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INTANGIBLE CAPITAL IN POLAND IN 1995-2013: FINAL REPORT

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Abstract

The classical growth factors are less important than they were several decades ago. Intellectual capital containing knowledge and human capital has become a crucial determinant of growth induced by innovation. Measurements of the intangible capital, based on the total factor productivity (TFP) may contribute to better explanation of the long-run economic growth, as well as deviations from its path. This report contains the results of estimation of the intangible capital in Poland in 1995-2013.

Keywords: intangible capital, national accounts, growth factors, knowledge-intensive economy

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Intangible Capital in Poland in 1995-2013: final report

By

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Introduction

Nowadays, the classical growth factors are less important than they were several decades ago. Intellectual capital containing knowledge and human capital has become a crucial determinant of growth induced by innovation. New factors of growth include not only Research and Development (R&D) but also other kinds of knowledge-intensive accomplishments. Firms that are in the centre of innovative growth, increase their economic competencies, produce specialized software and other intangibles. The growth accounting framework allows for GDP decomposition into labour input, (physical) capital input and Total Factor Productivity (TFP). The last one includes intangible capital, with all its components.

The main idea behind measurement of intangible capital in Poland corresponds with the Schumpeterian definition of innovative growth generated by the so called creative destruction, "*which includes product and process development, organizational change, management, marketing and finance*" (Schumpeter 1934). This type of capital may contribute to better explanation of the long-run economic growth, as well as deviations from its path. In early stage of economic growth technical advancements bring major job destruction. The intangible capital contributes to gradual transformation of the workforce from industry to services, hence enabling economies to advance to the next stage of development. There is a reason to conjecture that intangible capital might be related to the business cycle. The implementation of new advancements in, e.g. computerized information (for example by the new software) has a stimulating effect on companies' effectiveness. As a consequence, this new software affects development of technology, thus supporting the Real Business Cycle theory. Monitoring the level of intangible capital and its components might therefore contribute to the knowledge about structural changes cyclical fluctuations.

This report contains the results of estimation of the intangible capital in Poland in 1995-2013. Hitherto, a detailed study showing the estimates of intangible capital for 1995-2013 in Poland have not been presented. The results of this study might have relevant implications for policy. To make this estimation, we used methodology based on the work by Corrado et al. (2005, 2009) and followers. This allows us to prepare comparative analysis of Poland, United States and European countries. Our results showed that intangible capital has been an important factor behind economic development in Poland. Some of its components nonetheless has not been included in the economic account of Poland, and other European countries for that matter.

Research method and data estimation

The research on intangible capital is based on the work of Denison (1963), Kendrick (1961), Jorgenson (1963) and Griliches (1984). These pioneering research were further applied for the US economy and upgraded by Corrado and Hulten (2006) and presented in front of the US Federal Reserve Board (FRB). Their work was successfully reproduced and improved by Piekkola et al. (2011) on the European ground during the project INNODRIVE. The European Commission recognized the major determinants of R&D induced growth in the Lisbon process, reflected it in the Horizon 2020 agenda and sponsored another related project called INTANINVEST. Further research by both teams, from the EU and the USA resulted in the number of articles on various aspects of intangible capital. They provided a basic research structure and the methodology. Moreover, abovementioned projects used consistent methodology and therefore they allow for comparative analysis on the country level.

Both projects (INTANINVEST and INNODRIVE) produced a series of data for 29 countries. INNODRIVE provided data starting from 1995 until 2005 and INTANINVEST from 2005 until 2010. However, the latter provided estimates only for Austria, Belgium, Czech Republic, Denmark, Finland, France,

Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Slovenia, Spain, Sweden, Great Britain and United States, and thus excluded Bulgaria, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Norway. In one case country level data were estimated based on weighted average for the new EU member states. Particularly, during INTANINVEST research Cyprus' National Accounts did not provided sufficient information about software Gross Fixed Capital Formation.

