP PUBLISHING LTD. https://doi.org/10.1108/JIC-12-2016-0128

Cedefop. (2020). *Skills Panorama*. https://skillspanorama.cedefop.europa.eu/en/dashboard/browse-occupation?occupation=1&country=

Corrado, C., Haskel, J., & Jona-Lasinio, C. (2017a). Public Intangibles: The Public Sector and Economic Growth in the SNA. *Review of Income and Wealth*, *63*, S355–S380. https://doi.org/10.1111/roiw.12325

Corrado, C., Haskel, J., & Jona-Lasinio, C. (2017b). Public Intangibles: The Public Sector and Economic Growth in the SNA. *Review of Income and Wealth*, *63*, S355–S380. https://doi.org/10.1111/roiw.12325

Corrado, Carol, Haskel, J., & Jona Lasinio, C. (2014). *Smart Public Intangibles: SPINTAN Framework and Measurement Guidelines* [EU FP7 project report]. http://www.spintan.net/wp-content/uploads/public/Framework-Nov2014-Final.pdf

Corrado, Carol, Hulten, C. R., & Sichel, D. (2006). *Intangible Capital and Economic Growth* (NBER Working Paper No. 11948). National Bureau of Economic Research, Inc. https://econpapers.repec.org/paper/nbrnberwo/11948.htm

Corrado, Carol, Hulten, C., & Sichel, D. (2005). *Measuring Capital and Technology: An Expanded Framework* (pp. 11–46) [NBER Chapters]. National Bureau of Economic Research, Inc. https://econpapers.repec.org/bookchap/nbrnberch/0202.htm

Corrado, Carol, Jaeger, K., & Jona Lasinio, C. (2016). *MEASURING INTANGIBLE CAPITAL IN THE PUBLIC SECTOR: A MANUAL* [EU 7 FP NO.612774.]. http://www.spintan.net/wp-content/uploads/public/Spintan-Manual-2016.pdf

Craik, J. (2005). Dilemmas in policy support for the arts and cultural sector. *Australian Journal of Public Administration*, *64*(4), 6–19. https://doi.org/10.1111/j.1467-8500.2005.00460a.x

Das, L., & Raut, R. (2014). Impact of changes in Service Sector in India in shaping the future of Business & Society. In Londhe, BR and Divekar, R and Chandani, A (Ed.), *SHAPING THE FUTURE OF BUSINESS AND SOCIETY - SYMBIOSIS INSTITUTE OF MANAGEMENT STUDIES (SIMS)* (Vol. 11, pp. 795–803). ELSEVIER SCIENCE BV. https://doi.org/10.1016/S2212-5671(14)00243-3

Edvinsson, L., & Bounfour, A. (2004). Assessing national and regional value creation. *Measuring Business Excellence*, *8*(1), 55–61. https://doi.org/10.1108/13683040410524748

Eurostat. (2008). *Europa—RAMON - Classifications Download List*. https://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_CLS_DLD&StrNom=NACE_REV2&StrLanguageCode=EN&StrLayoutCode=

EUROSTAT. (2008). *NACE rev. 2: Statistical classification of economic activities in the European Community*. Office for Official Publications of the European Communities. https://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF

Eurostat. (2021). *Comprehensive database—Eurostat*. https://ec.europa.eu/eurostat/web/digital-economy-and-society/data/comprehensive-database

Fairchild, A. M., & de Vuyst, B. (2005). Intellectual capital valuation processing in higher education. *International Journal of Learning and Intellectual Capital*, *2*(1), 81–91. https://doi.org/10.1504/IJLIC.2005.006807

Guthrie, J., Petty, R., & Johanson, U. (2001). Sunrise in the knowledge economy: Managing, measuring and reporting intellectual capital. *Accounting, Auditing & Accountability Journal*, *14*(4), 365–384. https://doi.org/10.1108/EUM0000000005869

International Labour Organization. (2012). *International Standard Classification of Occupations* (p. 433). https://www.ilo.org/public/english/bureau/stat/isco/docs/publication08.pdf

