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Intangibles, can they explain the Dispersion in Return Rates?

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Abstract

It is proved that the observed return rates on capital have an upward bias if firms are producing with unobserved intangible capital. Using a comprehensive firm level database for Germany, this theoretical preposition can also supported empirically. Furthermore, making unobserved intangible 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.

JEL classifications: L23, D24, M10, C15

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

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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.[1]

In his paper, "Persistence of Profits Above the Norm", Mueller (1977) stated that "In an efficient market economy, profits above or below the norm should quickly disappear." This statement is contrary to the findings in 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). 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. They argue that the dispersion of return rates 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 own 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.

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

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

been with the growth aspects of intangible assets (Corrado/Hulten/Sichel 2006; Marrano/Haskel 2006; Marrano/Haskel/Wallis 2007; 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) refer 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 on the question to what extent observed dispersions in profitability of firms can be caused by the production and simultaneous use of capital 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), hereafter MHW, concluded in a more comprehensive deduction and with the focus on growth that observed labour productivity would be underestimated if hidden formation of intangible capital exists. They did not elaborate the consequences for the firm level return rates, which is in the focus of the following description. The conclusions are not only exclusively relevant for intangible assets, but can also 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, the own account production of 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 intermediate consumption. The second type of output, Y_I, is assumed to be own account production of assets. Total output Y is given as:

$$Y = Y_O + Y_I \tag{1}$$

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

$$Y_O = O(L_O, K_O, K_I)\,. \tag{2}$$

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

(3) $$Y_I = I(L_I).$$

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 are given by 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:

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

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" or competitive rate of return, calculated with respect to the total capital used in the firm and is the same for all types of capital in the firm (Jorgenson/Griliches 1967).

Next, we assume that production and use of capital from own account production remains unobserved. At firm level, accountancy legislation may be the reason. At the aggregate 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, or natural resources (OECD 2001).

Observed output is 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:

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

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:

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

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

(7) $$P_O = Y_O - W - D_O$$

and can be converted into

(8) $$P_O = P - (Y_I - D_I).$$

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,

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

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

(10) $$K = K_I + K_O,$$

converts to

(11) $$P_O = rK_O + rK_I - g_I K_I$$

such that

(12) $$r_O = \frac{P_O}{K_O}$$

converts to

$$r_O = r + (r - g_I)\frac{K_I}{K_O}. \tag{13}$$

The observed rate of return will only be equal to the true rate of return, if there is no unobserved capital: $K_I = 0$. If unobserved capital K_I exists, then the observed rate of return r_O will be in general 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, this will hold for the majority of firms but 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.

To include 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 do not necessarily signal a high profitability. For instance, whether an innovation strategy pays out for a firm can only be assessed if the return rate for total capital is considered. For this, intangible assets have to be capitalized with the result that previously measured high return rates are reduced such that they converge towards the ones of firms with less intangible input.

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[2]. Corrado/Hulten/Sichel (2006), hereafter CHS, made suggestions how to

[2] The recent literature on intangibles makes frequent use of intelligent guesses on shares of intangible in total expenditures to quantify intangibles. Furthermore, production figures frequently are used as proxies for expenditures.

quantify the impact of intangibles for the US. In the INNODRIVE[3] project (Görzig/Piekkola/Riley 2011), this approach is applied on the EU countries. In addition, based on a firm level analysis the magnitude 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 at the firm level and as well as on the national level in 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 widely accepted among economists, the practical problem is to identify the investment expenditures empirically. The currently applied methodology in this field is 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 National Accounts[4] as well as in the accountancies of firms. While recent revisions of the National Accounts go beyond this practice and define certain types of expenditure like software and intellectual property[5] as intangible investment, a broad consensus exists that these intangibles do not cover all possible cases, in particular organisational capital.

In the literature, various definitions for intangibles have been suggested. CHS 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, INNODRIVE defines three groups of employees in a firm, whose labour input can contribute to intangible capital formation:

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[3] 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.

[4] 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.

[5] The upcoming revisions will also include *R&D* intangible investments.

1. *ICT* personnel in total[6].
2. *R&D* employees.
3. Management and marketing employees (*OC personnel).*

INNODRIVE assumes that from these types of labour input only a certain proportion, depending on the type of good, is engaged in the production of new intangible goods. The remaining employees of the respective types of labour are engaged in current production.

Table 1: Share of labour cost dedicated to the production of intangible goods

	ICT	R&D	OC
Share of labour input for own account production	0.50	0.70	0.20

In addition to these groups of employees, in this study 20% of labour input made by self-employed is assumed to be part of own account organisational capital (OC) formation.

