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## Innovativeness and intangibles in transition: the case of Slovenia

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The article presents the micro data on intangibles for Slovenia during the period 1994–2005 using an augmented method by Corrado et al. and analyses the role of intangibles in the Slovenian economy during the transition. By examining the organisational, information and communication technologies (ICT) and research and development (R&D) component of intangibles, we observe a decrease in the value of R&D capital that was to some extent offset by an increase in the value of ICT capital. We find that organisational workers had higher productivity than the average worker. The dynamic of change was gradual during the transition. The capitalisation of intangibles implied an average 4.5% increase of gross domestic product (GDP) for the new member states. Nonetheless, a worrying convergence can be observed between the tangible and the intangible capital. One can thus expect the intangibles have an important role in the future growth in Slovenia and across the European countries, but only if proper attention is devoted to them in terms of policy measures and regulation.

**Keywords:** aggregate productivity; ICT; intangible capital; organisation; R&D; Slovenia; transition

**JEL classification:** M12, M40, J30, O30

### 1. Introduction

The expansion of innovative firms requires investment in intangibles, such as research and development (R&D) investments and more recently acknowledged investments in managerial, marketing, and information and communication technologies (ICT). These are typically omitted from the standard accounts of firms, such as balance sheets. In order to understand the importance of these types of investment, there is a need for more accurate measurement that includes managerial and marketing work (cf. Piekkola, 2010, p. 2). More and more of the expenditure on marketing and organisational investment need to be recognised as an intangible investment that increases productivity of firms over a longer period.

An important distinctive feature of organisational capital (OC) as the first intangible component is that it is more firm-specific and firm-owned than other types of intangibles on one hand, and less tradable and/or cannot be invested with only long-term goals on the other, as for example, investment in R&D (cf. Lev & Radhakrishnan, 2003; 2005; Subramaniam & Youndt, 2005; Youndt, Subramaniam, & Snell, 2004). R&D expenditure as the second intangible capital factor is in turn the first and only recognised type of intangible capital to be included in the satellite accounting of gross domestic product

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(GDP) by the OECD. Investments in ICT are the third intangible type of capital that also complements organisational work, as found in Ito and Krueger (1996), and Bresnahan and Greenstein (1999). ICT work needs to be analysed in conjunction with OC even in industries such as business services and finance. Indeed, Brynjolfsson, Hitt, and Yang (2002) argue that the reportedly high returns on ICT investments can be largely explained by a relationship between the utilisation of ICT and skilled workers on one hand, and human resource management on the other.

In this article, we analyse intangible capital and measure investment in OC (long-term investment in management and marketing activity), along with intangible investment from all other intangible capital type work, by accounting for expenditures and for productivity differences compared with other work. We distinguish between: (1) OC; (2) R&D; and (3) ICT. The benchmark approach is expenditure-based, utilising a measure of innovation input rather than innovation output or the productivity of innovative activities. Our reliance on occupational expenditures makes it comparable across firms and countries. In European firms, OC is poorly valued in the book value of brand, unless the total value of the firm is evaluated in mergers and acquisitions (Piekkola, 2010, pp. 2–3). Even R&D expenditures are often missing because the reporting of these expenditures is not required by accounting and fiscal regulations across most European countries.

The purpose of this article is to present the process of generating the micro data on intangibles for Slovenia, and to provide an analysis of the role of intangibles in the Slovenian economy during the transition. Specifically, we focus on the period 1994–2005 of the transitional process that started in 1991 with the dissolving of Yugoslavia and Slovenian independence, and is, at least in some respects, not yet finished. Since there were no comprehensive data on intangibles available for Slovenia, we had to build an inclusive micro database specifically for this purpose. Together with developing the methodology, this was one of the most important goals and a major effort.

Our research hypotheses relate first to the structure and compensations of private-sector employees engaged in work that generates intangible capital, defined as accumulated organisational, R&D and ICT work. We document the levels and dynamics of these variables for Slovenia. Second, we test whether these variables affected firm-level revenues, and among them especially the role of intangibles. What was the productivity of employees engaged in work related to intangible capital, specifically the organisational workers, in the economy? Did they bring additional value relative to the rest of the workers? Next, we present the evolution of intangibles in the private sector, where we are interested in the dynamics of organisational, R&D and ICT capital. How did the intangible capital relate to the tangible capital in time? Were there signs of convergence or divergence between the two? Additionally, we are interested in the policy recommendations that could be inferred based on our results. And finally, we want to establish how Slovenia compares to other countries of the EU-27 in terms of intangible capital.

In order to address these research questions, we use the methodology for calculating and analysing intangibles that we developed in the INNODRIVE project<sup>1</sup> (cf. Piekkola et al., 2011; Görzig, Piekkola, & Riley 2011). In particular, we assume that a certain fraction of OC, R&D and ICT workers engage in the production of intangible assets. The remaining employees in organisational, R&D and ICT occupations are engaged in current production, which in the national accounts means that the service life of the goods and services they produce is less than a year. The value of the necessary intermediate and capital costs in own-account production of intangible capital goods is also evaluated, which differs from the widely adapted expenditure-based approach by Corrado, Hulten, and Sichel (2006).

The alternative performance-based approach measures the relative productivity of organisational workers. For example, for Finland a clear productivity–wage gap was found among the managers (Hellerstein, Neumark, & Troske, 1999; Ilmakunnas & Piekkola, 2010; cf. Ilmakunnas & Maliranta, 2005). The gap was strikingly wide for organisational workers, so that expenditures might only partially capture the value of intangibles that they produce. The production function here includes the share of organisational workers as a proxy for labour-augmenting productivity improvement. Performance-based measure of OC together with the other intangibles is shown to yield a higher share of intangibles accounting for value added than what has been previously recorded. On average, intangibles account for about 50–60% of private sector value added.

The article is organised in the following way. Section 2 presents the INNODRIVE methodology for evaluating companies' intangible capital using the linked employer–employee data; the expenditure-based approach and the performance-based approach. Section 3 presents the INNODRIVE micro database for Slovenia and discusses the data on compensations and employee structure in Slovenia. Section 4 presents and discusses the empirical results for Slovenia; the micro-based estimation and calculation of intangible capital on one hand, and the macro-based computation of intangible capital on the other, together with a comparison with other EU-27 countries (and Norway). Section 5 provides the concluding remarks, including some policy recommendations.