Kamaruddin, K., & Abeysekera, I. (2013). Intellectual capital and public sector performance. *Studies in Managerial and Financial Accounting*, *27*, 1–210. https://doi.org/10.1108/S1479-3512(2013)0000027006

Mertlova, L., Dostalova, Z., Prokop, M., & Koziak, R. (2015). Assessing the Assumptions of Public Administration Performance from the Perspective of Complex Quality Management in State and Local Government Organisations in the Vysocina Region and USK Banska Bystrica. In Vankova, I (Ed.), *PROCEEDINGS OF THE 11TH INTERNATIONAL SCIENTIFIC CONFERENCE PUBLIC ECONOMICS AND ADMINISTRATION 2015* (pp. 139–146). VSB-TECH UNIV OSTRAVA.

Messica, A., & Agmon, T. (2008). The prerequisites of public policy for technology innovation. *International Journal of Foresight and Innovation Policy*, *4*(3–4), 307–320. https://doi.org/10.1504/IJFIP.2008.017582

Miller, L. M. (2015). E-health: Knowledge generation, value intangibles, and intellectual capital. *International Journal of Healthcare Management*, *8*(2), 100–111. https://doi.org/10.1179/2047971914Y.0000000094

Piekkola, H. (Ed.). (2011). *Intangible Capital – Driver of Growth in Europe*. University of Vaasa. http://www.innodrive.org/attachments/File/Intangible_Capital_Driver_of_Growth_in_Europe_Piekkola(ed).pdf

Piekkola, H., Lintamo, M., Geppert, K., Görzig, B., Neumann, A., Henningsen, M., Skjerpen, T., Jurajda, S., Stancik, J., & Verbič, M. (2011). Firm-level intangible capital in six countries: Finland,

Norway, the UK, Germany, the Czech Republic and Slovenia. In *Intangible Capital – Driver of Growth in Europe* (pp. 63–95). University of Vaasa. https://www.niesr.ac.uk/publications/firm-level-intangible-capital-six-countries-finland-norway-uk-germany-czech-republic-0

Piekkola, H., Redek, T., & Farčnik, D. (2020). *INTANGIBLE ASSETS IN THE PUBLIC SECTOR: AN EXTENDED DEFINITION AND METHODOLOGICAL GUIDE.* https://globalinto.eu/papers/deliverables/

Ramirez, Y., Manzaneque, M., & Maria Priego, A. (2017). Formulating and elaborating a model for the measurement of intellectual capital in Spanish public universities. In *INTERNATIONAL REVIEW OF ADMINISTRATIVE SCIENCES* (Vol. 83, Issue 1, pp. 149–176). SAGE PUBLICATIONS LTD. https://doi.org/10.1177/0020852315575168

Ramirez, Y., Tejada, A., & Baidez, A. (2013). Proposal of Indicators for Reporting on Intellectual Capital in Universities. In Green, A (Ed.), *PROCEEDINGS OF THE 10TH INTERNATIONAL CONFERENCE ON INTELLECTUAL CAPITAL, KNOWLEDGE MANAGEMENT AND ORGANISATIONAL LEARNING (ICICKM-2013)* (pp. 355–366). ACAD CONFERENCES LTD.

Rija, M., & Bronzetti, G. (2011). Intellectual Capital in the Italian Public Service Sector: Analysis on Management and Governance. In Schiuma, G and Lonnqvist, A and Spender, JC (Ed.), *2011 6TH INTERNATIONAL FORUM ON KNOWLEDGE ASSET DYNAMICS (IFKAD2011): KNOWLEDGE-BASED FOUNDATIONS OF THE SERVICE ECONOMY* (pp. 680–697). IKAM-INST KNOWLEDGE ASSET MANAGEMENT.

