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Intangibles, Can They Explain the Dispersion in Return Rates? [*]

Bernd Görzig [†] **and Martin Gornig** [‡]

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Abstract

It is argued that the observed return rates on capital at firm-level have an upward bias if firms are producing with unobserved intangible capital. Using EUKLEED, a comprehensive firm level data base for Germany, this theoretical preposition is proved empirically. Furthermore, making unobserved capital observable the dispersion in return rates reduces dramatically. The results clearly support the assumption that a considerable part of the observed dispersion in return rates among firms can be contributed to unobserved capital formation in intangible capital. Firms with high input in intangibles also have an above average observed rate of return. However, the question to what extent a more intense use of intangibles can be the cause for higher return rates in the sense of both the *monopoly-based* and the *innovation-based* explanations is not answered.

Keywords: Intangible capital, Rate of return, Firm-level profitability

JEL-Codes: L23, D24, M10, C15

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1. Research question

Labour economists in recent years have discussed intensively about the apparent inconsistency between the theory-based rule of equal wage for equal labour with the empirical observation that seemingly the same type of labour is paid differently (Abowd/Kramarz/Margolis 1999). Similarly, IO researchers are puzzled by the fact that profit rates differ considerably between firms.[iv]

Mueller (1977) stated in his paper, "Persistence of Profits Above the Norm", that "In an efficient market economy, profits above or below the norm should quickly disappear." This statement is contrary to the theoretical findings of several empirical studies, that some firms are able to maintain an above average level of profits for extended periods of time. Persistent diversions from the average level of profits have been found for several countries (*US:* Qualls 1974, Jacobson 1988; *UK:* Geroski/Jaquemin 1988, Cubbins/Geroski 1987; *Canada:* Rigby 1991).

Several theories have been discussed to explain these observed diversions (Roberts 2001). However, the focus of this paper is in the measurement aspects. Ayanian (1975), referring to Weiss (1969) and Bloch (1974), remarks that if advertising expenditures are assessed to be intangible capital formation then the accounting rate of return could be potentially biased upwards by an amount, which is positively related to the firm's advertising intensity. Fisher/McGowan (1983) indicate the measurement problem that not all activities - such as *R&D* - are proper capitalized as they should be under economic aspects. Megna/Mueller (1991) suspect that the observed dispersion in return rates might be the result of a measurement errors caused by the insufficient consideration of intangible capital.

It is argued that the dispersion of the rate of return can only be justified as a test of the effectiveness of competition if it refers to total capital in use, including also unobserved capital. Observed differences in the return rate could be caused by the different use of account capital formation. In particular, expenses for *R&D* and for *advertising* made by the firms are frequently not counted as capital formation and therefore the capital stock used in production is underestimated.

[iv] Throughout this paper firm is used synonymously with establishment, the local unit.

There is a direct line from this argumentation to the increasing interest of researchers into the impact of so far unobserved intangible assets. Most of this interest in recent years has been with the growth aspects of intangible assets (Corrado/Hulten/Sichel 2004, 2006; Marrano/Haskel/Wallis 2007; Marrano/Haskel 2006; Hao/Manole 2007). Dougherty/Jorgenson (1997) found that considering also human and intangible capital, output growth in most of the G7 countries could almost entirely be explained by differences in total investment. Timmer/van Ark (2005) refers to ICT as a driver for productivity.

In this paper intangible capital formation at the firm level is capitalized to calculate return rates on total capital. The focus of the analysis is to question what extent observed dispersions in profitability of firms can be caused by production and use of assets so far neglected. First, we deal with the question: what would happen to the rate of return if unobserved capital formation and unobserved use of capital in a firm has to be assumed? In the second step, we analyse this question empirically based the most comprehensive firm level dataset for Germany.

2. Methodology

2.1. The problem

Marrano/Haskel/Wallis (2007) found that with a more comprehensive deduction and focus of growth aspects of intangibles that observed labour productivity at firm level, and for the economy as a whole, would be underestimated if hidden capital formation can be assumed. However, they did not elaborate the consequences for the firm level return rates. The following description is a streamlined reduction of the model of Marrano/Haskel/Wallis (2007) with focus on the return rates. The results are not only exclusively relevant for intangible assets, but can be applied on any type of hidden capital formation within a firm. With respect to the empirical part of the paper, the following discussion refers to hidden capital produced by the firms themselves and their own account intangibles.