## 2. The methodology

Intangible capital is usually measured at the national level and incorporates the values of entire sectors such as financial services, the entertainment industry or computer software. We measure a firm's own intangible capital. The classification provided by Corrado, Haltiwanger, and Sichel (2005), and Corrado, Hulten, and Sichel, (2006) to measure intangible capital at the national level is shown in the left column of Table 1. The right column shows the firm-level approach, tracking similar categories.

OC is at the core of the economic competence category in Corrado, Haltiwanger, and Sichel (2005, 2006). This category includes the competence of the top management and human resources as well as the marketing and sales efforts. The organisational structure of a firm's own account in Corrado et al. (2005) is measured according to a predetermined share of management expenditures (20%) in the business sector. It also includes the firm-specific capital in the form of training provided by the employer. Such information is provided by surveys. Market research activities are measured by the size of the marketing industry in the System of National Accounts; in a study set in the UK, Marrano and Haskel (2006) use private sources from media companies.

Scientific innovation capital is a category of its own, in which our firm-level analysis only covers R&D capital. For ICT capital, Corrado et al. (2005) include software and hardware expenditures that are currently recorded in national statistics. Brynjolfsson et al. (2002) refer to case studies indicating that computers and software are just the tip of the iceberg of the implementation costs of ICT. OC should also include part of the implementation costs. National income accounting frequently use ICT-related work expenditures as proxies for software and hardware.

For the purpose of this article, we shall present the methodology for evaluating the firm-based estimates of intangible capital.<sup>2</sup> The national estimates, based on macro data, follow a somewhat different methodology (cf. Jona-Lasinio, Iommi, & Manzocchi, 2011; Roth & Thum, 2010). Nonetheless, even though the levels differ, the dynamics of intangibles is entirely comparable between the micro and macro approaches.

Table 1. Intangible capital in the knowledge economy.

Intangible capital	
Corrado et al. (2005)	Own Categories
<i>Economic Competencies</i>	
(1) Brand Equity: <ul style="list-style-type: none"> <li>• Advertising</li> <li>• Market Research</li> </ul>	(1) Organisational capital <ul style="list-style-type: none"> <li>• Management</li> <li>• Marketing</li> <li>• Skilled administration</li> </ul>
(2) Firm-specific resources: <ul style="list-style-type: none"> <li>• Firm-specific human capital (e.g. training)</li> <li>• Organisation structure (e.g. management)</li> </ul>	
<i>Innovative Property</i>	
(1) Scientific research & development	(1) Research & development
(2) Other research & development: <ul style="list-style-type: none"> <li>• Research and development in Social Science and Humanities</li> <li>• Mineral exploration</li> <li>• New motion picture films and other forms of entertainment</li> <li>• New architectural and engineering design</li> <li>• New product development in financial industry</li> </ul>	(2) Non-scientific research & development
<i>Digitalized information – ICT capital</i>	
(1) Software	(1) ICT personnel assets
(2) Database	

Sources: Corrado et al. (2005); INNODRIVE micro and macro databases.

The basic idea is that each firm produces three types of goods: (1) organisational competencies; (2) ICT; and (3) R&D. It is assumed that the production of these types of goods is directed towards the firm's own uses. The OC, R&D and ICT employees are also engaged in current production, which means that the service life of the goods they produce is less than a year. Following the INNODRIVE approach, a fraction of OC, R&D and ICT work is engaged in the production of intangible goods. These fractions were assessed for the participating economies.

To evaluate the value of intermediate and capital costs related to labour costs necessary in the production of intangible capital goods, the following industries within NACE category seven have been chosen: (1) other business activities (NACE 74) as a proxy for OC goods; (2) R&D (NACE 73) as a proxy for R&D goods; and (3) computer and related activities (NACE 72) as a proxy for ICT goods.

We assume that the weighted average relation between the production factors (labour, intermediates, and capital) in these industries can also be taken as an indicator for the cost structure in own-account production of these types of goods in the firms. Following Görzig et al. (2010), data for the assessment of these factors are taken as a weighted average using the EU KLEMS database. The weighted multipliers and depreciation rates for different intangibles are shown in Table 2.

The combined multiplier,  $M_{IC}$ , is the product of the share of intangible-type work and the use of other inputs.<sup>3</sup> Overall, organisational investment is 35% of wage costs when the use of intermediates and capital are added to the wage costs, which are 20% of all wage costs in organisational work. In R&D and ICT work, the total wage costs are closer approximates of the total investment. Conventional capital stock estimates use

Table 2. Multipliers and depreciation rates for intangibles.

Parameter	OC	R&D	ICT
Combined weighted multiplier $M_{IC}$	0.35	1.10	0.70
Depreciation rate $\delta_{IC}$	0.25	0.20	0.33

Sources: INNODRIVE micro database.

the perpetual inventory method to quantify the capital stock. Using the EU KLEMS methodology, the general definition of the closing capital stock,  $K_t$ , for an establishment is given by:

$$K_t = K_{t-1}(1 - \delta) + I_t, \quad (1)$$

with  $I_t$  for the capital formation of the current year and a constant depreciation rate  $\delta$ . Micro data do not allow for a long history of intangible capital accumulation. Capital stocks are based on observed figures and an estimate of the initial closing capital stock  $K_{\theta-1}$  in the last year before observations for a firm begin. We apply the following sum formula of a geometric row to estimate the initial stock:

$$K_{\theta-1} = \hat{I} \frac{1 - (1 - \delta - g)^T}{1 - (1 - \delta - g)}, \quad (2)$$

where  $\hat{I}$  is the initial investment, and  $g$  is the growth of capital stock.  $\hat{I}$  is set to be the average investment in the five-year period following the first observation year  $\theta$ . The average is used to assess the average investment rate over the business cycle. The initial investment  $\hat{I}$  is taken as the starting value for the back extrapolation using the growth rate of investment  $g$  before the first observation.  $T$  should theoretically be infinite, but for practical purposes, it can be set to 100. Growth rate  $g$  is set at 2%, which follows the sample average growth rate of 2% of real wage costs for intangible capital-type work.

Expenditure-based calculations are made separately for every type of intangible expenditure,  $I_{ICit} \equiv M_{IC} w_{ICit} L_{ICit}$ , with  $IC = \{OC, R\&D, ICT\}$ . Here,  $M_X$  is the weighted multiplier in Table 2, by which labour costs have to be multiplied to assess total investment expenditures on intangibles,  $w_{ICit}$  is the wage cost for every type of worker (deflated by the wage index) and  $L_{ICit}$  is the respective labour input.