Only some of intangible capital components had been included in the European System of Accounts ESA95, and also in Polish National Accounts. These accounts have been mainly oriented on classical growth factors (Jeznach 2010). In 2013 a regulation No 549/2013 was issued, obligating all member states to apply new methodological standards of ESA2010. In ESA2010 United Nations Statistical Commission (2009) changed the treatment of R&D from being 'used up' within the period, to investments in fixed assets that are used and held in the process for multiple periods. It also included the amortization of intangible non-produced assets.

While we have been collecting the data for intangible capital components we had to deal with changes in the NACE methodology. INNODRIVE used NACE rev 1.1 structure while all following projects (ours included) needed to use NACE rev 2 classification. Piekkola et at. (2011) specifies what intangible capital NACE rev 2 components have been corresponding with the NACE rev 1.1. Therefore, we could incorporate changes without losing integration of the data in our time series. The changes in the NACE classification occurred in 2006. The structure has been extended from 17 sections (and 62 divisions) to 21 sections (with 88 divisions). The extension allowed to introduce new concepts, for instance the J – transport, storage and communications section have been separated into H – transportation and storage and J – Information and Communication. The results presented in this report show intangible capital in Poland before and after the update in the ESA methodology. They cover the existing gap that will allow for comparative analysis of structural changes.

Primary source of information on intangible capital was EUROSTAT database. These data included intangible capital components according to sectors of production corresponding to NACE classification. Gross Intangible Capital Formation estimates include only non-agricultural business sectors. The excluded NACE rev. 1.1 sections are: agriculture (A), fishing (B), public administration (C), defense and compulsory social security (L), education (M), health (N), other community, social and personal service activities (O) and private households (P) (Jona-Lasinio et al. 2011). Corresponding sections have been also excluded (since 2007 in Poland) from the NACE rev. 2 statistics.

There are three main categories of intangible capital: computerized information, innovative property and economic competencies. The first component has in great part been included in the Polish National Accounts, however the later have mostly not been included. From **computerized information** ESA95 have included the investments in computer software but not included computer software development (creation of databases or maintenance). From the category of **innovative property** R&D investments have been included. The estimates include the costs of acquiring property rights, cost of acquiring patents, licenses and trademarks. However, they do not include the development of non-scientific R&D and financial products development. Similarly, mineral exploration and evaluation was included in the National Accounts, but only as a change in inventories – the research have not been included. The **economic competencies** have not been included in the Polish National Accounts. This category of intangibles should include brand equity, advertising expenditure and market research, firm-specific human capital, continuing vocational training and apprentice training and organizational structure – purchased or developed on own account.

Some of the missing information were gathered from a periodic information of enterprises for GUS on F-01/I-01 forms. These included data that were not publicly available at a suitable detail level. Some of the data could not be gathered either from National Accounts or other official statistics. These data must have been estimated otherwise. According to Piekkola et al. (2011) on the basis of research by Landes and Rosenfield (1994) and Marrano and Haskel (2006) about 60% of the advertising expenditures can be included in capital formation. We accepted this estimate. Another missing data included development cost in financial services. To estimate them we incorporated Piekkola's et al. (2011: 42) assumptions, who postulated that development costs in financial services comprises of 20% of total intermediate spending for intermediate inputs by the financial intermediation excluding insurance and pension funding. According to Corrado et al. (2009) intangible innovative property capital is also generated by financial sector. Therefore, we also collected data on development cost in financial industry excluding insurance and pension funding. Data on pension funding was not available at EUROSTAT. In the INNODRIVE the missing data was substituted by other monetary intermediation. It was possible to retrieve the abovementioned data from Polish Statistical Office. According to Piekkola et al. (2011) only 20% of other monetary intermediation should be included as intangible capital. We followed this estimate.

After estimating the particular types of intangible capital several missing data were identified. They were interpolated with the use of unobserved components models (Harvey 1989).