We assume a perfect competitive economic surrounding for a firm. The firm is producing two types of output. One type Y_O is assumed to be sold on the markets. We do not explicitly say whether Y_O is for consumption goods or for investment goods. For simplicity reasons, we have excluded the fact they could be intermediate goods. The second type of output, Y_I, is assumed to be own account production of assets. Total output Y is given as:

$$Y = Y_O + Y_I$$

Production of Y_O affords labour L and capital K, both from purchased capital K_O and own account produced capital K_I:

$$Y_O = O(L_O, K_O, K_I) .$$

Another production function assumes that production of own account capital depends on labour input:

$$Y_I = I(L_I) .$$

To simplify the deductions only labour is assumed as a factor of production.

The costs of total production are the expenses for wages $W = w(L_O + L_I)$ and the costs for the use of capital, which are depreciations D and operating surplus, $P = r(K_O + K_I)$.

We assume competitive prices for production, labour input, and the use of capital. The only relevant price for the following deductions is the rate of return, calculated as:

$$(1) \qquad r = \frac{P}{K}.$$

r might be assumed to be the competitive market rate of return for capital input K. For the discussion put forth here, it is sufficient to assume that it defines the "true" rate of return, calculated in respect to the total capital used in the firm and is the same for all types of capital in the firm.

Next, we assume that production and use of capital from own account production remains unobserved. At the micro level, accountancy legislation may be the reason. At the macro level, the reason could be that own account production is not related with market transactions such that it remains undiscovered for external observers, in particular, for statistical institutions. Intangible capital formation could be such a case. Other candidates for hidden use of capital could be land, inventories, and natural resources (OECD 2001).

Observed output is then lower than total output $Y_O = Y - Y_I$ because production of Y_I cannot be observed, while observed labour input L and labour compensation W remain unchanged. Obviously observed labour productivity will also be lower. We want to quantify the net effect on the observed rate of return:

$$(2) \qquad r_O = \frac{P_O}{K_O} = \frac{Y_O - W - D_O}{K_O}.$$

Both, observed depreciation $D_O = D - D_I$ and observed capital stock, $K_O = K - K_I$ will be lower. In contrast, wages W and labour input L do not change, since labour input necessary to produce Y_I can be observed completely. Labour input L_I and labour compensation W_I used to produce the unobserved own account capital formation Y_I are now falsely allocated to the production of observed output Y_O. The basic assumption is that of asymmetric measurement: Capital formation and the use of capital with respect to own account production are not observed, while the other factors of production are. This implies a falsely specified production function for Y_O:

$$Y_O = O'(L_O + L_I, K_O).$$

Observed operating surplus, calculated as a residual, is given with:

$$P_O = Y_O - W - D_O$$

and can be converted into

(3) $$P_O = P - (Y_I - D_I)\,.$$

Observed operating surplus is the "true" operating surplus, minus net own account capital formation $Y_I - D_I$, the change in unobserved capital. In a growing economy, when capital formation tends to be higher than depreciation, we would have to expect that the observed values of operating surplus to be below those, which would arise, if all capital would be included.

Expanding the term $(Y_I - D_I)$ with K_I, yields $g_I K_I$ with,

$$g_I = \frac{Y_I - D_I}{K_I},$$

the growth rate of unobserved capital. "True" operating surplus P can be transformed to rK, and given equation,

$$K = K_I + K_O,$$

converts to

$$P_O = rK_O + rK_I - g_I K_I$$

such that

$$r_O = \frac{P_O}{K_O}$$

converts to

(4) $$r_O = r + (r - g_I)\frac{K_I}{K_O}\,.$$

The observed rate will equal the true rate of return, if there is no unobserved capital: $K_I = 0$. If we have to assume that unobserved capital K_I exists, then the observed rate of return r_O will be above the market rate of return r; as long as the growth rate of hidden capital g_I is below the market return rate on capital. In most economies, it can be expected that this will be the case for the majority of firms. However, it cannot be excluded that r_O is below r if the growth rate of unobserved capital is higher than the market rate of return. In rare cases, if the growth rate of

unobserved capital is more than twice the market rate of return, even negative observed return rates could occur.

Therefore, including unobserved intangibles into the calculation of the rate of return, results in a value below the one that can be observed. High correlations between expenditures for intangibles and observed profitability might be misleading. For instance, an innovation strategy that a firm pays out can only be assessed if the return rate for total capital is considered. In order for this to occur intangible assets have to be capitalized.

