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INTANGIBLES, CAN THEY EXPLAIN THE DISPERSION IN RETURN RATES?

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It is proven 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 is supported empirically. Furthermore, by making unobserved intangible capital observable, dispersion in return rates is dramatically reduced. The results support the assumption that a considerable part of the observed dispersion in return rates among firms is attributable to unobserved capital formation in intangible capital.

JEL Codes: D24, E01, L23

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1. RESEARCH QUESTION

Labor economists are intensively discussing the apparent inconsistency between the theory-based rule of equal wage for equal labor with the empirical observation that the same type of labor is, in fact, paid differently (Abowd *et al*., 1999). Similarly, IO researchers are puzzled by the fact that profit rates differ considerably between firms.[1]

In "The Persistence of Profits Above the Norm," Mueller (1977, p. 369) states 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 can maintain above average level of profits over extended periods of time. Persistent deviations from the average level of profits are found for several countries (U.S.: Qualls, 1974; Jacobson, 1988; U.K.: Cubbin and Geroski, 1987; Geroski and Jacquemin, 1988; Canada: Rigby, 1991).

Several theories exist explaining 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 that is positively related to the firm's advertising intensity. Fisher and McGowan (1983)

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

suggest a measurement problem: not all activities—such as R&D—are properly capitalized as they should be under economic aspects.

Megna and Mueller (1991) suspect that the observed dispersion in return rates might be the result of 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 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 interest is with the growth aspects of intangible assets (Marrano and Haskel, 2006; Hao and Manole, 2008; Corrado *et al*., 2009; Marrano *et al*., 2009; Jona-Lasinio *et al*., 2011). Dougherty and Jorgenson (1997) find that if human and intangible capital is included, then output growth in most of the G7 countries can almost entirely be explained by differences in total investment. Timmer and van Ark (2005) refer to ICT as a driver for productivity. Basu *et al*. (2003) argue that growth of Total Factor Productivity (TFP) will be biased if unmeasured outputs or inputs are neglected. In particular, TFP growth will be overestimated if unmeasured input is growing, and underestimated if unmeasured output is growing.

In this paper, intangible capital formation at the firm level is capitalized to calculate return rates on total capital. This analysis focuses on the extent to which observed dispersions in firm profitability are caused by the production and simultaneous use of capital assets neglected in conventional calculations. First, we address the question: What would happen to the rate of return if unobserved capital formation and unobserved use of capital in a firm must be assumed? In the second step, we analyze this question empirically using a comprehensive firm level dataset for Germany.

2. Methodology

2.1. *The Problem*

Marrano, Haskel, and Wallis (2009), hereafter MHW, focusing on growth, conclude that observed labor productivity would be underestimated if hidden formation of intangible capital existed. They do not elaborate the consequences for firm level return rates, which is the focus of the following description. The conclusions are not just relevant for intangible assets, but can also be applied to any type of hidden capital formation within a firm. With respect to the empirical part of the paper, the following discussion addresses the hidden capital produced by the firms themselves, their own account production of intangibles.[2]

We assume a perfect competitive economic surrounding for a firm. The firm is producing two types of output. One type, X_O, is assumed to be sold on the

[2]Purchased intangibles have to be treated differently in the accountancy framework.

markets. We do not explicitly state whether X_O is an investment or consumption good. For simplicity, we exclude intermediate consumption. The second type of output, X_I, is assumed to be own account production of assets.

Production of X_O requires labor L and capital K, both from purchased capital K_O and own account produced capital K_I:

$$X_O = O'(L_O, K_O, K_I). \tag{1}$$

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

$$X_I = I'(L_I). \tag{2}$$

To simplify the deductions, only labor is assumed to be a factor of production. For the following discussion, we do not need to specify details on the production function. The argumentation is based on nominal values, using simple accountancy relations. Given p_O and p_I as product prices, the value of total output Y is given as:

$$Y = Y_O + Y_I = p_O X_O + p_I X_I. \tag{3}$$

The costs accruing to produce total output are the expenses for wages, $W = w(L_O + L_I)$, and the costs for the use of capital, given by depreciations, D, and operating surplus, $P = r(K_O + K_I)$. The only relevant price for the following deductions is the rate of return, calculated as:

$$r = \frac{P}{K}. \tag{4}$$

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 internal rate of return of a firm, which is applied to decide on alternative investments. It is assumed to be the same for all types of capital in the firm (Jorgenson and Griliches, 1967).