Different from CHS, INNODRIVE also evaluate the value of intermediate and capital cost related to labour cost necessary in own account production of intangible capital goods. This is done in referring to those industries, which are engaged in market production of comparable type of goods. These are the following industries:

- Computer and related activities (Nace 72) as proxy for *ICT* goods,
- Research and development (Nace 73) as proxy for *R&D* goods, and
- Other business activities (Nace 74) as proxy for *OC* goods.

Based on the EU KLEMS data base, weighted averages are used for the relationship between labour, intermediates, and capital expenditures in NACE 72-74 as proxies for the cost structure of own account production of intangible goods in the firms. Combined with the figures for the share of labour costs dedicated to the production of intangible capital, a combined multiplier on labour costs is applied. The central settings on intangibles by INNODRIVE are shown in Table 2.

[6] It has to be mentioned that there might be the possibility of double counting with this item, since the calculations of own account software already included in the National Accounts are partly based on the same source.

Table 2: Central settings for intangibles in INNODRIVE

	ICT	R&D	OC
Investment share of labour input	0.50	0.70	0.20
Combined factor for other inputs	1.48	1.55	1.76
Final multiplier on labour costs	0.70	1.10	0.35
Depreciation rate	0.33	0.20	0.25

Many firm level studies rely on readily available databases such as COMPUSTAT, which is based on published balance sheets. While bigger firms in this data set are quite reliable represented, small and medium sized firms (SMEs) are not covered; bearing the danger that the conclusions might be biased[7]. To include SMEs into our firm-level analysis, an establishment level panel dataset Eukleed for Germany (Görzig 2011) is applied. Eukleed is a comprehensive integrated micro data set on employment, investment, and output based on the German Social Security (SIS) data (Fritsch/Brixi 2004). It is fully integrated into the National Accounts for Germany. It covers 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 (2007) and the 16 Federal States level with respect to all data published (NA FED 2009).

For each firm, labour cost for *ICT*, *R&D*, *OC* employees, and self-employed are calculated according to the employment structure of the firm[8]. A number of industries are excluded from the analysis, namely the public sector, dwellings, agriculture, and mining[9].

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:

$$K_t = K_{t-1}(1-\delta) + I_t, \tag{14}$$

[7] 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.

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

[9] See Annex: 6.3 for a list of the industries applied in this analysis.

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, 0.25 for *OC*. 0.25 is also taken for assets produced by self-employed.

Starting values for 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 calculated from the EU KLEMS database is used. This relation is applied on firms existing at the first day of our observation period (January 1st, 1999) to calculate the opening stock of firm-specific capital. Capital stock calculations are based on observed figures for investment and an estimate of the initial closing capital stock $K_{\theta-1}$ in the year before we start to observe a firm in the data. We assume a constant growth of investment g before the first year of observation. Let θ be the first observation for a firm. Back extrapolating yields:

$$I_{\theta-1} = I_{\theta}(1-g) \tag{15}$$

with I_t for the capital formation[10] of the current year and a constant growth rate g. Given the general cumulative definition of the closing stock in equation 15, we can apply the following equation to calculate the initial stock:

$$K_{\theta-1} = I_{\theta-1}\sum_{0}^{\infty}(1-\delta-g)^t \ . \tag{16}$$

δ is the depreciation rate and g is the growth of investment in the years preceding the initial year. Applying the sum formula for a geometric row leads to

$$K_{\theta-1} = \hat{I}\ \frac{1-(1-\delta-g)^T}{1-(1-\delta-g)}. \tag{17}$$

The initial investment $\hat{I}$ stands for the starting value $I_{\theta-1}$ in the back extrapolation, assuming the growth rate of investment g before the first observation. In theory, *T* should be infinite, for practical purposes it can be set to 100. The growth rate g depends on the average growth rate of intangible investment in the observation period. This implies that we assume that the past and current average growth rates are similar. $\hat{I}$ is set to be the average

[10] 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.

investment in the five-year period following the first observation year θ. The average is used to assess the average investment over the business cycle. It is corrected by a discount factor to reflect the growth of investment in the observation period.

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[11].

3. RESULTS

3.1 Aggregate results

Table 3: Composition of capital formation - averages 1999 - 2003

	mill. €	%
Revised capital formation	310.613	100
National Accounts[1]	181.705	58
Buildings	52.167	17
Equipment	113.818	37
Intangibles (software, databases, etc.)	15.720	5
New intangibles[2]	128.908	42
Information & Communication	14.464	5
Research & Development	55.759	18
Organisational	58.685	19
of which:		
Self-employed	24.898	8

[1] Establishment values for Nace rev1 industries: D to J, K (excl. 70), N, O. - [2] Firm-level estimates with Eukleed (2010). - *Sources*: EU KLEMS (2006), own calculations.