The performance-based approach uses these estimates as a starting point, but re-estimates the productivity of organisational workers. In Mankiw, Romer, and Weil (1992), the human capital investment decision for each individual is made by the individuals themselves as part of their long-term investment (the alternative investment is in physical capital). It is convenient to model the production function following Mankiw et al. (1992), but with human capital replaced by OC. The OC inherit in each organisational worker is considered as fixed and determined by the combination of labour costs with intermediates and capital, as in the expenditure-based approach. The effective labour input, however, is quality-adjusted for the productivity of organisational workers that may differ from the wage costs used in the expenditure-based calculations. Indeed, Hellerstein et al. (1999) find a clear productivity–wage gap among the managers. They also remark that labour market theory has no clear explanation for this. Ilmakunnas and Piekkola (2010) further provide evidence that in Finland, organisational workers in particular, and to some extent, R&D workers, increase profitability so that productivity exceeds the wage costs.

OC is suggested here as the important missing input in production that may explain the productivity–wage gap. Thus, our first argument is that the high returns are explained by the omitted OC in the production function. There are also other explanations for the gap that relate to the difficulty of assessing management’s productivity in general. We sum up the most important arguments: (1) organisational work creates OC; (2) complementarities exist with other unobserved inputs, or inputs not properly controlled for in estimation; (3) management and marketing workers may be paid in shares or in other non-wage benefits; and (4) the output of these workers may be difficult to observe.

Managers are also partly remunerated in shares, and therefore, wages do not reflect their total remuneration. Rent sharing has also become more common but is usually not intended to give all benefits to employees. Intangible goods are indeed by definition assumed to be owned by the firm, and hence, the rewards are not (at least fully) compensated for workers. The productivity estimate is sensitive to the inclusion of all types of unobserved inputs and is thus open to the bias of omitting inputs not properly controlled for in estimation. Accordingly, we include in the production function all types of intangible capital stock using an expenditure-based method and OC per organisational worker (which is considered as fixed).

In the simplest framework, workers are divided into two categories: organisational workers, OC, and other workers, non-OC. The performance-based measure of organisational investment is given by:

$$I_{OCit} \equiv M_{OC} \hat{w}_{OCit} L_{OCit}, \quad (3)$$

where  $M_{OC}$  is the total multiplier as given before in a separate production function (from Table 2) and  $\hat{w}_{OCit}$  is the estimated true productivity of OC-labour that may deviate from the wage costs. The quality-adjusted labour is:

$$L_t \equiv L_{NON-OCt} + a_t L_{OCt} \equiv q_t L_t, \quad (4)$$

where  $a_t \equiv \hat{w}_{OCit} / w_{NON-OCit}$  is the relative productivity of organisational workers with respect to the rest of the workers with an average annual compensation  $w_{NON-OCit}$  that is assumed to reflect their marginal productivity in case of perfect competition, and  $q_t \equiv 1 + (a_t - 1)z_{OCt}$  denotes the quality adjustment due to different productivity levels of organisational and other workers, where:

$$z_{OCt} \equiv \frac{L_{OC}}{L_{NON-OCt} + L_{OCt}}. \quad (5)$$

In the constant-returns-to-scale (CRS) production function estimation, the explanatory variable is turnover, including investment in all types of intangibles,  $y_{it} = SALES_{it} + \sum_{IC} I_{ICit}$ , for the firm  $i$  in year  $t$ .<sup>4</sup>

$$y_{it} = \exp(e_{it}) b_0 (q_{it} L_{it})^{(1-b_{OC} - \sum_{IC \neq OC} b_{IC} - b_M - b_{TAN})} (k_{OC} z_{OCit} L_{it})^{b_{OC}} \prod_{IC \neq OC} K_{ICit}^{b_{IC}} M_{it}^{b_M} K_{TANit}^{b_{TAN}}, \quad (6)$$

where  $K_{TANit}$  is tangible capital (plant, property and equipment),  $M_{it}$  is consumption of intermediate inputs (materials and services),  $K_{ICit}$  refers to capital stocks of intangible types  $IC$ , and  $e_{it}$  is an error term. We use material inputs as our control variable in the ideal production function. OC per worker,  $k_{OCit}$ , is considered as fixed and hence entering the constant in the estimation. The organisational labour,  $L_{OCit}$ , is correlated with

quality-adjusted labour,  $q_{it}L_{it}$ , and cannot be used as an independent regressor. We approximate the former OC deepening effect using a proxy for the number of organisational workers given by an industry average value in five firm-size categories, denoted as  $\bar{L}_{OCit}$ . Finally, the specification imposes higher returns to an additional investment in all types of intangible capital at low levels. It is therefore appropriate to use a wide definition of occupations that are engaged in the production of intangible capital.

Following Hellerstein et al. (1999) in log form, we can approximate the quality adjustment parameter with:

$$\ln q_t = \ln[1 + (a_t - 1)z_{OCt}] \approx (a_t - 1)z_{OCt}, \quad (7)$$

because organisational workers are 10% of total workers and because we are measuring relative productivity (so that the second term in square brackets does not deviate significantly from zero). The final estimation is done by industry and year, and the reference productivity level is that of the non-organisational workers in each industry  $j$ . Our estimation equation is then of the following form:

$$\ln y_i = b_0 + b_{OC} \ln L_{OCi} + b_L \ln L_i + cz_{OCi} + \sum_{IC \neq OC} b_{IC} \ln K_{ICi} + b_M \ln M_i + b_{TAN} \ln K_{TANi} + e_i, \quad (8)$$

with:

$$b_L = (1 - b_{OC} - \sum_{IC \neq OC} b_{IC} - b_M - b_{TAN}), \quad (9)$$

$$c = \left(1 - b_{OC} - \sum_{IC \neq OC} b_{IC} - b_M - b_{TAN}\right)(a - 1) = b_L(a - 1). \quad (10)$$

The relative productivity of organisational workers is  $a_{jt} = c_{jt}/b_{Ljt} + 1$ . Here,  $c_{jt}/b_{Ljt}$  shows the magnitude by which the marginal productivity of management and marketing work exceeds that of the rest of the workers in the industry. Productivity is thus  $(c_{jt}/b_{Ljt} + 1 - 1) \cdot 100 = c_{jt}/b_{Ljt} \cdot 100\%$  higher than for the rest of workers. The organisational investment and productivity of organisational workers is then given by:

$$I_{OCit} \equiv M_{OC} \hat{w}_{OCjt} L_{OCit}, \quad (11)$$

$$\hat{w}_{OCjt} = a_{jt} w_{NON-OCjt}. \quad (12)$$

In empirical estimates, the hypothetical wage sum  $w_{NON-OCjt} L_{OCit}$  is evaluated from the annual wage sum for organisational workers, multiplied by the hourly wage ratio of organisational and other workers in each industry. The econometric estimation is finally conducted separately by industry and by year.