2.2. Measurement

If unobserved capital formation differs between firms, divergent return rates can be observed even if the market return rate is the same for all firms. Accounting for intangible capital as part of the unobserved capital might help to explain observed differences in return rates between firms.

It is broadly accepted that estimates on the use of intangibles in firms are extremely difficult and researchers often have to refer to simple plausible settings for many relevant parameters[v]. Corrado/Hulten/Sichel (2006) made suggestions how to quantify the impact of intangibles for the US. In the INNODRIVE[vi] project (Piekkola 2009), this approach is applied on the EU countries. In addition, founded on a firm level analysis the size and the impact of organisational capital is quantified for selected countries.

The methodology applied is based on the rules of an accountancy framework, as it is common on the firm level and as well as on the national level by the National Accounts. A key definition is the one of investment. Investments are all expenditures not used for consumption - intermediate or final - in the current period (Hunter/Webster/Whyatt 2005). While this definition (based on an exclusion principle) is commonly accepted among economists, it is important to identify the investments empirically. The currently applied methodology basically is a bottom up approach. Certain types of goods are characterized as investments and added up to yield total capital. This is practised in the

[v] The recent literature on intangibles (Corrado/Hulten/Sichel 2004, 2007; Marrano/Haskel 2006; Marrano/Haskel/Wallis 2007; Hao/Manole 2007) contains multiple examples for the application of intelligent guesses on shares of intangible in total expenditures to quantify intangibles. Furthermore, production figures frequently are used as proxies for expenditures.

[vi] INNODRIVE is a project funded by the EC under the Socioeconomic Sciences and Humanities Theme in the 7th Framework Programme. Its aim is estimate organisational capital at firm level for several countries and to integrate the results in an macroeconomic growth accounting approach.

National Accounts[vii] as well as in the accountancies of firms. While recent revisions of the National Accounts also introduced certain types of intangible investment as software and intellectual property, a broad consensus exists that these intangibles do not cover all possible cases.

There are literary examples that suggest there are various definitions for intangibles. Corrado/Hulten/Sichel (2006) distinguish between three broad categories of intangibles: computerized information, innovative property, and economic competencies. We restrict our exercise only to a segment of these types of intangibles, namely the own account production of information technology (*ICT*), research and development (*R&D*), and organisational capital (*OC*). We exclude purchased intangibles. Own account production apparently constitutes a major share of intangibles. According to Corrado/Hulten/Sichel (2006) firm-specific resources account for nearly one third of all intangibles, non-scientific *R&D* for another 20 %.

Own account capital formation frequently is estimated in calculating the expenditures for labour input afforded to produce them. Based on employment characteristics as types of occupation and education. Piekkola (2009) defines three groups of employees in a firm, whose labour input can be qualified as intangible capital formation:

1. Expenditures for *ICT* personnel in total[viii].
2. Expenditures for *R&D* employees in total, plus 25 % to consider additional intermediate input[ix].
3. Management and marketing employees are assumed to produce *OC* assets with 20 % of their labour input.
4. In addition to the groups of employees in this study, 20 % of labour input done by self-employed is assumed to be part of own account organisational capital formation.

Many firm level studies rely on readily available databases such as COMPUSTAT, which is based on published balance sheets. While bigger firms described in this data set are quite reliable, small and medium sized firms (SMEs) are not covered; bearing the danger

[vii] Even for tangible goods, problems exist in distinguishing empirically between goods used for investment, final, or intermediate consumption. This will not be elaborated further here.

[viii] Potential occurence of double counting, since the calculation of own account software already included in the National Accounts are partly based on the same source.

[ix] This value of 25 % is taken from the INNODRIVE project. For Germany, there is evidence that at least in manufacturing the additional intermediate input is around 50 % of the personnel cost (DESTATIS 2003).

that the conclusions might be biased[x]. To include SMEs into our firm-level analysis, an establishment level panel dataset (EUKLEED) for Germany is applied. EUKLEED is a comprehensive integrated micro data set on employment, investment, and output, based on the German social security data (Fritsch/Brixi 2004). It is fully integrated into the National Accounts for Germany. It covered about 1.6 million establishments in the years 1999 to 2003 with around 40 million employment cases per year. Integration into the National Accounts means that the basic data set is compatible with the National Accounts for Germany at the 70-industry level of EU KLEMS (EU KLEMS 2007) and the 16 Federal States level with respect to all data published (NA FED 2009). This dataset serves as a reference for two alternative calculations:

INNODRIVE Narrow: Intangibles of type 1 to 3 are considered as additional capital formation.