Rooney, J., & Dumay, J. (2016). Intellectual capital, calculability and qualculation. In *BRITISH ACCOUNTING REVIEW* (Vol. 48, Issue 1, pp. 1–16). ELSEVIER SCI LTD. https://doi.org/10.1016/j.bar.2015.07.002

Salas-Velasco, M. (2018). Resource misallocation and production inefficiency: Estimating cross-country differences in macroeconomic performance. *Journal of Economic Studies*, *45*(6), 1272–1287. https://doi.org/10.1108/JES-04-2017-0091

Selvam, M., Thanikachalam, V., Dhanasekar, D., & Amirdhavasani, S. (2020). Efficiency of intellectual capital performance of public sector banks and private sectors banks in India using mvaic. *Journal of Advanced Research in Dynamical and Control Systems*, *12*(6 Special Issue), 205–211. https://doi.org/10.5373/JARDCS/V12SP6/SP20201024

Shapiro, M. (2007). Public-private R&D collaboration in Korea-A cross-sector survey of incentive structures. In *Innovation and Technology in Korea: Challenges of a Newly Advanced Economy*. Physica-Verlag HD. https://doi.org/10.1007/978-3-7908-1914-4_8

Sharp, J.A., & Bharath, T. K. T. (1983). Adaptive DSS design strategy for a regional socioeconomic balance sheet. *Computers, Environment and Urban Systems*, *8*(2), 71–81. https://doi.org/10.1016/0198-9715(83)90003-0

Sharp, John A., & Bharath, T. K. T. (1983). Adaptive DSS design strategy for a regional socioeconomic balance sheet. *Computers, Environment and Urban Systems*, *8*(2), 71–81. https://doi.org/10.1016/0198-9715(83)90003-0

Sposato, D., & Puntillo, P. (2012). Measuring, Managing and Reporting Knowledge and Intellectual Capital in the Public Sector. In Schiuma, G and Spender, JC and Yigitcanlar, T (Ed.), *IFKAD - KCWS 2012: 7TH INTERNATIONAL FORUM ON KNOWLEDGE ASSET DYNAMICS, 5TH KNOWLEDGE CITIES WORLD SUMMIT: KNOWLEDGE, INNOVATION AND SUSTAINABILITY: INTEGRATING MICRO & MACRO PERSPECTIVES* (pp. 1812–1844). IKAM-INST KNOWLEDGE ASSET MANAGEMENT.

Statistical Office of the Republic of Slovenia. (2020). *Protected micro datasets (registry and survey data at firm and individual level).*

UNESCO. (2012). *International Standard Classification of Education: ISCED 2011*. UNESCO. http://uis.unesco.org/sites/default/files/documents/international-standard-classification-of-education-isced-2011-en.pdf

UNESCO. (2015). *International Standard Classification of Education: Fields of Education and Training 2013*. https://circabc.europa.eu/sd/a/286ebac6-aa7c-4ada-a42b-ff2cf3a442bf/ISCED-F%202013%20-%20Detailed%20field%20descriptions.pdf

United Nations. (2006). *GOVERNMENT / PUBLIC SECTOR / PRIVATE SECTOR DELINEATION ISSUES*. https://unstats.un.org/unsd/nationalaccount/aeg/papers/m4Delineation.PDF

Velibeyoglu, K., & Yigitcanlar, T. (2010). An evaluation methodology for the tangible and intangible assets of city-regions: The 6K1C framework. *International Journal of Services, Technology and Management*, *14*(4), 343–359. https://doi.org/10.1504/IJSTM.2010.035783

Veretennik, E. (2018). The intellectual capital of schools in St Petersburg: Analysing the status quo of IC application in Russia. In B. E. Di Maria E. Scarso E. (Ed.), *Proceedings of the European*

Conference on Knowledge Management, ECKM (Vol. 2, pp. 1181–1185). Academic Conferences Limited. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85055503570&partnerID=40&md5=61556440c740f7bc99821b4961d361a4

Wall, A. (2005). The measurement and management of intellectual capital in the public sector: Taking the lead or waiting for direction? *Public Management Review*, *7*(2), 289–303. https://doi.org/10.1080/14719030500091723

6 Appendices

Appendix 1: Occupations based on Globalinto

The following occupations were chosen using ISCO08 3-digit coding (the earlier ISCO2001 version is in parentheses):