### 3. The data

We use linked employer–employee data, which have been extensively utilised in the study of human capital formation, starting with Abowd, Kramarz, and Margolis (1999). These data are convenient for use in an analysis relying on the valuation of different tasks and occupations. In building the INNODRIVE micro database for Slovenia, three main data sources were merged: (1) balance sheets for Slovenian firms provided by the Slovenian Agency for Public Legal Records and Related Services (AJPES); (2) income tax statements at the individual level were provided by the Tax Office of the Republic



of Slovenia (TORS); and (3) Statistical registry of the labour force (SRDAP). The INNODRIVE micro database for Slovenia was created by merging the data sets in a secure room at the Statistical Office of the Republic Slovenia (SORS).

The balance sheet data contain key variables measuring output and inputs at the firm-level, such as total domestic and foreign sales, tangible and intangible capital, costs of materials and services, labour costs, number of workers based on the aggregate number of working hours and industry at 5-digit NACE level. These data are available for firms in all sectors, including services.

The income tax data contain information on annual income earned by all workers that filed the personal income tax (PIT) statement, which amounts at present to more than 500,000 employees in private firms. We used information on gross wage of workers with full- and part-time employment contracts.

SRDAP data links the employees to employers as it contains information on full and part-time contracts. While this data-set does not include all work done by workers (e.g. it excludes workers with short-term contracts and student work), these are relatively small categories. The data include information on gender, age, job title (occupation), educational attainment (field and degree), location of work, and spans of employment by worker and firm.

While building the database, we dealt with several measurement issues. First, there was missing data in the income tax statements, e.g. for managers, which had to be inputted. There was also a problem of duplicated data in the SRDAP, where some individuals were registered multiple times for the same event, which made, e.g. the employment spells problematic (months of employment). Furthermore, to determine the categories of intangible capital, it was essential to establish a proper occupational classification in the linked employer–employee data. As there was a change of classification of occupations in Slovenia between 1999 and 2000, where the previous Standard classification of occupations (SCO) was replaced by the International standard classification of occupations (ISCO–88), the occupations had to be back-casted for worker observations before 2000, which was possible due to the longitudinal nature of the data, i.e. by using additional information on education level (for qualifications) and industrial codes.

Most importantly, the occupations in manufacturing and services were separated. Organisational compensations were obtained from occupations classified as relating to OC; management, marketing, and administrative work by those with tertiary education. We thus obtained 41 non-production worker occupations (cf. Görzig et al., 2011, p. 39; Piekkola et al., 2011, p. 95).

Our database covers the complete NACE industry classification for the period 1994–2004. After merging the data sets, restricting and aggregating industries from C to N (cf. Piekkola, 2010, p. 39; Jurajda & Stančik, 2011, p. 33), and adjusting our data-set as described above, our full sample of data consisted, depending on the analysed year, between 30,000 and 40,000 firms, and between 430,000 and 450,000 employees. This amounted to between 419,472 observations for 1994 and 468,583 observations for 2004. The estimation sample<sup>5</sup> covered, depending on the analysed year, from 32.2% to 35.6% of persons in employment in Slovenia and from 32.8% to 34.2% of the Slovenian economy in terms of value added.

Figure 1 shows the structure of private-sector employees by occupation in Slovenia for the analysed period. As it can be observed, the production workers have the highest share (32.5% on average), followed by employees in other services (33.8% on average), while the marketing workers and other non-production workers have the lowest share (0.1% on average). Through time, the share of workers in the production sector was

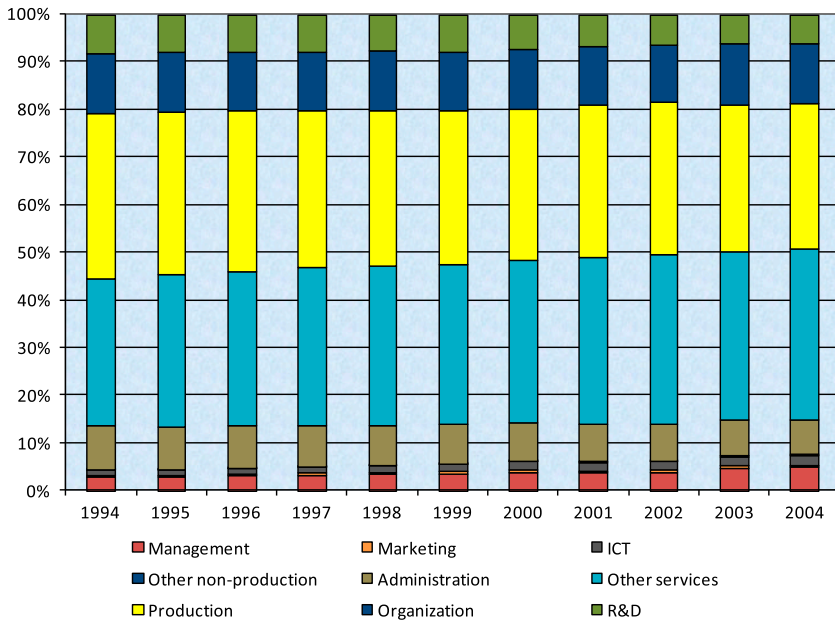


Figure 1. Structure of private-sector employees by occupation, Slovenia (1994–2004). Sources: INNODRIVE micro database; own calculations.

decreasing (from 34.8% in 1994 to 30.3% in 2004) in favour of other service workers, thus reflecting the transitional character of the Slovenian economy during the 1990s.

The share of workers in work related to intangible capital varied on average from 1.5% in ICT and 7.3% in R&D and 12.4% in organisation of firms. Over time, the share of workers had an increasing trend in the ICT sector and a distinct decreasing trend in the R&D sector, while there was no clear dynamics in the share of organisation workers. Share of workers in work related to intangible capital as a whole decreased slightly over time; from 21.8% in 1994 to 20.9% in 2004.

Figure 2 shows the hourly compensation of private-sector employees engaged in work related to intangible capital in Slovenia for the analysed period (in euros at constant 2000 prices). As it can be observed, the hourly compensation was highest in the organisation sector (8.2 EUR on average), followed by the R&D and ICT workers (6.1 EUR on average in each). The latter two were relatively stable over time, while the hourly compensation of organisation workers had a decreasing trend. Overall, the lowest hourly compensation was recorded for production workers (3.6 EUR on average) and the highest for the non-production workers (9.8 EUR on average). The average hourly compensation in all sectors amounted to 5.4 EUR.