INNODRIVE Wide: In addition, intangibles of type 4, organisational capital of self-employed are included.

For each firm, labour cost for *ICT*, *R&D*, *OC* employees, and self-employed are calculated according to the employment structure of the firm[xi]. A number of industries are excluded from the analysis, namely the public sector, dwellings, agriculture, and mining[xii].

Intangible stocks are calculated applying the EU KLEMS methodology. Capital stock at historical prices as in commercial accountancies is applied. The opening stock K_t for an establishment is given with:

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

with I_t for the capital formation of the current year and a constant depreciation rate δ. For intangibles, we use depreciation rates as applied in the INNODRIVE project: 0.33 for *IT* and *R&D* assets, 0.40 for *OC*. 0.40 is also taken for assets produced by self-employed. These rates, mostly taken from Corrado/Hulten/Sichel (2006), are comparatively high,

[x] In addition, some authors, as McGahan/Porter (2002), drop the remaining comparative small enterprises from the COMPUSTAT data file for their analysis of the variance of profitability.

[xi] See annex 6.1 for a description of the types of employees classified as producer of intangibles.

[xii] See annex 6.3 for a list of the industries applied in this analysis.

implying a short service life of the assets. For Germany, there is some evidence that depreciation rates for intangibles might be lower. Tax authorities allow for a 5 year linear depreciation period on a "firm value"[xiii] bought by a company. Translated into the EU KLEMS methodology with geometric depreciation patterns, one would expect a depreciation rate of 0.20 or below.

Starting values for tangible capital stocks are calculated by using a modified version of a methodology suggested by Griffith (1999). The relation between capital formation and capital stock by type of asset and industry from the EU KLEMS database is used. This relation is applied on firms existing at the first day of our observation period (1 January 1999) to calculate the opening stock of firm-specific capital. For intangibles time series for capital formation are back extrapolated based on a reduced trend of the development in the observation period, applying the sum formula for a geometric row:

$$K_t = I_t(1-(1-\delta-\gamma)^T/(1-(1-\delta-\gamma)).$$

This gives a very good approximation of the opening capital stock K at *t = starting year* if capital formation I_t is growing continuously with the rate γ and T is chosen high enough in relation with the depreciation rate δ. In our case, a value for *T = 100* proved to be sufficient.

Firms that do not exist at the beginning of the observation period are assumed to have an opening capital stock of zero. If a firm is closed before the end of a year, the average stock is reduced according to the days of its usage. This implies the assumption that the closing stock of the firm is sold to other firms[xiv].

[xiii] The "firm value" in this case is defined as the difference between the amount paid for the company and the sum of the replacement cost for all assets accounted for in the balance sheet.

[xiv] According to the definition given by ESA 95, gross fixed capital formation (GFCF) of a firm is defined as new investment plus acquisition of used assets minus the sale of used assets.

3. Results

3.1. Aggregate results

Table 1 gives an overview of the composition of the totals calculated from the firm-level estimates. Nearly 18 % of the total wage sum is classified as intangible capital formation. This amounts to 10 % of the total value added. Corrado/Hulten/Sichel (2006) calculate for the US 15 % of total income to be intangible capital formation, referring to the whole economy and including purchased intangibles.

Own account production of intangibles in our study accounts for more than 75 % of conventional capital formation as quantified in the National Accounts. One third of these expenditures are organisational capital formation. Organisational capital accounts for 32 % of total own account intangibles. For the UK, Marrano/Haskel/Wallis (2007) found that 50 % of total intangible investment could be attributed to economic competencies. Again, this figure is based on estimates for the whole economy including purchased intangibles and items not considered in our calculations.

Table 1: Structural indicators of estimated intangibles - 2003

	dimension	Occupational type of employed persons						
		total	ICT	R&D	Organi-sational	*of which:*		
						Manage-ment	Marke-ting	Self-employed
		1	*2*	*3*	*4*	*5*	*6*	*7*
Labour compensation by type	bill. €	734	23	53	210	90	17	103
Intangible capital formation	bill. €	131	23	66	42	18	3	21
Share of labour compensation	%	17.8	100.0	125.0	20.0	20.0	20.0	20.0
Composition	%	100.0	17.6	50.3	32.1	13.8	2.5	15.8
percentage of National Accounts values of								
Value added	%	10.2	1.8	5.1	3.3	1.4	0.3	1.6
Labour compensation	%	17.8	3.1	9.0	5.7	2.5	0.5	2.8
Capital formation	%	75.6	13.3	38.0	24.3	10.4	1.9	11.9

Own account production of intangibles does not only change capital formation and capital stock. Gross production, value added, depreciation, and operating surplus are affected. Gross production and value added increase by the production value of intangible

capital formation. Operating surplus increase by net investment. These changes are calculated at firm level and consequently aggregated to compare the outcome with the reference EU KLEMS/National Accounts based calculations. The aggregated result can be derived from table 2.