Table 1 gives an overview of the composition of the totals calculated from the firm-level estimates. The assumptions made on the production of intangible assets increase capital formation by a factor of 1.8 in the industries covered by this analysis. Research and

[11] 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.

development and organisational capital contribute with equal shares of about 19% most to the increase in capital formation. Self-employed, neglected in other studies, contribute with 8% to total capital formation. Own account production of intangibles in our study accounts for more than 80% of conventional capital formation as quantified in the National Accounts. Nearly half of these expenditures are organisational capital formation. For the UK, Marrano/Haskel/Wallis (MHW 2007) found that 50% of total intangible investment could be attributed to economic competencies.[12]

According to the accountancy rules in commercial and national accounting systems, own account capital formation is part of value added. If hitherto not counted capital in intangibles formation is explicitly considered, value added will increase by the same amount as capital formation itself. For the industries considered this amounts to 10% of 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.

Table 4: Impact of intangibles on value added and its components - averages 1999 - 2003

	mill. €	%
Revised value added	1.231.084	100
National accounts[1]	1.102.176	90
New intangibles[2]	128.908	10
Revised operating surplus	181.769	100
National accounts[1]	162.980	90
+ New intangibles[2]	128.908	71
- New depreciation[2]	- 110.119	- 61

[1] Establishment values for Nace rev1 industries: D to J, K (excl. 70), N, O. - [2] Firm-level estimates with Eukleed (2010). - *Sources*: EU KLEMS (2006), own calculations.

Some of the components of value added, such as taxes and wages, remain unchanged by the assumptions on additional capital formation. Production taxes usually are calculated only for market transactions and wages are already covered in total, only for some wages are now used in the production of intangible assets. Major changes in the accounting system have to

[12] These figures are not directly comparable, since the MHW estimates are made for a different industry breakdown and include also purchased intangibles and items not considered in our calculations.

be made for operating surplus. It increases because of the higher value added calculated. This increase is partly compensated by the depreciation cost connected with the additional capital stock accumulated by additional capital formation. Thus, operating surplus changes are given by net investment. These changes are calculated here 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 4. The calculation show that the net effect on operating surplus has a similar magnitude of 10% as in the case of value added.

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 (Table 5). 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 5: Rate of return for revised estimates - averages 1999 - 2003

	Dimen-sion	National accounts	Revised[2]
Operating surplus	mill. €	162.980	181.769
Net capital stock[3]		1.453.661	1.941.975
Return on capital	%	11,2	9,4
[1] Establishment values for Nace rev1 industries: D to J, K (excl. 70), N, O. - [2] Firm-level estimates with Eukleed (2010). [3] Valued at historical prices - *Sources*: EU KLEMS (2006), own calculations.			

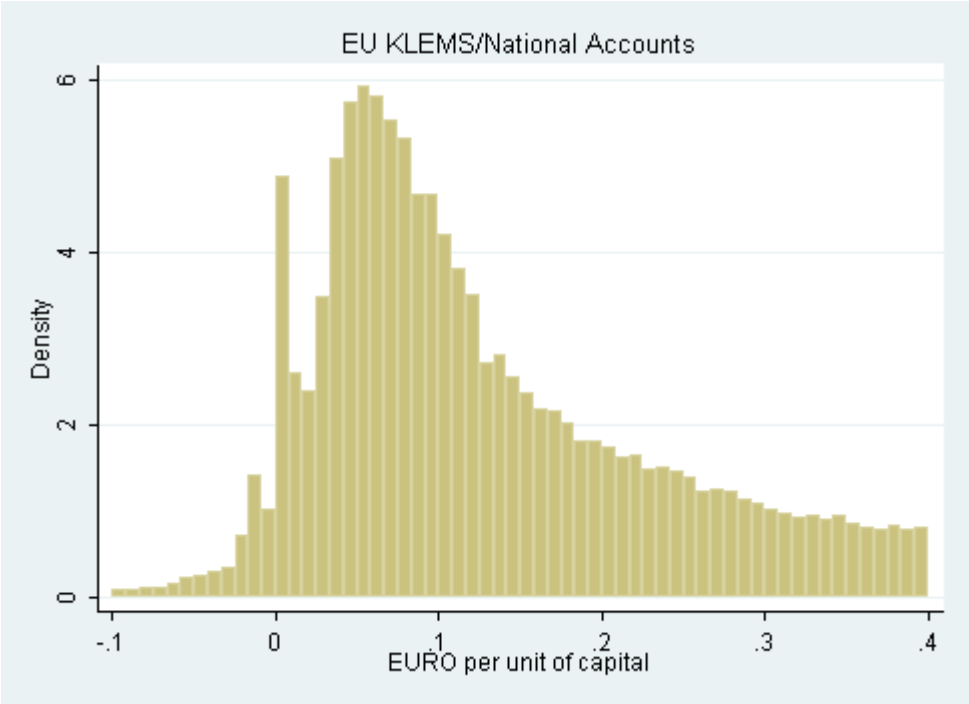
3.2 Firm-level results

Firm specific rates of return on capital are calculated as operating surplus (after deductions of labour compensation for self-employed) divided through the average net capital stock at historical prices. Figure 1 shows that the dispersion of return rates among firms is fairly big. A few firms have negative return rates. A majority of firms is gathering around the return rate of 10%. There is a long tail on the right of the distribution - partly cut off in figure 1 - with a number of firms having really huge return rates.