The annual compensation of private-sector employees (again, in euros, constant 2000 prices) varied in a similar fashion as the hourly compensation; it was the lowest for production workers (8,094 EUR on average) and the highest for the other non-production workers (21,924 EUR on average). The annual compensation for work related to intangible capital amounted to 12,949 EUR on average in the organisation sector, 13,801 EUR on average in the R&D sector, and to 13,919 EUR on average in the ICT sector. Both the hourly and the annual compensation showed evidence of high

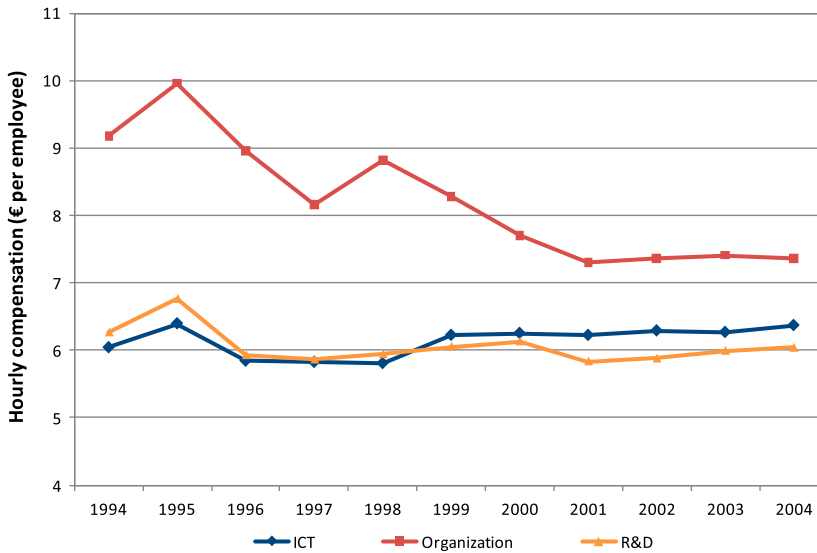


Figure 2. Hourly compensation of private-sector employees engaged in work related to intangible capital, Slovenia (1994–2004).

Note: Hourly compensations in euros were recalculated in constant 2000 prices (wage index used).

Sources: INNODRIVE micro database; own calculations.

compression of wages, which originated from the former socioeconomic system in Slovenia (within Yugoslavia) during 1945–1991 and managed to maintain itself throughout the transition (Verbič & Kuzmin, 2009).

#### 4. Empirical results

In the first step, the log of annual sales (turnover) was regressed on different types of intangibles, organisational worker share, and other controls, including fixed year and firm effects. The first step gives an expression of the firm-specific shocks in terms of the estimated polynomial and the intangible variables. In the second step, assuming a Markov process for the productivity shock, log sales minus the contribution of the controls is regressed on the organisational worker share and a polynomial of the shocks. Our main interest is the evolution of intangible capital stock over the years and by industry. Table 3 first reports the fixed-effect estimates over industries using the derived production function that includes organisational work augmenting labour productivity (all variables except shares are in logs).

As can be seen in Table 3, sales in expression (6) were positively and significantly related to the share of organisational workers (the coefficient is 0.151). Recall from Section 2 that organisational workers bring additional value relative to the rest of the workers if the coefficient for the organisational worker share is positive. In our panel regression, organisational workers appeared to have 102.7% ( $0.151/0.147 = 1.027$ ) higher productivity than the average<sup>6</sup>, which was much lower compared to 190–270% for Finland (*cf.* Piekkola, 2010). The effects of the other variables on sales were expected and comparable to those for other countries (Piekkola, 2010; Piekkola et al.,

Table 3. Panel data estimates explaining sales, Slovenia (1995–2004).

Variable	Sales
Organisational worker share	0.151 ** (0.0048)
Employment	0.147 ** (0.0034)
Net plant, property, equipment	0.070 ** (0.0018)
R&D capital	0.012 ** (0.0095)
Material	0.768 ** (0.0110)
Observations	23,823
Number of firms	3,370
R Squared within	0.859
R Squared between	0.964
R Squared	0.965
Wald $\chi^2$	139,389
<i>p</i> -value	0.000

Notes: Estimates include year and industry fixed effects, and their interactions. Robust standard errors are given in parentheses. Asterisks \* and \*\* denote significance at 5% and 1% level, respectively.  
Sources: INNODRIVE micro database; own calculations.

2011). Namely, the semi-elasticities of net plant, property, equipment (0.070), R&D capital (0.012), and material cost (0.768) with respect to sales were all positive and statistically significant.

Next, we report in Table 4 the average coefficients and mean *t*-statistics from the panel estimations of equation (6) separately for the *n* industry-year categories. Fama and MacBeth's (1973) '*t*-statistic' of the form:

Table 4. Average estimates explaining sales across industries and years, Slovenia (1995–2004).

Variable	Panel mean	Weighted
Organisational worker share	0.142	0.158
t-value	(1.417)	
standard error over years	0.071	
Employment	0.129	0.153
t-value	(6.150)	
standard error over years	0.027	
Net plant, property, equipment	0.086	0.076
t-value	(4.927)	
standard error over years	0.015	
R&D capital	0.022	0.014
t-value	(2.777)	
standard error over years	0.010	
Material	0.780	0.774
t-value	(31.920)	
standard error over years	0.018	

Notes: Estimation spans over eight industries. Table shows the average coefficient, Fama and MacBeth's (1973) '*t*-statistic', standard error over years, and weighted average coefficient over industries and years with inverse of variance in the industry as weight.

Sources: INNODRIVE micro database; own calculations.

$$t(\bar{\beta}_k) = \frac{\bar{\beta}_k}{\frac{se(\beta_k)}{\sqrt{n}}} \quad (13)$$

is shown for each of the coefficients. We also report coefficients, weighted by the inverse of each variable's variance in each industry class.

In the first column of Table 4, the non-weighted average coefficient for the organisational worker share was 0.142, showing important gains from recruiting organisational workers. The ratio of this average coefficient of organisational worker share to that of log employment was 1.101, so organisational workers are about 110.1% more productive than the average worker, which is somewhat higher than the panel estimate from Table 3. Weighting the coefficients by the inverse of the variance in the industry (second column of Table 4) would yield a lower ratio of 1.033 (103.3%), again closer to the estimate from Table 3. This is consistent with the occupational structure of hourly wages and compensations, where we had only small deviations for organisational workers compared to other workers. The effects of other variables on sales were again expected and comparable to those for other countries, analysed in the INNODRIVE project (*cf.* Piekkola et al., 2011).