As predicted in the methodological part, for the sum of all establishments the return rate for total capital is lower than the observed rate of return. Total capital stock is higher than in the conventional measure by the amount of cumulated net capital formation. Operating surplus is also higher, but not as much that with respect to the return rate it can compensate the increase in capital stock.

Table 2: Expanding National Accounts by intangibles - 2003

description	Dimen-sion	Conventional National accounts[1]	Impact of own account intangibles[3]	Expanded National Accounts
		1	*2*	*3*
Production Account				
Value added	bill. €	1 158	131	1 288
Taxes ms. Subsidies		9	.	9
Labour compensation		837	.	837
Employees		734	.	734
Self-employed		103	.	103
Depreciation		110	110	220
Operating surplus		201	21	222
Capital Account				
Capital formation	bill. €	173	131	304
Net capital stock		1 465	325	1 790
Rates				
Rate of return[2]	%	13.7	6.4	12.4
Depreciation rate		7.5	33.8	12.3

[1] Establishment values for Nace rev1 industries: D to J, K(excl. 70), N, O.- [2] Operating surplus per unit of net capital stock. [3] Firm-level estimates with ESTAPAN (2010). - Sources: EU KLEMS (2006), Own calculations.-

3.2. Firm-level results

Firm specific rates of return on capital are calculated as operating profit (after deductions of labour compensation for self-employed) divided through average capital stock of the year. Table 3 describes firm level indicators for the conventional return rates analysed with the establishment data set.

The first column describes the average return rate weighted with the size of the firms' capital stock. This is the rate that is found in conventional aggregate analysis. It changes over time according to the macroeconomic changes of operating surplus in the business

cycle. All other columns refer to non-weighted firm-level results. Note that all establishments have the same weight independently of their size, which is quite a natural assumption in IO analysis of entrepreneurial behaviour. Since the majority of establishments in the analysis are very small, the return rates of small firms exert a strong influence on the results.

Table 3: Firm-level characteristic for the conventional rate of return on capital

year	Rate of return on capital[1]					
	Weighted mean[2]	Mean	Standard Deviation	Percentiles		
				50 % Median	10%	90%
1999	0.15	1.54	18.20	0.12	-0.16	3.85
2000	0.13	2.58	21.02	0.13	-0.03	3.37
2001	0.13	2.29	21.04	0.14	-0.03	3.61
2002	0.13	2.12	24.17	0.13	-0.15	3.19
2003	0.14	1.96	10.59	0.12	-0.11	2.78

1 Operating surplus (excluding labour compensation of self-employed) divided by net capital stock. - 2 Weighted with firm-specific net capital stock at historical prices. - Sources: ESTAPAN (2010), Own calculations.

If there would be no dispersion in the return rates between firms all three measures: the weighted mean, the mean, and the median would return the same value. However, the dispersion of return rates, measured as standard deviation, is considerable. The median remains relatively stable over time and the lower percentile shows that a number of firms have negative returns. High return rates can be observed for the upper percentile with very extreme values. The results seem to be heavily influenced by outliers in the sense that a number of firms earn an operating surplus per unit of capital, which is extremely above the average. A possible explanation for such extreme return rates could be that operating surplus includes elements, which should economically be counted as costs: for example, the costs of the use of intangibles.

As expected, the assumption of additional creation and use of intangible assets reduces the overall rate of return (table 4). Assuming own account production created by employees, reduces the mean of the return rates. This refers not so much to the weighted mean, which indicates that a considerable amount of the dispersion is caused by smaller units. The stable median and the reduction of the upper percentile support this fact. That fact that the lower percentile does not change economically makes sense. In this area, we can assume that the difference between observed and marked rate of return is comparatively low and it is difficult to imagine that negative return rates are persistent. It would be more probable that firms with negative profits cease to exist.