Next, we assume that production and use of capital from own account production remain unobserved. At the 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 statistical institutions. Intangible capital formation could be such a case. Other candidates for hidden use of capital in conventional studies could be land, inventories, or natural resources (OECD, 2001).

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

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

Both the numerator and the denominator of the return rate are understated if we neglect unobserved intangible capital. Principally, the bias could go either way or could be equalized. 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 labor input, L, do not change, since the labor input necessary to achieve total output, including Y_I, can be observed completely. Labor input, L_I, and labor compensation, W_I, used to produce the value of unobserved own account capital formation Y_I are now falsely allocated to the value 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 but partly attributed to the wrong type of output.

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

$$P_O = Y_O - W - D_O \tag{6}$$

and can be converted into

$$P_O = P - (Y_I - D_I). \tag{7}$$

The 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 expect the observed values of the operating surplus to be below those which would arise if all capital is included.

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

$$g_I = \frac{Y_I - D_I}{K_I}, \tag{8}$$

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

$$K = K_I + K_O, \tag{9}$$

converts to

$$P_O = rK_O + rK_I - g_I K_I \tag{10}$$

such that

$$r_O = \frac{P_O}{K_O} \tag{11}$$

converts to

$$r_O = r + (r - g_I)\frac{K_I}{K_O}. \tag{12}$$

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, provided

the growth rate of hidden capital, g_I, is below the market return rate on capital. In most economies, this holds 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, negative observed return rates could even occur.

If unobserved intangibles are included in the rate of return calculations, then resulting values will be below the observable values. Therefore, high correlations between expenditures for intangibles and observed profitability might be misleading. They do not necessarily signal a high overall 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 earlier measured high return rates are reduced and converge toward that of firms with less intangible input.

2.2. *Measurement of Intangibles*

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.[3] Corrado, Hulten, and Sichel (2009), hereafter CHS, suggest how to quantify the impact of intangibles for the U.S. In the INNODRIVE[4] project (INNODRIVE, 2011), the size and the impact of organizational capital are quantified for selected countries at firm level.

The methodology applied is based on the rules of an accountancy framework, as it is common at the firm level, as well as at the national level in the National Accounts. A key definition is that of investment. Investments are all expenditures not used for consumption—intermediate or final—in the current period (Hunter *et al*., 2005). While this definition—based on an exclusion principle—is widely accepted among economists, the practical problem is empirically identifying investment expenditures. The currently applied methodology in this field is basically a bottom-up approach: certain types of goods are characterized as investments and cumulated to yield total capital. This is practiced both in the National Accounts[5] and in firm accountancies. While recent revisions of the National Accounts go beyond this practice and define certain types of expenditure, like software and intellectual property[6] as intangible investment, a broad consensus

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

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

[5]Even for tangible goods, problems exist in distinguishing empirically between goods used for investment, final, or intermediate consumption.

[6]Upcoming revisions of the National Accounts will include R&D intangible investments.

TABLE 1
SHARE OF LABOR COST DEDICATED TO THE PRODUCTION OF INTANGIBLE GOODS

	Type of Labor Input		
	ICT	R&D	OC
Share of labor costs used for own account production of intangibles	0.50	0.70	0.20

Source: INNODRIVE (2011).

exists that these intangibles are not exhaustive and omit, in particular, organizational capital.

In the literature, various definitions for intangibles are suggested. CHS distinguish between three broad categories: computerized information, innovative property, and economic competencies. We restrict our exercise to a segment of these intangibles, namely the own account production of information technology (ICT), research and development (R&D), and organizational capital (OC). We have to exclude purchased intangibles because our data do not separate purchased intangibles from intermediate consumption. Own account production apparently constitutes an important share of intangibles. CHS find that they account for nearly one third of all intangibles. Because of data restrictions the following analysis is restricted to the own account component of intangibles, which plays a minor role in total intangible investment.

Frequently own account capital formation is estimated using the expenditures for labor input afforded to produce it. Based on employment characteristics such as types of occupation and education, INNODRIVE defines three groups of employees in a firm, whose labor input can contribute to intangible capital formation:[7]

- ICT personnel in total.[8]
- R&D employees.
- Management and marketing employees (OC personnel).