Organizational work

- Managing directors and chief executives 112 (112)
- Administrative and commercial managers 12 (123 all)
- Services and administration managers 121, Sales, marketing and development managers 122
- Managing, mining, construction and distribution managers 13, 131 (122)
- Manufacturing, mining, construction and distribution managers 132 (122)
- Professional services managers 134 (122)
- Teaching professionals 23 (23)
- Business and administration professionals 24 (241 all)
- Finance professionals 241, Administration professionals 242, Sales, marketing and public relations professionals 243
- Legal, social, cultural and related associate professionals 34 (all) (242)
- Legal, social and religious associate professionals 341 (343), Sport and fitness workers 342 (347), Artistic, cultural and culinary artist professionals, 343 (347)
- Business and administration associate professionals 33 (excluding 335):
- Financial and mathematical associate professionals 331 (343), Sales and purchasing agents and brokers 332 (342), Services agents 333 (342)
- Administrative and specialized secretaries 334 (332)

Notes:

OC work is reclassified as R&D work if the educational field code is not social sciences and business and isco3 in 1, 12, 13, 23, 24, and 34.

OC work is reclassified as ICT work if the educational code is Isced2011 computing in 1, 12, 13, 23, 24, and 34.

R&D work

- Technical and mathematical work professional R&D managers 1223 (1237)
- Science and engineering professionals 21 (excluding telecommunication engineering 2153)
- Physical and earth science professionals 211 (211), Engineering professionals 212 (212) Mathematicians, statisticians, life science professionals 213 (212), 214 (212), Electrical, electronics engineering 2151, 2152 (212), Architects, planners 216 (212)
- Health professionals 22

- Medical doctors 221 (222), Nursing and midwifery professionals 222 (223), Other health professionals 226 (223), 22 (isco3 not available)
- Science and engineering associate professionals 31
- Physical and engineering science technicians 311 (311), Life science technicians and related associate professionals 314 (321)
- Nursing and midwifery associate professionals 226 (322)

Notes:

R&D work is reclassified as OC work if the educational field code is social sciences and business and isco3 in 2, 21, 22, 3, 31, and 32.

R&D work is reclassified as ICT work if the educational field code is International Standard

Classification of Education (Isced2011) computing and Isco3 in 2, 21, 22, 3, 31, and 32.

ICT work

- ICT managers 133 (1236)
- Telecommunication engineering 2153 (213)
- Information and communications technology professionals 25
- Information and communications technicians 35 (312)

Appendix 2: Share of stock of intangible capital, by type of intangible capital, by identification of public sector, 2009-2017, Slovenia