Table 4: Rate of return for different definitions of intangibles - 2003

Name	Source	Rate of return on capital[1]					
					Percentiles		
		Weighted mean[2]	Mean	Standard Deviation	50 % Median	10%	90%
Conventional	EUKLEMS/National Accounts	0.14	1.96	10.59	0.12	-0.11	2.78
INNODRIVE Narrow	Innodrive Own Account Intangibles	0.12	1.11	6.08	0.12	-0.09	2.04
INNODRIVE Wide	Additional Intangibles for Self Employed	0.12	0.45	1.06	0.13	-0.04	1.20

[1] Operating surplus (excluding labour compensation of self-employed) divided by net capital stock. - [2] Weighted with firm-specific net capital stock at historical prices. - *Sources:* ESTAPAN (2010), Own calculations.

The impact of intangibles produced by self-employed must also be analysed. This is measured by the weighted mean and the reduction in the average return rates induced by those intangibles produced by the self-employed. These tend to be negligible. This could be explained with the fact that intangible production of the self-employed is mainly relevant for smaller establishments. The raw average return rate, the mean of the return rates of all establishments, shows that the assumptions made to make unobserved capital observable do not only reduce the overall level of observed profitability but also change the relative levels between the establishments. The standard deviation is reduced dramatically. This is mainly due to the reduction of extreme above average return rates as the 90th percentiles shows. Contrary, the 10th percentiles do not change so much and a slight convergence between the weighted mean and the median can be observed if intangibles produced by the self-employed are included into the calculations.

4. Conclusions

A critical assessment of these results has to acknowledge that they depend heavily on at least two relevant settings: First, nobody really knows what share of wage expenditures in a firm can be assumed to be classified as capital formation; in the sense that these expenditures are made in expectation of future returns. We apply for each firm the same share as found in the literature for the aggregate. These shares might be higher or lower for a specific firm. Second, depreciation rates for intangibles are assumed to be high. We apply the ones found in the literature, but lower depreciation rates might be more realistic.

To assess the impact of the assumptions made, alternative calculations will be necessary to check for the robustness of the results. It is quite transparent that intangible capital will increase with higher expenditure shares and lower depreciation rates. Both operating surplus as well as capital stock will increase. However, the impact on the rate of return has to be evaluated empirically.

Despite this, the results clearly support the preposition that a considerable part of the observed dispersion in return rates among firms could be contributed to unobserved capital formation in intangible capital. Firms with high input in intangibles also have an above average observed rate of return. The findings make clear that any causal analysis of the relationship between innovations and profitability will have to control for unobserved intangibles.

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6. Annex

6.1. EU KLEMS Depreciation Rates

type of asset	abreviation	minimum rate	maximum rate
Residential structures	Rstruc	0.011	0.011
Non-residential structures	NRStruc	0.023	0.069
Infrastructure	Infra	0.023	0.069
Transport equipment	TraEq	0.061	0.246
Computing equipment	ICT	0.315	0.315
Communications equipment	CT	0.115	0.115
Other machinery and equipment	OMach	0.073	0.164
Products of agriculture and forest	Agri	0.073	0.164
Other products	Oth	0.073	0.164
Software and other intangibles	Soft&Int	0.315	0.315
Note: for rates by industry, see Appendix Table 1 in EU KLEMS 2007.			

6.2. INNODRIVE Classification of Intangibles

BKdl88[1]	description[2]	Characteristics of employees creating intangible assets of type:			
		ICT	R&D	Manage-ment	Marke-ting
31-32	Agricultural engineers and administrators, a.s.			All	
601-612	Engineers, physicist, mathematicians, a.s.		Low	High	
621-635	Technicians, a.s.		All		
681	Wholesale, retail trade agents, puchasing agents, a.s.			High	Low
682-688	Sales assistents, a.s.				High
691-692	Banker, a.s.			High	
703	Advertising specialists, a.s.				High
733-734	Communication experts, a.s.	All			
751-763	Chief executives, consultants, tax adviser, a.s.			All	
771-773	Financial officers, chief accountants, a.s.			High	
774	IT experts, a.s.	All			
781-782	Office executives, a.s.			High	
783	IT assistents, a.s.	All			
784-794	Office clerks, a.s.			High	
862-863	Chief executives, consultants of social institutions, a.s.			High	
881	Economists, statisticians, a.s.		All		
883	Natural scientists, a.s.		All		
911	Directors of hotels, restaurants, a.s.			High	
921	Home ecomy administrators, a.s.			High	

[1] German classification of occupations (IAB 2007; chapter 5). - [2] Translated from German - All: All employees; High: Employees with higher education; Low: Employees without higher education. - Higher education: University degree or similar (Code numbers 4 to 6 in IAB (2007; chapter 8). - a.s.: and similar. - *Sources:* IAB (2007), Piekkola (2009), own definitions.