INNODRIVE assumes that, from these types of labor input, only a certain proportion, depending on the type of good, is engaged in the production of new intangible goods. The remaining employees of each respective type of labor are engaged in current production (Table 1). In addition to these groups of employees, in this study 20 percent of labor input made by the self-employed is assumed to be part of own account organizational capital (OC) formation.

Different from CHS, INNODRIVE also evaluates the value of intermediate and capital cost in addition to the labor cost necessary in own account production of intangible capital goods. This is done in referring to those industries that are engaged in market production of comparable goods. These are the following industries:

[7]A more detailed description of the characteristics of employees who contribute to the production of intangible capital formation can be found in Görzig (2011).

[8]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 empirical source.

TABLE 2
CENTRAL SETTINGS FOR INTANGIBLES IN INNODRIVE

	Type of Labor Input		
	ICT	R&D	OC
Intangible investment share of labor costs	0.50	0.70	0.20
Combined factor for other inputs (capital and intermediates)	1.48	1.55	1.76
Final multiplier on labor costs	0.70	1.10	0.35
Depreciation rate	0.33	0.20	0.25

Source: INNODRIVE (2011).

– Computer and related activities (NACE 72) as proxy for ICT goods.
– Research and development (NACE 73) as proxy for R&D goods.
– Other business activities (NACE 74) as proxy for OC goods.

Based on the EU KLEMS database (www.euklems.net), weighted averages are used for the relationship between labor, intermediates, and capital expenditures for NACE 72, 73, and 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 labor costs dedicated to the production of intangible capital, a combined multiplier on labor costs is applied. The central settings for intangibles by INNODRIVE are shown in Table 2.

For each firm, labor cost for ICT, R&D, and OC employees, and the self-employed are calculated according to the employment structure of the firm.[9] A number of industries are excluded from the analysis, namely the public sector, real estate, agriculture, and mining.[10]

The figures for capital formation are applied in order to calculate intangible capital stock and depreciation. Principally, these are calculated following the EU KLEMS methodology (EU KLEMS, 2007) and are made for tangible stock in the same manner as for intangible stocks. Following the European System of Accounts (ESA 95), and in line with theory, depreciation should be calculated at constant prices and revaluated at current replacement prices to yield current depreciation costs. Since we do not have firm specific investment prices[11] in our database, this methodology is not possible. We are only able to calculate stocks and depreciation at historical costs, as it is done in commercial accountancies. Thus the calculated rate of return is comparable with the return rate calculated from balance sheets of firms.

While we do not follow exactly the definitions of the National Accounts with respect to depreciation, we do not expect that this will severely influence our results on the dispersion of the return rate for three reasons. First, because the assumed depreciation rates of intangible assets are fairly high, valuation changes are expected

[9]See Görzig (2011) for a description of the types of employees classified as producers of intangibles.

[10]See EU KLEMS (2007) for a list of the industries applied in this analysis.

[11]Taking industry specific deflators from the EU KLEMS database would mean that for all firms of an industry, the same deflator is applied, with the result that the relation between the firms would be the same as in the case that historical costs are used.

to have a low impact. Second, because valuation changes affect both the denominator and the numerator, only the net effect is relevant. Third, we are primarily looking at the relationship between firms and not at the development over time.

3. Results

3.1. *Aggregate Results*

Capital Formation

Table 3 gives an overview on the composition of the totals calculated from the firm-level estimates. The assumptions made about the production of intangible assets result in considerably higher values for revised capital formation compared with the observed ones. Research and development as well as organizational capital contribute with equal shares of 18–19 percent to the revised capital formation. The self-employed, neglected in other studies, contribute with 8 percent to total capital formation. In our study, own account production of intangibles accounts for more than 70 percent compared with observed capital formation, as quantified according to the definitions in the National Accounts.

In the revised estimates some components of value added, such as taxes and wages, remain unchanged with the assumptions of additional capital formation. Usually production taxes are calculated only for market transactions and wages are already covered in total. The only difference is that now some wages are treated as costs in the production of intangible assets instead of in the production of traded goods of a firm.