As can be seen from the summary of correlations between the crucial determinants of production in Table 5, all components of the expenditure-based intangible capital (organisation, R&D and ICT) were positively correlated, with the highest correlation coefficient between R&D capital and ICT capital (0.686), which suggests complementarity between these two types of capital. Net plant, property and equipment was positively correlated with the intangibles and weakly negatively correlated with sales growth. More intangibles in the production process also require more net plant, property and equipment. Sales growth was weakly positively correlated with OC (0.004) and ICT asset (0.020), and weakly negatively correlated with R&D capital (-0,004). Material cost was positively correlated to all other variables, as increasing the level of the other factors of production also requires more material and consequently accelerates sales growth.

We now turn to Figure 3 and to the evolution of organisational, ICT and R&D capital per value added in the private sector in Slovenia for the period 1995–2004. We used expenditure-based intangibles, though the development of both expenditure-based and performance-based figures was similar for Slovenia<sup>7</sup>. As we can observe, the R&D capital per value added steadily decreased over time; from 46.6% in 1995 to 31% in 2004 (Figure 3). On the contrary, the ICT capital per value added increased over time; from

Table 5. Summary of correlations, Slovenia (1995–2004).

	Organisational capital	ICT capital	R&D capital	Sales growth	Net plant, property, equip.
Organisational capital	1.0000				
ICT capital	0.4112	1.0000			
R&D capital	0.4713	0.6864	1.0000		
Sales growth	0.0036	0.0202	-0.0035	1.0000	
Net plant, property, equipment	0.3157	0.1816	0.3560	-0.0033	1.0000
Material	0.2504	0.2766	0.3453	0.0221	0.3731

Sources: INNODRIVE micro database; own calculations.

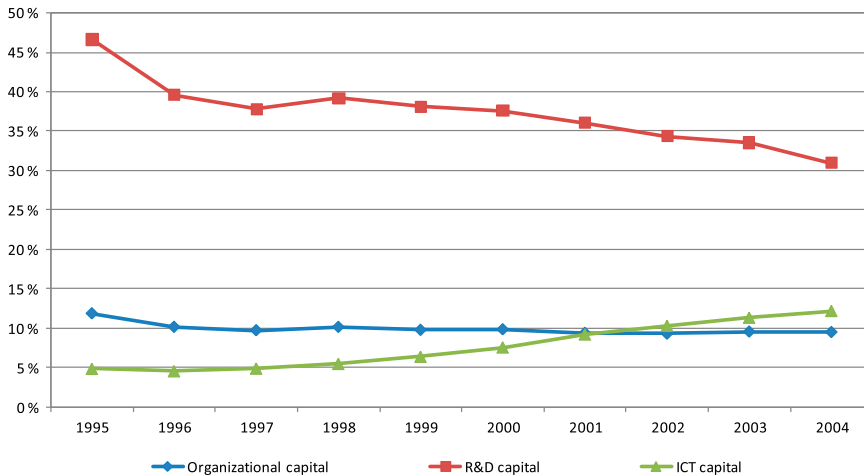


Figure 3. Organisational, R&D and ICT capital per value added, Slovenia (1995–2004).

Note: OC, R&D and ICT capital and value added in euros were recalculated in constant 2000 prices (capital investment index used).

Sources: INNODRIVE micro database; own calculations.

4.8% in 1995 to 12.2% in 2004. The OC per value added was relatively stable during 1995–2004 with the mean of 9.9%. Additionally, the performance-based OC per value added had a similar relatively stable dynamic with the mean of 4.5%.

Combining all three components of the intangible capital (organisation, R&D and ICT) resulted in the aggregate value of intangible capital. Figure 4 shows the evolution of tangible and intangible capital per value added in the private sector in Slovenia for the period 1995–2004. Again, we used expenditure-based intangibles, although the performance-based figures were similar in the Slovenian case. As we can observe, the tangible capital per value added (computed from gross capital formation using only the INNODRIVE industries) increased over time; from 19.2% in 1995 to 33% in 2004. The intangible capital per value added, on the contrary, remained relatively stable after the initial decrease (during 1995–1996) and amounted to 54% on average during 1997–2004. Thus the increase in the ICT capital per value added managed to ‘compensate’ the decrease in the R&D capital per value added to a large extent. Nonetheless, a considerable convergence can be observed between the tangible and the intangible capital per value added in Slovenia during 1995–2004.

Examining the evolution of intangible capital per sales (turnover) in the private sector in Slovenia for the period 1995–2004 gives us a similar dynamic. The expenditure-based R&D capital per sales steadily decreased over time (from 11.5% in 1995 to 7% in 2004), the expenditure-based ICT capital per value added increased over time (from 1.1% in 1995 to 2.8% in 2004), while the expenditure-based OC per value added was relatively stable during 1995–2004 (with the mean of 2.3%). The expenditure-based intangible capital in the aggregate per sales remained relatively stable after the initial decrease (from 13.3% to 12.2% during 1995–1996) and amounted to 12.5% on average during 1997–2004.

Figure 5 presents the new intangibles for Slovenia in the period 1995–2005, divided into scientific R&D, market research, advertising, firm-specific human capital, and

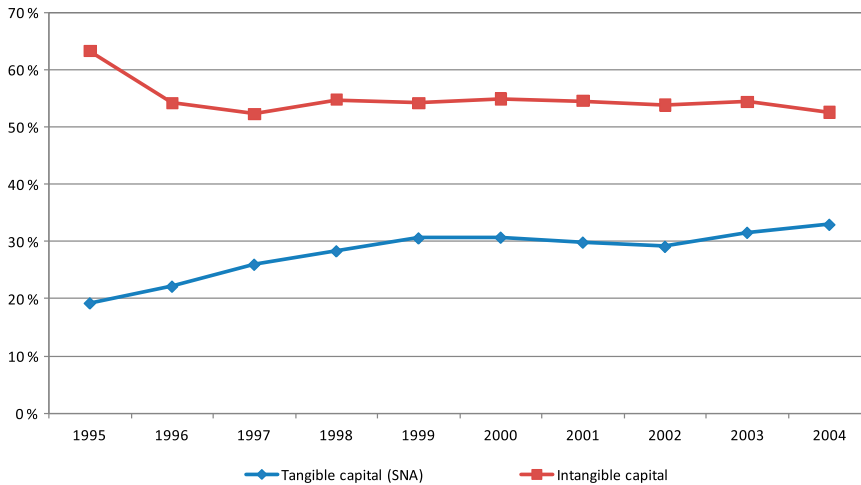


Figure 4. Tangible and intangible capital per value added, Slovenia (1995–2004).