6.3. Classification of EU KLEMS Industries

description	Nace Rev 1	EU KLEMS	NA FED
TOTAL MANUFACTURING	D	D	D
FOOD, BEVERAGES AND TOBACCO	DA	15t16	
Food and beverages	15	15	
Tobacco	16	16	
Textiles and textile	DB	17t18	
Textiles	17	17	
Wearing apparel, dressing and dying of fur	18	18	
Leather, leather and footwear	DC	19	
WOOD AND OF WOOD AND CORK	DD	20	
PULP, PAPER, PAPER , PRINTING AND PUBLISHING	DE	21t22	
Pulp, paper and paper	21	21	
Printing and reproduction 1	220	22x	
Publishing	221	221	
Printing and reproduction 2	222	22x	
Coke, refined petroleum and nuclear fuel	DF	23	
Chemicals and chemical products	DG	24	
Chemicals excluding pharmaceuticals 1	240	24x	
Pharmaceuticals	244	244	
Chemicals excluding pharmaceuticals 2	245	24x	
Rubber and plastics	DH	25	
OTHER NON-METALLIC MINERAL	DI	26	
BASIC METALS AND FABRICATED METAL	DJ	27t28	
Basic metals	27	27	
Fabricated metal	28	28	
MACHINERY, NEC	DK	29	
ELECTRICAL AND OPTICAL EQUIPMENT	DL	30t33	
Office, accounting and computing machinery	30	30	
Other electrical machinery and apparatus nec 1	310	31x	
Insulated wire	313	313	
Other electrical machinery and apparatus nec 2	314	31x	
Electronic valves and tubes	321	321	
Telecommunication equipment	322	322	
Radio and television receivers	323	323	
Scientific instruments	331	331t3	
Other instruments	334	334t5	
TRANSPORT EQUIPMENT	DM	34t35	
Motor vehicles, trailers and semi-trailers	34	34	
Railroad equipment and transport equipment nec	350	350	
Building and repairing of ships and boats 1	351	35x	
Aircraft and spacecraft	353	353	
Building and repairing of ships and boats 2	354	35x	
MANUFACTURING NEC; RECYCLING	DN	36t37	
Manufacturing nec	36	36	
Recycling	37	37	
ELECTRICITY, GAS AND WATER SUPPLY	E	E	E
Electricity supply	400	40x	
Gas supply	402	402	
WATER SUPPLY	41	41	
CONSTRUCTION	F	F	F
WHOLESALE AND RETAIL TRADE	G	G	G
Sale, maintenance and repair of motor vehicles and motorcycles	50	50	
Wholesale trade and commission trade, except of motor vehicle	51	51	
Retail trade, except of motor vehicles and motorcycles; repair of	52	52	
HOTELS AND RESTAURANTS	H	H	H
TRANSPORT AND STORAGE AND COMMUNICATION	I	I	I
Other Inland transport	60	60	
Other Water transport	61	61	
Other Air transport	62	62	
Other Supporting and auxiliary transport activities; activities of tr	63	63	
POST AND TELECOMMUNICATIONS	64	64	
FINANCIAL INTERMEDIATION	J	J	J
Financial intermediation, except insurance and pension funding	65	65	
Insurance and pension funding, except compulsory social securi	66	66	
Activities related to financial intermediation	67	67	
RENTING AND BUSINESS ACTIVITIES	K1	K1	K1
Renting of machinery and equipment	71	71	
Computer and related activities	72	72	
Research and development	73	73	
Legal, technical and advertising	741	741t4	
Other business activities, nec	745	745t8	
HEALTH AND SOCIAL WORK	N	N	N
OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES	O	O	O
Sewage and refuse disposal, sanitation and similar activities	90	90	
Activities of membership organizations nec	91	91	
Media activities	921	921t2	
Other recreational activites	923	923t7	
Other service activities	93	93	

1 Nace rev1 industries A to C, L, M and Real estate excluded for this analysis. - *Sources:* ESA 95, EU KLEMS 2007, NA FED 2009.