Major changes in the accounting system have to be made for operating surplus. Its value increases because of the higher value added calculated. This increase is partly compensated by the depreciation cost connected with the

TABLE 3

Composition of Capital Formation of German Firms; Averages 1999–2003

	mill. €	%
Capital formation	310,613	100
Observed (Eukleed)[1]	181,705	58
Buildings	52,167	17
Equipment	113,818	37
Intangibles (software, databases, etc.)	15,720	5
New intangibles (INNODRIVE)[2]	128,908	42
Information & Communication	14,464	5
Research & Development	55,759	18
Organizational	58,685	19
of which:		
Self-employed	24,898	8

Notes:
[1]Establishment values for Nace rev1 industries: D to J, K (excl. 70), N, O.
[2]Firm-level estimates with Eukleed (Görzig 2011).
Source: EU KLEMS (2007), INNODRIVE (2011), own calculations.

TABLE 4

Impact of Intangibles on Value Added of German Firms; Averages 1999–2003

	mill. €	%
Value added	1,231,084	100
Observed (Eukleed)[1]	1,102,176	90
New intangibles (INNODRIVE)[2]	128,908	10
Operating surplus	180,762	100
Observed (Eukleed)[1]	162,980	90
+ New intangibles (INNODRIVE)[2]	128,908	71
– New depreciation (INNODRIVE)[2]	–111,126	–61

Notes:

[1]Establishment values for Nace rev1 industries: D to J, K (excl. 70), N, O.

[2]Firm-level estimates with Eukleed (Görzig 2011).

Source: EU KLEMS (2007), INNODRIVE (2011), own calculations.

additional capital stock accumulated by additional capital formation. Thus, operating surplus changes are given by net investment in intangible assets. These changes are calculated here at firm level and consequently aggregated to compare the outcome with the observed Eukleed (Görzig, 2011) based calculations. The aggregated result can be derived from Table 4. The calculations show that the net effect on operating surplus has a similar magnitude of 10 percent as in the case of value added.

A comparison of these aggregated firm-level results with other relevant studies made at the macro level (Jona-Lasinio *et al*., 2011; see also CHS and MHW) must consider that INNODRIVE uses firm level data with a partly differing industry selection. Comparing the shares in value added, divergences of the assumptions compared with other studies come from the inclusion of self-employed intangible capital formation and the assumption that apart from wages, conventional capital and intermediate costs are also needed in the production of intangible assets.

CHS calculate for the U.S. at the macro level, that 15 percent of total income is used as intangible capital formation, referring to the whole economy and including purchased intangibles. INNODRIVE considers only own account production, which according to CHS counts for one third of intangible capital formation, i.e. 5 percent of value added (Table 5). However, looking at own account production only, the INNODRIVE definition of intangible investment is broader. CHS only refer to labor costs as intangible capital formation. These account for 5 percent of value added in INNODRIVE as well. INNODRIVE includes additional capital and intermediate costs to be applied in producing intangible assets (3 percent). Furthermore, INNODRIVE considers intangible assets produced by the self-employed (2 percent). If we drop these additional assumptions, intangible production reduces to half of the value assumed by INNODRIVE and would account for about 36 percent of conventional capital formation instead of 70 percent.

Nearly half of the expenditures defined here as intangible capital formation consist of organizational capital formation. This corresponds with the results

TABLE 5
COMPARISON OF THE ANALYZED CATEGORIES WITH CHS

	INNODRIVE[1]	CHS[2]
	% of Value Added	
Total intangible investment	X	15%
Purchased	X	10%
Own account production	10%	5%
Self-employed	2%	X
Other personnel	8%	5%
Wage costs	5%	5%
Capital & intermediate costs	3%	X

Notes:
[1]Corrado/Hulten/Sichel (2009).
[2]INNODRIVE (2011).

found by MHW for the U.K. that 50 percent of total intangible investment is attributable to economic competencies. Again it should be noted that these figures are not directly comparable, since the MHW estimates are made for a different industry breakdown and also include purchased intangibles and other items not considered in our calculations.

Return Rates

Return rates are calculated by dividing operating surplus through capital stock. As already shown, operating surplus, including intangible capital is higher than in conventional accountings. Clearly, capital stock will also be higher due to the additional capital formation. Since both the numerator and the denominator are affected by the additional capital formation in intangibles, the return rate will reflect the net results of both.

Indicators on the economic development at the firm level are subject to strong fluctuations (Comin and Mulani, 2006). This applies to sales and factor inputs, in particular capital formation, and even more to the return rate calculated from the residual. Although in the long run firm level volatility seems to decline (Davis *et al.*, 2006), the impact of the business cycle remains strong (Faberman, 2006). If we calculate the average for all firms, the aggregate result would be heavily biased by outliers with extreme return rates during the business cycle. We therefore concentrate the analysis on the average firm specific return rates between 1999 and 2003.