Estimates of intangible capital allow for expanding the growth model specification. We have supplemented the classical growth factors with intangible capital measures. This leads to the expansion of the conventional Solow–Jorgenson–Griliches sources-of-growth (SOG) model (Solow 1957) to include intangible capital. In result we achieve Corrado-Hulten-Sichel (CHS) model of a form

$$P^Q(t)Q(t) = P^C(t)C(t) + P^I(t)I(t) + P^N(t)N(t) = P^L(t)L(t) + P^K(t)K(t) + P^R(t)R(t) \quad (1)$$

where P indicates prices, Q is output, C means consumption, I means physical or tangible capital investments, N means intangible capital investments. GDP is produced on the basis of a function of production factors, L being labour, K being physical or tangible capital and R being intangible capital accumulated as follows: $R(t) = N(t) + (1 - \delta_R)R(t-1)$, where δ_R is a depreciation rate.

When intangible and tangible capitals are treated symmetrically the economic growth equals

$$g_Q(t) = s_C(t)g_C(t) + s_i(t)g_i(t) + s_n(t)g_n(t) = s_l(t)g_l(t) + s_k(t)g_k(t) + s_r(t)g_r(t) + g_a(t) \quad (2)$$

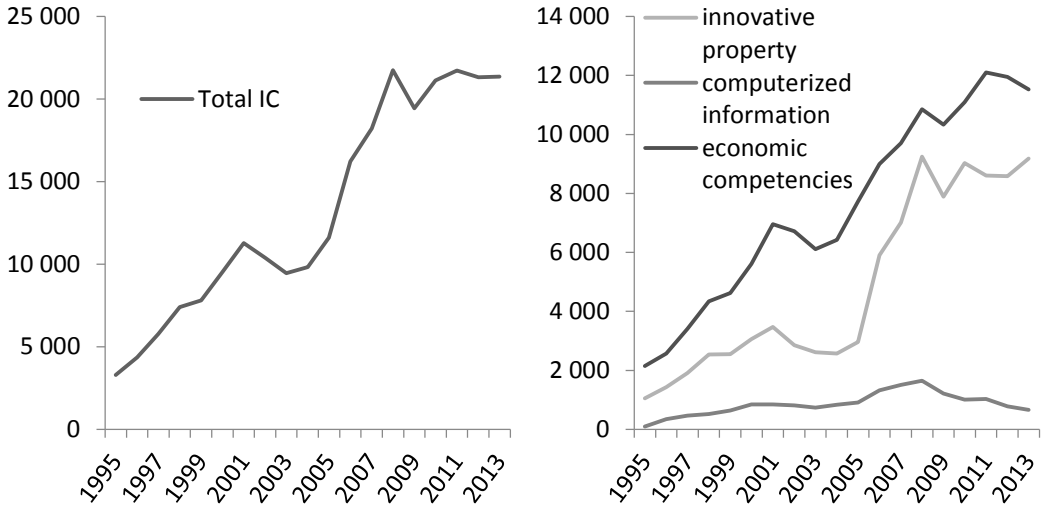
where g denotes growth rate of $g_Q(t)$ – output, $g_C(t)$ –consumption, $g_i(t)$ – investments in tangibles, $g_n(t)$ – investments in intangibles and $g_l(t)$ – labour, $g_k(t)$ – tangible capital, $g_r(t)$ – intangible capital, $g_a(t)$ – multifactor productivity, while s denotes output shares. Such an approach enables to calculate the impact of intangible capital on economic growth.

The results

In 1995 intangible capital formation in Poland amounted 3.3 billion EUR (figure 1). In relation to GDP it was 3.1%. This share increased until 2001, reaching 5.3%. Then it decreased for the next five years to 4.8%. From 2006 to 2009 it grew again, reaching the highest value 6.3%. Since the following year it decreased and in 2013 it amounted 21.4 billion EUR, and accounted for 5.5% GDP. General tendencies of intangible capital formation were similar to the one of GDP, including the trends and

cycles. From its main components economic competencies and innovative property also went through similar changes, with more visible decrease of the latter during early 2000s. Value added of computerized information grew until 2008. Since then it decreased.