Notes: Tangible capital, intangible capital and value added in euros were recalculated in constant 2000 prices (capital investment index used). Tangible capital per value added was calculated from the official statistics.

Sources: INNODRIVE micro database; Statistical Office of the Republic of Slovenia (SORS, 2010); own calculations.

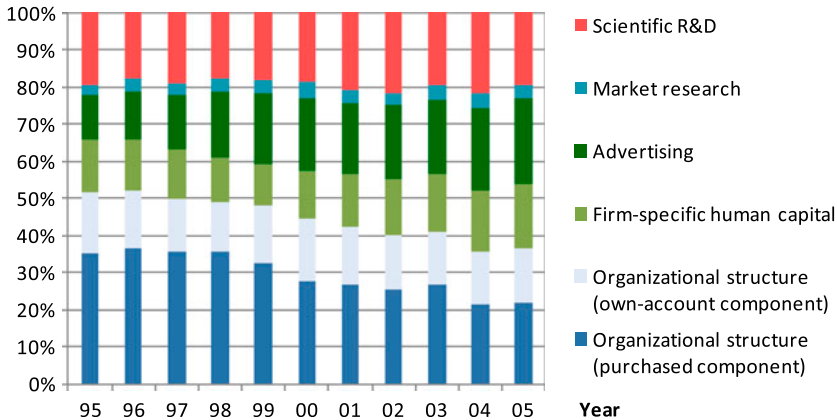


Figure 5. National estimates of intangibles, Slovenia (1995–2005).

Sources: INNODRIVE macro database; Jona-Lasinio et al. (2011); own calculations.

organisational structure (own account component and purchased component). As can be observed, the share of scientific R&D in new intangibles did not change during 1995–2005 (19.4% on average), the share of market research in new intangibles increased somewhat (from 2.9% in 1995 to 3.6% in 2005), the share of firm-specific human capital also increased modestly (from 14.3% in 1995 to 17.4% in 2005), while the share of advertising increased substantially (from 11.9% in 1995 to 23.1% in 2005). The share of organisational structure as a whole in new intangibles decreased substantially in Slovenia during 1995–2005; from 51.5% in 1995 to 36.6% in 2005. Within the

organisational structure, the share of the own-account component in new intangibles hardly changed (14.8% on average), while the share of the purchased component in new intangibles was the one that decreased (from 35.4% in 1995 to 21.8% in 2005). The dynamic of changes in the new intangibles was gradual in Slovenia during the transition.

In Figure 6, we compare Slovenia to other countries of the EU-27 (and Norway) in terms of intangible capital. As can be observed for 2005 (see Figure 6), Slovenia ranked tenth among the 28 countries in terms of the intangibles in the aggregate, with 7.21% of GDP. Slovenia was between Finland (7.35%) and Denmark (7.13%) in terms of the share of intangibles in the GDP. The average was 5.9% of GDP, with the highest-ranking country being the UK (9.17%) and the lowest ranking country being Greece (2.14%). Slovenia was thus 1.27 percentage points above the EU-27 (and Norway) average in terms of the share of intangible capital in GDP in 2005, according to the INNO-DRIVE macro-based estimates. The capitalization of intangibles during 1995–2005 implied an average 5.5% increase of GDP for the EU-27, and a somewhat lower 4.5% increase of GDP for the new member states.

Finally, the aggregate of intangibles was decomposed into scientific R&D, organisational competence excluding training, and other intangibles. In terms of organisational competence (excluding training), Slovenia ranked fifteenth among the 28 countries with 2.45% of GDP. Slovenia was close to Finland (2.54%), the Netherlands (2.49%) and Poland (2.43%). The average was 2.51% of GDP, with the highest and the lowest ranking country being again the UK (5.23%) and Greece (1.14%), respectively. In terms of scientific R&D, Slovenia ranked eleventh among the 28 countries with 0.84% of GDP. According to this criterion, Slovenia was comparable to the UK (0.93%), the Netherlands (0.92%) and Czech Republic (0.80%).

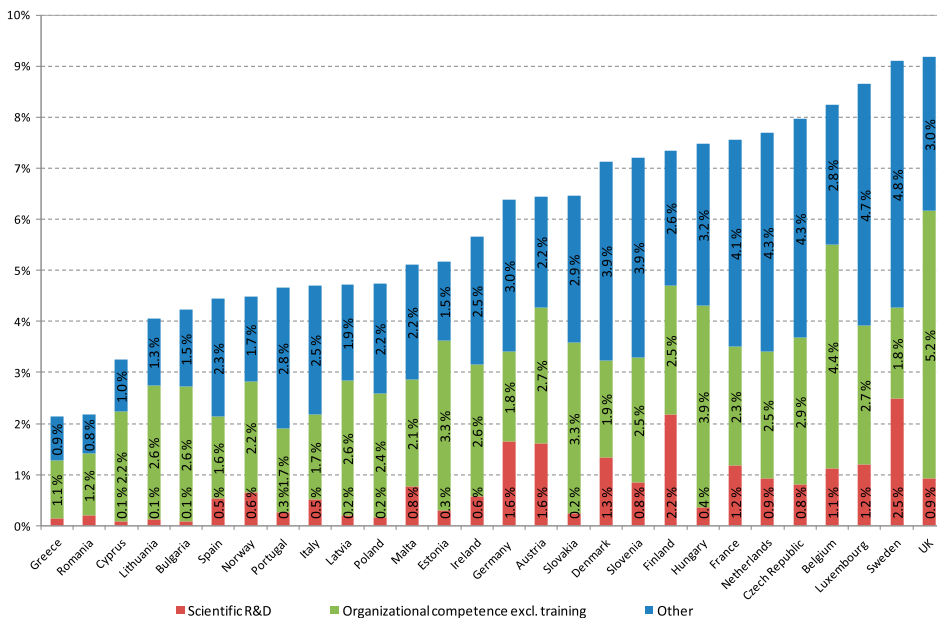


Figure 6. Intangibles as a percentage of GDP in 2005, EU-27 countries (and Norway). Sources: INNODRIVE macro database; Jona-Lasinio et al. (2011); own calculations.



with the highest and the lowest ranking country being Sweden (2.49%) and Cyprus (0.08%), respectively. In 2005 Slovenia was above the average in terms of the share of scientific R&D in GDP, and just a bit below the EU-27 (and Norway) average in terms of the share of organisational competence (excluding training). The macro data exhibited similar inter-country dynamic in other analysed years (*cf.* Jona-Lasinio et al., 2011).