As seen in Table 6, aggregated operating surplus is higher due to net investment into intangibles. The increase is about 11 percent. But total capital stock is higher than in the conventional measure due to the cumulated additional net intangible capital formation. This increase in aggregated capital stock is about 34 percent. As predicted in the methodological section, for the sum of all establishments, the weighted return rate including intangible capital and its depreciation is about 20 percent below the observed rate of return of 11.2 (Table 6). For the aggregated return rate, firms are weighted with the capital they use in production; such that bigger firms are weighted heavier than the numerous small firms.

TABLE 6

Rate of Return for Revised Estimates for German Firms; Averages 1999–2003

	Dimension	Observed (Eukleed)[1]	Revised (INNODRIVE)[2]
Operating surplus	mill. €	162,980	180,762
Net capital stock[3]		1,453,659	1,945,495
Return rate on capital			
Weighted mean	%	11.2	9.3
Mean of firm specific annual averages		175.6	25.7

Notes:
[1]Establishment values for Nace rev1 industries: D to J, K (excl. 70), N, O.
[2]Firm-level estimates with Eukleed (Görzig 2011).
[3]Valued at historical costs.
Source: EU KLEMS (2007), INNODRIVE (2011), own calculations.

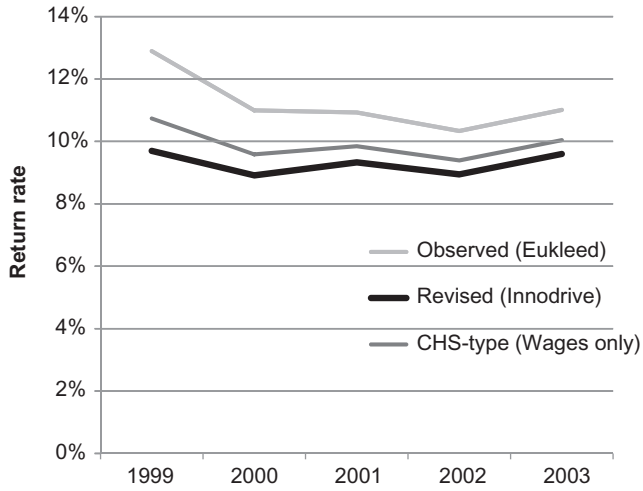

Figure 1. Development of the Aggregate Return Rate of German Firms
Source: INNODRIVE (2011), own calculations.

The reduction in the return rate is quite remarkable if we look at the mean of the non-weighted return rate where each firm has the same weight. The mean of the observed non-weighted return rate is 176 percent, which is extremely high. Including intangible capital into the calculations reduces it to 26 percent (see also Section 3.2). Note that the analysis considers own-account intangible capital formation only. According to CHS, this covers only one third of total intangible capital formation.

The observation period for which our dataset is available is rather short in order to allow reliable judgments on the impact of own account intangible capital formation on the development of the rate of return. Figure 1 shows that the general pattern of the weighted original rate of return is also kept if own account intangible capital formation is included. This applies for the revised return rate in

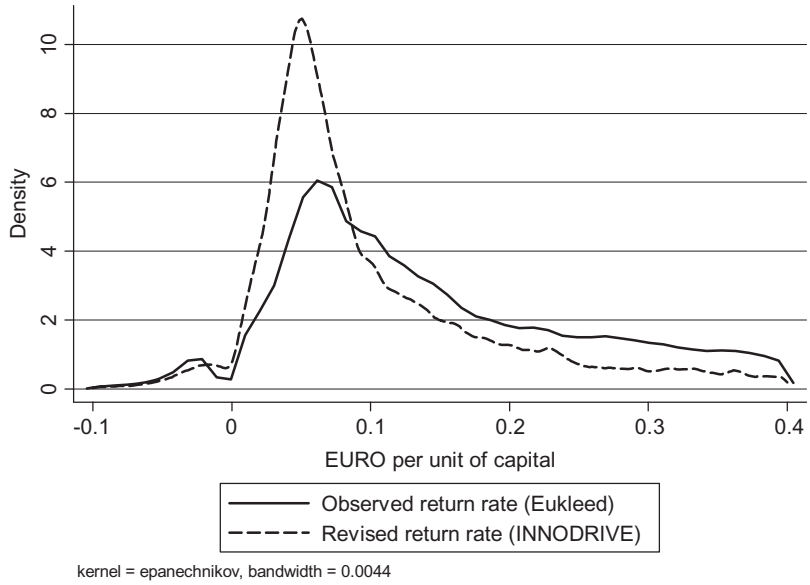

Figure 2. Density Distribution of the Return Rate of German Firms; Averages 1999–2003
Source: INNODRIVE (2011), own calculations.