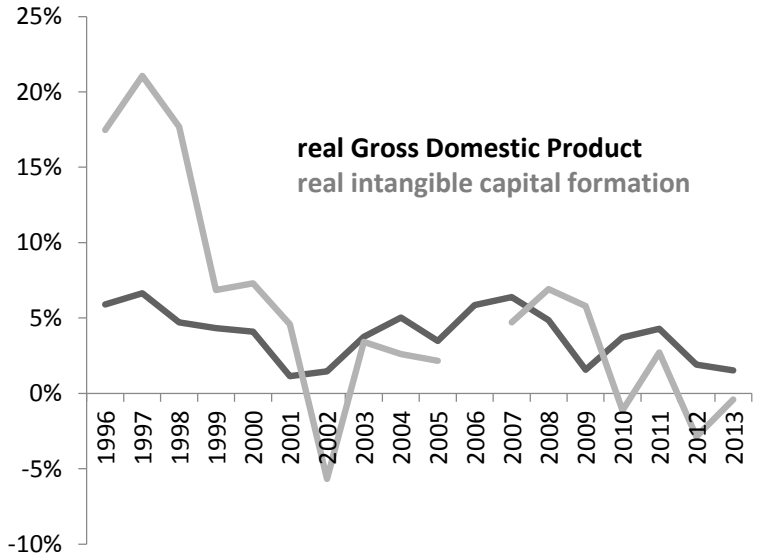
Figure 1 Intangible capital formation and its main components, millions EUR



Source: Own calculations.

During 1995-2013 the intangible capital formation in Poland grew annually in average by 7.5%. The average annual growth of GDP at that time was 4.1%. This favourable for intangibles difference occurred mainly during 1996-2001 (figure 2). After this period the growth rates of both aggregates did not differ considerably. The fastest growing component was innovative property. It grew in average by 9.3% a year. Among its elements mineral exploration, license and copyright costs grew fastest – by 15.6% a year. The other two components developed in an approximately 9% annual growth rate. Gross value added contributed by the second component of intangibles – computerized information grew annually by 7.8%. Out of its elements advertising expenditures grew fastest (by 9.9% annually), than brand equity (7.3%), organizational structure and firm-specific human capital (5.9%). Average growth of value added of economic competencies, third component of intangibles, was 6.3%.

Figure 2 Annual growth rate of Intangible Capital formation and GDP in Poland



2006 gap is the result of change in the national accounts methodology. Price index, 2000=100.
Source: Own calculations.

After sharp increase in the share of investments in computerized information in 1996 (from 2,9% do 8%), until 2007 it was stable and amounted 8% of intangible capital. Since 2008 both the level and share of investments in computerized information in Poland have been decreasing to 3.1% in 2013.

The share of investments in innovative property during 1996-1998 increased slightly (from 31.9% to 34.3%). After that until 2005 we can see its negative tendency, during which it decreased to 25.5% of intangible capital. During the next period – 2006-2008 it grew sharply, reaching 42.5%. Since then it fluctuated around this share. Out of the elements of innovative property mineral exploration and evaluation, as well as copyright and license cost exhibited similar tendencies. Main element of this components, i.e. new architectural and engineering designs also changed similarly until 2009, since when it started to decrease. This decrease have been compensated by sharp growth of the share of R&D expenditures, including social sciences and humanities and by rising development costs in financial industries. Both elements did not reach, however, the high shares observed during, respectively 1995-1996 (R&D) and early 2000s. (development costs).

Investments in economic competencies share for the most part of 1995-2005 was over 60% of all intangible capital. Afterwards, it decreased and fluctuated between 50% and 55%. The first element of economic competencies – brand equity rose from 1995 to 2005, then considerably decreased, and in 2010 again started to grow, although slowly. The share of firm-specific human capital did not exhibit visible trend. Instead it fluctuated roughly according to the business cycle. Interestingly its peaks and troughs occurred with a lead in comparison to GDPs. Organizational structure share decreased in the beginning of the analysed period and since then it stabilised on the level of 30% intangible capital.