(1) H2020 Identification									
	Narrow NACE Identification			Broad NACE Identification			Legal Status Identification		
Year	ORG	R&D	ICT	ORG	R&D	ICT	ORG	R&D	ICT
2009	6.37	0.98	n.a.	6.13	1.92	n.a.	5.83	1.42	n.a.
2010	6.45	0.98	n.a.	6.21	1.98	n.a.	6.12	1.46	n.a.
2011	6.58	1.04	n.a.	6.35	2.15	0.04	6.48	1.58	0.04
2012	6.40	1.17	0.06	6.21	2.32	0.09	6.59	1.68	0.10
2013	6.37	1.19	0.07	6.18	2.38	0.12	6.72	1.76	0.13
2014	5.91	1.23	0.08	5.77	2.41	0.13	6.53	1.81	0.15
2015	5.73	1.34	0.09	5.60	2.49	0.15	6.57	1.91	0.20
2016	5.77	1.42	0.11	5.64	2.58	0.15	6.64	2.00	0.24
2017	5.83	1.50	0.12	5.71	2.69	0.17	6.77	2.10	0.27
(2) Higher level of education									
Year	ORG	R&D	ICT	ORG	R&D	ICT	ORG	R&D	ICT
2009	6.33	0.98	n.a.	6.10	1.92	n.a.	5.79	1.41	n.a.
2010	6.40	0.97	n.a.	6.16	1.97	n.a.	6.06	1.46	n.a.
2011	5.45	0.93	n.a.	5.24	1.96	n.a.	5.22	1.44	0.01
2012	5.22	1.05	0.04	5.04	2.09	0.06	5.17	1.50	0.06
2013	5.19	1.06	0.05	5.02	2.14	0.08	5.24	1.56	0.08
2014	4.87	1.10	0.05	4.74	2.15	0.09	5.10	1.59	0.10
2015	4.72	1.17	0.06	4.59	2.21	0.10	5.10	1.67	0.12
2016	4.75	1.24	0.08	4.63	2.26	0.11	5.11	1.73	0.15
2017	4.79	1.30	0.08	4.67	2.34	0.12	5.21	1.81	0.17
Difference: (2) - (1)									
	ORG	R&D	ICT	ORG	R&D	ICT	ORG	R&D	ICT
2009	-0.01	0.00	n.a.	-0.01	0.00	n.a.	-0.01	0.00	n.a.
2010	-0.01	0.00	n.a.	-0.01	0.00	n.a.	-0.01	0.00	n.a.
2011	-0.17	-0.11	n.a.	-0.17	-0.09	n.a.	-0.19	-0.09	-0.69
2012	-0.18	-0.11	-0.34	-0.19	-0.10	-0.33	-0.22	-0.11	-0.38
2013	-0.19	-0.11	-0.31	-0.19	-0.10	-0.31	-0.22	-0.11	-0.35
2014	-0.18	-0.11	-0.34	-0.18	-0.11	-0.34	-0.22	-0.12	-0.36
2015	-0.18	-0.12	-0.29	-0.18	-0.11	-0.33	-0.22	-0.12	-0.37
2016	-0.18	-0.13	-0.29	-0.18	-0.12	-0.31	-0.23	-0.14	-0.38
2017	-0.18	-0.13	-0.30	-0.18	-0.13	-0.31	-0.23	-0.14	-0.36
Average decrease	-0.14	-0.09	-0.31	-0.18	-0.11	-0.32	-0.22	-0.12	-0.37

Notes: * Specific identification of sub-sectors identified as public sector is in Table 4. Data for ICT capital in some years is missing due to low number of observation that can not be reported.

Data: (Statistical Office of the Republic of Slovenia, 2020), own calculations.

Appendix 3: Share of stock of intangible capital, by alternative list of occupations (1) and level of education (2), by identification of public sector, 2009-2017, Slovenia, (in %)

(1) ADDITIONAL LIST OF OCCUPATIONS

	Narrow NACE Identification					Broad NACE Identification					Legal Status Identification				
Year	ORG	R&D	ICT	EDU	HEALTH	ORG	R&D	ICT	EDU	HEALTH	ORG	R&D	ICT	EDU	HEALTH
2009	6.37	0.92	n.a.	1.22	6.27	6.15	1.84	n.a.	1.13	5.82	5.85	1.38	n.a.	0.63	3.34
2010	6.46	0.92	n.a.	1.27	6.45	6.23	1.89	n.a.	1.17	5.97	6.15	1.42	n.a.	0.68	3.52
2011	6.59	0.95	n.a.	4.08	7.24	6.37	2.03	0.45	3.74	6.68	6.50	1.52	0.04	2.18	3.98
2012	6.41	1.07	0.06	6.50	7.67	6.23	2.20	0.09	5.95	7.07	6.62	1.62	0.10	3.53	4.25
2013	6.38	1.08	0.07	7.07	7.97	6.21	2.26	0.12	6.47	7.34	6.77	1.69	0.13	3.83	4.39
2014	5.93	1.13	0.08	7.38	8.28	5.81	2.29	0.13	6.75	7.63	6.58	1.74	0.15	3.99	4.54
2015	5.75	1.23	0.09	7.78	8.64	5.64	2.37	0.15	7.12	7.96	6.63	1.84	0.20	4.23	4.75
2016	5.79	1.30	0.11	8.35	8.95	5.68	2.44	0.15	7.65	8.26	6.71	1.93	0.24	4.57	4.92
2017	5.85	1.37	0.12	8.93	9.25	5.75	2.56	0.17	8.18	8.53	6.85	2.03	0.27	4.94	5.12