line with the INNODRIVE assumptions as well as for the return rate calculated following the CHS assumptions.

3.2. *Firm-Level Results*

Firm specific rates of return on capital are calculated as operating surplus (after deductions of labor compensation for the self-employed) divided by the average net capital stock at historical costs.[12] Figure 2 shows that the dispersion of the return rates among firms is fairly wide if calculated with the conventional methodology, including some firms with negative return rates. A majority of firms gather around the 10 percent return rate. The distribution displays a long right tail—partly cut off in Figure 2—with a number of firms having really large return rates.

To better understand these facts, it should be noted that production behavior of existing firms can be very different from the typical textbook examples. This is particularly true for the quite large number of small firms in the sample. Factual capital usage by small service firms is very often not based on previously invested capital goods but is instead renting the capital necessary for production. These expenditures are counted as intermediate consumption in the firm's accounting system. 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, the costs are only for labor and intermediate consumption. Although there is no

[12]As already discussed, we would prefer a valuation at current replacement costs. Due to the lack of firm-specific investment prices, this is not possible.

TABLE 7

Dispersion Indicators of the Return Rate of German Firms; Averages 1999–2003

		Firm Annual Averages	
		Observed (Eukleed)[1]	Revised (INNODRIVE)[2]
Number of firms		1,555,029	
Averages[3]	weighted	0.11	0.09
	not weighted	1.76	0.26
Standard deviation		11.37	0.58
Coefficient of variation		6.48	2.27
Percentiles	0.1	0.05	0.03
	0.5	0.26	0.09
	0.9	3.34	0.77

Notes:
[1]Establishment values for Nace rev1 industries: D to J, K (excl. 70), N, O.
[2]Firm-level estimates with Eukleed (Görzig 2011).
[3]Operating surplus divided by net capital stock at historical costs.
Source: EU KLEMS (2007), INNODRIVE (2011), own calculations.

capital observable, the residual in textbooks is often described as capital income. It accrues to the owner of the firm. Literature suggests several, non-exclusive explanations for this residual. One is that the residual can be seen as the compensation of entrepreneurial labor input, a common procedure in growth accounting. Another is that it is not a rent on capital, but rather exhibits the characteristics of innovation or monopolistic rent. As discussed in the methodological section, it can be also explained as rent for unobserved capital, in this case the use of intangible capital invested by the owner.

The statistics of the distribution in Figure 2 are presented in the first column of Table 7. The first number of 11 percent in the column with observed values is the average return rate, weighted by the size of the firm's capital stock. This is the rate frequently found in conventional aggregate analysis. All other numbers in this column refer to non-weighted firm-level results. Note that all firms have the same weight independent of size, which is a natural assumption in IO analysis of entrepreneurial behavior. 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 not weighted average return rate is 176 percent, far above the weighted average return rate.

In the theoretical world of perfect competition, only a unique return rate would exist and no profits could 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 be identical. However, the actual dispersion of return rates between firms, measured by the 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 that is far above the average. A possible explanation for such extreme return rates could be that operating surplus includes elements that should economically be counted as costs: for example, the costs of the use of intangibles.

The verification of the expectations developed in the methodological section, that own account production of intangible assets reduces the overall rate of return,

is seen in the second column of Table 7. Including own account production of intangibles in the calculations reduces all average return rates (weighted, not weighted, and median). This refers far less to the weighted average, which indicates that a considerable amount of the dispersion is caused by units with lower weight. This impression is supported by the fact that firms in the higher percentiles move further to the left in the revised calculations than those in the lower percentiles.

That the standard deviation reduces dramatically if intangibles are included in the calculations is expected, since the average level of the return rates is reduced. More striking is the fact that the coefficient of variation is roughly a third of the one found with the observed return rates. Thus, the assumptions made about intangible capital clearly lead to a higher uniformity of firm specific return rates.