Table 1 Intangible capital in Poland and its components during 1995-2013, millions EUR, current prices

Type of Investment	1995	2000	2005	2010	2013
1. Computerized information	**95.1**	**845.9**	**912.6**	**1003.9**	**657.7**
a) Software publishing b) Database	95.1	845.9	912.6	1003.9	657.7
2. Innovative property	**1049**	**3064**	**2963**	**9023.3**	**9175.9**
a) R&D including social sciences and humanities	238.9	396.6	380.3	597.3	1289.9
b) Mineral exploration and evaluation c) Copyright and license cost	72.4	645.3	322.0	1664.3	1754.1
d) Development cost in financial industry	143.4	701.7	872.6	1008.0	1145.8
e) New architectural and engineering designs	594.3	1320.2	1388.1	5753.7	4986.2
3. Economic competencies	**2142.0**	**5609.1**	**7727.6**	**11092.9**	**11523.5**
a) Brand equity	631.6	2180.4	3316.3	3833.3	4009.2
- Advertising expenditure	363.3	1541.9	2682.9	3364.0	3536.0
- Market research	268.3	638.4	633.4	469.3	473.2
b) Firm-specific human capital	251.1	554.9	844.9	1226.5	1248.1
- Continuing vocational training - Apprentice training	251.1	554.9	844.9	1226.5	1248.1
c) Organizational structure	1259.3	2873.8	3566.5	6033.2	6266.3
- Purchased	620.3	1718.9	2251.2	3111.3	3554.1
- Own account	639.0	1154.9	1315.3	2921.9	2712.2
Total Intangible Capital	3286.1	9518.8	11603.2	21120.1	21357.1

Source: own calculations.

Cobb-Douglas function growth model with classical capital and labour inputs for Poland gives constant returns to scale (table 2). As expected productivity of labour is much lower than the productivity of capital. Labour is not significant. TFP is significant at $\alpha = 0.10$. Inclusion of intangible capital formation in the specification diminishes productivities of both labour and fixed capital. The productivity of intangible capital is statistically significant at $\alpha = 0.01$. Its productivity is 3.2-times higher than the productivity of labour, and 2.8-times lower than the productivity of fixed capital. Such a model exhibits constant returns to scale. The hypothesis of eliminating intangible capital as non-significant growth factor is rejected at $\alpha = 0.01$. It confirms that it has been an important factor behind Polish economy growth during 1995-2013.

Table 2 Estimated production functions

$\mathrm{dln}(Y)$	Classical growth factors	With intangible capital
$const$	0.023*	0.011
st. error	0.011	0.009
$\mathrm{dln}(K)$	0.872***	0.666***
st. error	0.110	0.110
$\mathrm{dln}(L)$	0.372	0.074
st. error	0.388	0.325
$\mathrm{dln}(R)$	-	0.236***
st. error	-	0.77
Adjusted R^2	0.82	0.90
Log-likelihood	34.61	39.27
AIC	-63.22	-70.54
BIC	-60.55	-66.98
HQ	-62.85	-70.05
LR	-	9.32
p-value	-	<0.01
Wald CRTS	0.45	0.01
p-value	0.51	0.94
DW	1.66	2.32
p-value	0.20	0.69
BP	7.74	2.75
p-value	0.26	0.43
DH	4.69	3.83
p-value	0.10	0.15

* means significant at 0.10, *** means significant at 0.01. d denotes first difference and $\ln$ – natural logarithm.
Source: own calculations.

Poland and other countries

Tables 3 and 4 show the level of intangible capital investment related to GDP. From the eight East-European economies the Czech Republic had been the leader of boosting economic growth by intangible capital up to 2005. Hungary and Slovenia followed. It changed with the following years, during which Slovenia increased intangible capital formation. Steady advancement in IC investments in Czech Republic has been broken and IC investment/GDP ratio in 2010 became considerably smaller than in 2005. Data for most of the other countries were unavailable. Out of them only Poland proved to increase relative IC formation, although still being behind Slovenia and Czech Republic.