(2) ADDITIONAL LIST OF OCCUPATIONS, HIGHER LEVEL OF EDUCATION

Year	ORG	R&D	ICT	EDU	HEALTH	ORG	R&D	ICT	EDU	HEALTH	ORG	R&D	ICT	EDU	HEALTH
2009	6.34	0.92	n.a.	1.17	6.17	6.12	1.83	n.a.	1.08	5.73	5.81	1.38	n.a.	0.60	3.30
2010	6.41	0.91	n.a.	1.18	6.29	6.18	1.88	n.a.	1.09	5.83	6.08	1.42	n.a.	0.63	3.44
2011	5.46	0.84	n.a.	2.57	4.68	5.26	1.85	0.02	2.36	4.34	5.24	1.38	0.01	1.38	2.66
2012	5.23	0.96	0.04	4.79	4.60	5.06	1.98	0.06	4.39	4.26	5.19	1.44	0.06	2.61	2.64
2013	5.20	0.96	0.05	5.20	4.73	5.04	2.02	0.08	4.76	4.37	5.27	1.50	0.08	2.83	2.70
2014	4.89	1.00	0.05	5.40	4.87	4.77	2.04	0.09	4.94	4.51	5.13	1.53	0.10	2.94	2.76
2015	4.73	1.08	0.06	5.67	4.97	4.61	2.09	0.10	5.19	4.61	5.14	1.61	0.12	3.11	2.83
2016	4.77	1.14	0.08	6.11	5.03	4.66	2.14	0.11	5.60	4.67	5.16	1.67	0.15	3.36	2.87
2017	4.81	1.19	0.08	6.58	5.12	4.70	2.22	0.12	6.02	4.75	5.27	1.74	0.17	3.65	2.94

DIFFERENCE (2)- (1)

Year	ORG	R&D	ICT	EDU	HEALTH	ORG	R&D	ICT	EDU	HEALTH	ORG	R&D	ICT	EDU	HEALTH
2009	-0.01	0.00	n.a.	-0.05	-0.02	0.00	-0.04	n.a.	-0.05	-0.02	0.00	-0.03	n.a.	-0.05	-0.01
2010	-0.01	-0.01	n.a.	-0.07	-0.02	-0.01	-0.05	n.a.	-0.07	-0.02	-0.01	-0.03	n.a.	-0.07	-0.02

2011	-0.17	-0.11	n.a.	-0.37	-0.35	-0.17	-0.14	-0.54	-0.37	-0.35	-0.19	-0.13	-0.69	-0.37	-0.33
2012	-0.18	-0.11	-0.97	-0.26	-0.40	-0.18	-0.15	-0.33	-0.26	-0.40	-0.21	-0.14	-0.38	-0.26	-0.38
2013	-0.18	-0.11	-0.96	-0.26	-0.41	-0.18	-0.15	-0.31	-0.26	-0.40	-0.22	-0.15	-0.35	-0.26	-0.38
2014	-0.17	-0.11	-0.96	-0.27	-0.41	-0.17	-0.15	-0.34	-0.27	-0.41	-0.21	-0.15	-0.36	-0.26	-0.39
2015	-0.17	-0.12	-0.95	-0.27	-0.42	-0.18	-0.16	-0.33	-0.27	-0.42	-0.22	-0.16	-0.37	-0.27	-0.40
2016	-0.17	-0.13	-0.95	-0.27	-0.44	-0.18	-0.17	-0.31	-0.27	-0.43	-0.22	-0.17	-0.38	-0.26	-0.42
2017	-0.18	-0.13	-0.95	-0.26	-0.45	-0.18	-0.18	-0.31	-0.26	-0.44	-0.22	-0.17	-0.36	-0.26	-0.43
Average decrease	-0.14	-0.09	-0.95	-0.27	-0.42	-0.18	-0.16	-0.32	-0.27	-0.42	-0.22	-0.16	-0.37	-0.26	-0.40

Notes: * Specific identification of sub-sectors identified as public sector is in Table 4. Data for ICT capital in some years is missing due to low number of observation that can not be reported.

Data: (Statistical Office of the Republic of Slovenia, 2020), own calculations.