3.3. *Sensitivity Calculations*

As noted before, a number of very crude assumptions are necessary to complete these calculations. Most of these are in line with the assumptions encountered in the literature. We checked to what extent these assumptions influence our results. Quite obviously, assumptions that will influence the level of the estimated intangible investment will also affect the level of value added and operating surplus in the same direction. In the long run, this also holds for intangible stock. However, since depreciation is also affected, it is an open question what happens to the return rate since both denominator and numerator are affected.

In one calculation, we dropped the assumption of capital and intermediate costs as input in the production of intangibles. Thus, we applied at firm level the same assumption as CHS did at the macro level (Table 8). As expected, this results in a lower level of intangible investment, such that the reduction in the return rates

TABLE 8

Results of Alternative Assumptions

Alternative Assumptions and Calculation Methods	Average Firm Level Return Rates at Historical Costs[1]		
	Mean	Standard Deviation	Coefficient of Variation
All firms			
Observed (Eukleed): Without intangibles	1.76	11.37	6.48
Revised (INNODRIVE): Including intangibles	0.26	0.58	2.27
CHS type: Wages of OC, IT, R&D employees as production costs, excluding capital and intermediate costs[1]	0.31	0.66	2.13
Proportional type: Intangible investment proportional to wages of all employees in the firm[1]	1.10	7.13	6.46
Big firms[2]			
Observed (Eukleed): Without intangibles	0.21	0.38	1.80
Revised (INNODRIVE): Including intangibles	0.16	0.23	1.45

Notes:
[1]Based on (annual) averages of firm level return rates.
[2]Firms with 10 and more employees and a turnover of 2 mill € and more.
Source: EU KLEMS (2007), INNODRIVE (2011), own calculations.

is less than in the INNODRIVE case. The same holds for the standard deviation. Compared with the observed values in Eukleed, the CHS-type assumptions result in the same pattern as the INNODRIVE assumptions. The reduction for the coefficient of variation is nearly of the same dimension as in the INNODRIVE case.

In another sensitivity calculation we assumed the same level of intangible investment as in INNODRIVE, but defined it as a constant share of total wages in each firm, without relating the expenditures to certain occupational categories as managers, R&D or IT personnel, as is done in INNODRIVE. As expected, we also get a reduction in return rates. However, the standard deviation in return rates is reduced far less, just reflecting the lower level of the return rates. In this case, the coefficient of variation remains unchanged, which indicates that the reduction in return rates in INNODRIVE is mainly due to the assumption that intangible assets are produced by certain segments of occupations.

As discussed before, the large number of small firms seems to affect the dispersion of return rates. Economically, their influence is rather small. In our sample, firms with less than €2 million production value account for 1.3 million firms out of roughly 1.5 million firms. Only 10 percent of all firms can be classified as "Big Firms." However, Big Firms make up about 66 percent of total employment, 74 percent of value added, and 90 percent of operating surplus. It therefore makes sense to have a separate analysis for the Big Firms in Table 8.

The differences between the observed values in Eukleed and the results found with INNODRIVE, when intangible capital is assumed, are less remarkable than in the case for all firms. However, the general results found for all firms are confirmed. Furthermore, for Big Firms it can be stated that including intangibles lowers not only the return rates, but even more the standard deviation, such that the coefficient of variation becomes smaller as well, a clear sign that the dispersion is reduced.

4. Conclusions

As expected, the empirical analysis confirms that unobserved intangible capital leads to an overstatement in the observed rate of return, in particular for smaller sized firms. More important, the results clearly support the preposition that a considerable part of the observed dispersion in return rates between firms can be attributed to unobserved capital formation in intangible capital.

These findings are quite robust to a variation in the assumptions made. However, it has to be acknowledged that not all types of unobserved capital could be included in the analysis. Due to data restrictions, only the impact of own-account intangible capital formation could be analyzed. Purchased intangibles apparently are twice as high. If these could be included, the discrepancies might be even bigger. Similarly, the impact of unobserved tangible capital, for instance land and inventories, could not be evaluated.

Even so, the findings make clear that any causal analysis of the impact of profitability on a firm's decision on factor input and innovation should control for unobserved intangibles.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix A: Additional Remarks on Data and Capital Stock Methodology