Table 3 The Intangible Investment/GDP Ratios in % in 1995, 2000, 2005, and 2010 for the Eight Countries (ranked from the top ratio down)

Country	1995	2000	2005	2010
Slovenia	6.0	6.8	7.0	7.2
Czech Republic	5.4	6.6	7.6	6.3
Hungary	5.8	7.0	7.3	-
Slovakia	3.2	5.8	6.4	-
Estonia	5.1	4.6	5.2	-
Latvia	2.8	3.8	4.7	-
Poland	3.0	4.8	4.6	5.8
Lithuania	2.4	3.2	4.0	-

Source: Calculated by C. Jona-Lasinio, M. Iommi, and S. Manzocchi, Intangible capital and productivity growth in European countries, February 2011, from *Innodrive* project data; 2010 for Poland – own calculations.

East-European leaders of intangible capital formation were in the bottom of the top ten European countries (table 4). Sweden, United Kingdom and Belgium proved to use intangible capital to the largest extent, even though in the former two, relative level of intangible capital investment slightly lowered at the end of the first 2000s decade. In most of other West-European countries with high intangible capital formation its level increased (with the exception of the Netherlands).

Table 4 Ranking of the Top Ten EU Countries in Accordance with their Intangible Capital Investment/GDP Ratios in 2005 and 2010 (middle-developed countries under consideration in italics)

Country	2005	2010
Sweden	9.1	8.7
United Kingdom	8.9	8.5
Belgium	8.1	8.5
France	7.6	7.8
Denmark	7.1	7.8
Finland	7.3	7.4
Slovenia	7.0	7.2
Netherlands	7.5	6.9
Czech Republic	7.6	6.3
Hungary	7.3	-

Source: See Table 3.

One of the prominent components of intangible capital – firm-specific human capital decreased in most of the leading Western and Eastern European economies during 2005-2010 (table 5). From Western economies this component (relative to GDP) remained highest in Denmark, France and Germany. Data for few Eastern economies (estimates for most of the countries were unavailable) show even deeper slowdown in the formation of this type of capital.

Table 5 Firm-specific Human Capital in Selected Highly-developed and Middle-developed economies in Terms of Its Ratio to GDP

Country	2005	2010
Highly developed economies		
France	1.51	0.96
Denmark	1.49	1.35
Germany	1.29	0.94
Austria	0.79	0.79
Italy	1.02	0.55
Spain	0.81	0.40
Middle-developed economies		
Latvia	2.89	-
Hungary	2.83	-
Estonia	2.73 *a*	-
Czech Republic	2.28	0.57
Slovenia	2.06 *b*	0.74 *c*

Poland	1.81	0.30
Slovakia	1.63	-
Lithuania	1.46	-

a – 2004 b – 2003 c – 2009

Source: For highly-developed, see van Ark, Hao, Corrado, and Hulten, 2009; for middle-developed, see Cywinski and Harasym, 2014, mimeo, all on the basis of *Innodrive* project data, for Poland in 2010 – own calculations.

Changes in intangible capital formation seem to be positively correlated with changes in the share of science and engineering graduates (table 6). This share considerably increased in Slovenia and Estonia during 2005-2010. In the Czech Republic it increased slightly, but from an already high level. Poland, Latvia and Hungary made an enormous progress in this case, even though the level is still lower than in the East-European leaders. In Poland public subsidies and labour market programs contributed to this change. In Slovakia and Lithuania the analysed share decreased.

Table 6 The Share of Science and Engineering Graduates in the Supply of University Graduates in 2001 and 2013 in %

Country	2001	2013
Slovenia	20.2	26.1
Estonia	18.1	24.7
Czech Republic	22.0	23.2
Lithuania	25.6	22.2
Poland	10.4	21.0
Slovakia	25.6	20.5
Latvia	12.1	17.9
Hungary	10.0	17.3

Source: Kos, 2003 (2001) and own calculations on the basis of Eurostat database (2013).

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