## 5. Concluding remarks

The importance of intangibles increased substantially during the globalisation process. In the past decades, the key drivers of economic growth were investment in physical and human capital, and investment in R&D. However, these factors do not fully account for differences in economic performance. Until now, intangible capital has been measured at the national level, most often according to the classification provided by Corrado et al. (2005). The INNODRIVE project developed the Corrado et al. (2005) approach further by supplying new data on intangibles at the firm level, which allowed us to analyse different types of intangibles and their role for economic performance and growth. Using both expenditure and performance-based estimates of intangible capital, firm data provided information on the own account part of intangibles. The results of the INNODRIVE project showed that economic competences, related to OC of management and marketing, were one of the key drivers of growth.

Within the INNODRIVE project, Slovenia was one of six pioneer countries (together with Czech Republic, Finland, Germany, Norway, and the UK) and one of two transition countries (together with Czech Republic) involved in the development and implementation of the new micro-based approach to quantifying the intangibles. For this purpose, an inclusive micro database was built for Slovenia and an adapted common methodology was developed for the countries being analysed. The purpose of this article was to provide evidence on intangibles for Slovenia in the period 1994–2005 and to analyse the role of intangibles in Slovenian economy during the transition.

To begin with, our analysis showed that the share of workers in work related to intangible capital varied on average from 1.5% in the ICT and 7.3% in the R&D, up to 12.4% in the organisation. Through time, the share of workers had an increasing trend in the ICT and a distinct decreasing trend in the R&D. The compensations were highest for organisation workers, followed by the R&D and ICT workers. The latter two were relatively stable over time, while the compensations in the organisation sector had a decreasing trend. There was evidence of high compression of wages, which originated from the former socioeconomic system in Slovenia and managed to maintain itself throughout the transition.

Next, the results of econometric estimation showed modest gains from recruiting organisational workers in the production process in Slovenia. The organisational workers had higher productivity than the average during the transition, though this difference was lower in Slovenia compared to some other countries. The effects of net plant, property, equipment, of R&D capital, and of material cost on turnover of Slovenian firms were all positive and statistically significant for the transitional period. The significance of a skilled workforce for economic growth thus lies in its ability to create value added in the form of intangibles.

By examining the evolution of organisational, ICT and R&D capital, we observed that the R&D capital per value added steadily decreased over time, while on the contrary, the ICT capital per value added was increasing. By comparing the dynamic of tangible and intangible capital in the aggregate, we observed that the tangible capital

per value added increased over time; from 19.2% in 1995 to 33% in 2004, while the intangible capital per value added, on the contrary, remained relatively stable after the initial decrease and amounted to 54% on average. Thus the increase in the ICT capital per value added managed to ‘compensate’ the decrease in the R&D capital per value added to a large extent. Nonetheless, a considerable convergence can be observed between the tangible and the intangible capital per value added in Slovenia during the transition.

By observing the national estimates for Slovenia during this period, we can establish that the share of scientific R&D in new intangibles did not change, the shares of market research and firm-specific human capital increased modestly, while the share of advertising increased substantially. On the contrary, the share of organisational intangibles decreased substantially during the transition, with the share of the purchased component (not the own-account component) being the one that decreased. The dynamic of changes in the new intangibles was gradual in Slovenia during the transition.

Lastly, in comparison to other countries of the EU-27 (and Norway) in terms of the share of intangible capital in the GDP, Slovenia ranked tenth in 2005 among the 28 countries, being 1.27 percentage points above the average according to the INNODRIVE macro-based estimates. The capitalization of intangibles during 1995–2005 implied an average 5.5% increase of GDP for the EU-27, and a somewhat lower 4.5% increase of GDP for the new member states (among them for Slovenia). One can expect that the intangibles will represent an important source of future growth across the European countries, if proper attention is devoted to them in terms of policy measures and regulation.

It is thus crucial not only to measure the intangibles, but also to improve their management and utilisation. This is why policy measures should aim to stimulate a better understanding of intangibles by including them in the GDP measure and encouraging their use by means of appropriate incentives. The data and conclusions on intangibles for Slovenia should facilitate the preparation and implementation of appropriate economic policies and regulation by the Slovenian government within the European Union framework; especially those related to innovation, education, research and sustainable growth (*cf.* Verbič, Majcen, & Čok, 2014; Verbič, Majcen, Ivanova, & Čok 2011). Additionally, the INNODRIVE database should facilitate analysis of the role of intangibles for the European Union’s growth strategy ‘Europe 2020’ and within this strategy the ‘Smart growth’ flagship initiatives; especially the ‘Innovation Union’ initiative.

In terms of future research, one should focus on refining the range of production inputs, and the extent to which they should be classified as intermediate consumption or intangible investment. In addition, more resources should be dedicated to further developing performance-based methodologies and market valuation models that are better adapted to the firm-level evaluation of intangibles under the pressures of globalisation.

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## Notes

1. INNODRIVE is a FP7–SSH project with the full name *Intangible Capital and Innovations: Drivers of Growth and Location in the EU*. See the official website at [www.innodrive.org](http://www.innodrive.org).
2. See Görzig, Piekkola, and Riley (2011) for a more detailed description of the INNODRIVE methodology for evaluating companies' investment in intangible assets using linked employer–employee data. We only give here those parts that are necessary for understanding the results presented in this article.
3. Capital cost is the sum of the external rate of return (4%, representing the market interest rate) and depreciation multiplied by net capital stock.
4. Caves and Barton (1990), and Jorgenson, Griliches, and Intriligator (1986) provide details regarding the estimation of firm production functions with fixed effects.
5. The *estimation sample* is a category narrower than the *full sample* used for calculating the main labour variables (worker shares and compensations) due to incomplete data.
6. Recall from Section 2 that  $a = c/b_L + 1$ . Productivity of organisational workers is thus  $c/b_L \cdot 100\%$  higher than for the rest of workers.
7. Expenditure-based measurement (EXP) applies expenditures with the parameter set from Table 2 to calculate investment using expression (3), while performance-based measurement (PER) applies industry-year specific productivity of organisational or R&D workers as given by expressions (9) and (10).

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