For a better understanding of these facts it should be noted that production behaviour of existing firms can be very different from the typical textbook examples. This in particular is true for the very big number of small firms in the sample. Factual capital usage by small service firms very often is not based on previously invested capital goods but instead is made in renting the capital necessary for production. For example, a consultant firm consisting of

the owner and an office clerk may rent the office and the office equipment and use a leased car. In this case, only costs develop for labour and intermediate consumption. The residual, in textbooks often described as capital income, accrues to the owner of the firm. Several explanations for this residual exist in the literature. One suggestion is that the residual can be seen as the compensation of entrepreneurial labour input, a common procedure in growth accounting. Another one is that it is not a rent on capital but exhibits the characteristics of an innovation or monopolistic rent. As discussed in the methodological section, it can be also explained by the rent for unobserved capital, in this case the use of intangible capital invested by the owner. All three explanations do obviously not exclude each other.

Figure 1: Rate of return on capital - density distribution: All firms 2003



The statistics of the distribution in figure 1 are described in table 6 in the first column. The first value of 11% is the average return rate weighted with the size of the firms' capital stock. This is the rate that is mostly found in conventional aggregate analysis. All other calculations refer to non-weighted firm-level results. Note that all firms 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. The value of the not weighted average return rate is with 139% far above the weighted average return rate.

In the theoretical world of perfect competition, only one price for the use of capital exists and no profits can develop. In this case, there would be no dispersion in the return rates

between firms and the three measures - the weighted average, the average across firms, and the median - would return the same value. However, the dispersion of return rates between firms, measured as standard deviation, is considerable. 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.

Table 6: Dispersion indicators for All Firms and for Big Firms - 2003

		All firms[1]		Big firms[1] (turnover above 2 million €)	
		National accounts	Revised[2]	National accounts	Revised[2]
Number of firms		1.454.417		161.515	
Averages[3]	weighted	0,11	0,10	0,11	0,09
	not weighted	1,39	0,23	0,21	0,17
Standard deviation		9,08	0,47	0,40	0,26
Coefficient of variance		6,51	2,05	1,94	1,57
Percentiles	0,1	0,04	0,01	0,02	0,01
	0,5	0,19	0,10	0,11	0,09
	0,9	2,58	0,65	0,43	0,37

[1] Establishment values for Nace rev1 industries: D to J, K (excl. 70), N, O. [2] Firm-level estimates with Eukleed (2010). [3] Operating surplus divided by net capital stock at historical prices. - *Sources*: EU KLEMS (2006), own calculations.

As expected in the methodological section, the assumption made on intangible assets reduces the overall rate of return, as can be seen in the second column of table 6. Assuming own account production created by employees, reduces all average return rates (weighted, not weighted, and median). This refers less to the weighted average, which indicates that a considerable amount of the dispersion is caused by units with low weight. This impression is supported by the fact that the higher percentiles are moving much more to the left than the lower percentiles.

That the standard deviation reduces dramatically if intangibles are included in the calculations has to be expected, since also the average level of the return rates is reduced. More important is the fact that the coefficient of variance is less than one third of the one in the conventional calculations of return rates. Thus, the assumptions made on intangible capital clearly lead to a convergence of firm specific return rates.

As discussed before, small firms seem to have a considerable impact on the dispersion of return rates. Economically, their influence is rather small. An analysis of firms with more than 2 million € production value shows that in our sample of roughly 1.5 million firms only 160 000, a bit more than 10% of the total, can be classified as Big Firms. However, the Big Firms have about 66% of total employment, 74% of value added and 90% of operating surplus. It therefore makes sense to make a separate analysis for the Big Firms in table 6.

The differences between the conventional calculations and the results found if intangible capital is assumed are less dramatic than in the case for all firms. However, the general result, found for all firms can be confirmed. Also for Big Firms it can be stated that the inclusion of intangibles reduces mainly the very high return rates, while the mean is only reduced by a small amount.

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 as capital formation in the sense that these expenditures are made in expectation of future returns. We apply on 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 tra	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.