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Interindustry Differences in Rates of Return: New Evidence from Germany

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Interindustry Differences in Rates of Return

– New Evidence from Germany

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Abstract

Researchers have found plenty of evidence that profit rates vary considerably across industries. Moreover, existing evidence suggest that these interindustry differences in rates of return are not temporary but tend to persist. This is at odds with standard theories of open and (perfectly) competitive markets that underly, for instance, applied empirical work in growth accounting.

At the same time, several studies have shown that intangible capital is an important source of innovation and growth at the country level. Recent research on intangible capital has made transparent that these assets cover a mean part of the total capital employed in firms. Moreover, depending on their industry, firms are exposed to different degrees of risk. Since capital employed in more risky firms demands a risk premium, rates of return have to be adusted accordingly.

These issues are central to our analysis of interindustry differences in rates of return. We proceed in two steps. Initially, we use data on German industries to study sectoral differences in rates of return, as conventionally measured. We document the magnitude, structure and persistence of these differences and relate our empirical results to the explanations for such differences that have been offered in the literature. To do so, we take advantage of the EUKLEMS database with its detailed information at the sectoral level. It allows us to follow German industries over a period of more than 35 years.

In the second part of our analysis, we focus on the five most recent years (1999 - 2003) in our data, for which we have the most detailed information. It combines EUKLEMS data with additional information from the INNODRIVE project on intangible capital and the dispersion of return rates between firms within an industry. We use this combined data to study if and how return rate differences change if we adjust for sectoral differences in intangible capital and risk aversion.

JEL classifications: L23, E01, D24

Keywords: Rate of return on capital, Inter-sectoral convergence, Intangible capital, Rrisk aversion

1 Introduction

In “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 of empirical studies that document persistent inter-sectoral differences in the rate of return on capital (Qualls 1974, Geroski and Jacquemin 1988, Jacobson 1988). In EU KLEMS (2007), for instance, sectoral rates of return are reported for Germany ranging from -11% in hotels and restaurants to 22% in wholesale trade (averages over 1999 to 2003). Moreover, these pronounced differences appear to be persistent which is at odds with a competitive economy were resources in principle can be freely reallocated from less profitable to more profitable sectors.

However, lack of competition is not the only explanation for persistent differences in sectoral return rates. In this paper, we consider two potential explanations that have been increasingly receiving attention: intangible capital and risk. The former has long been discussed in the literature on the measurement of return rates; see for instance Ayanian (1975), Fisher and McGowan (1983) or Megna and Mueller (1991). It has also been considered as a source of innovation and growth (e.g. Corrado, Hulten, and Sichel 2009; Marrano and Haskel 2006; Marrano, Haskel, and Wallis 2009) at the country level or as a source of competitive advantage (in the form of superior intellectual property or business models) at the firm level. We consider its role (and measure it) at the sectoral level by asking if the persistent above average return rates of some sectors can be explained by their higher levels of intangible capital. We thus focus on its potential role as an explanatory variable for conventionally measured sectoral rates of return.[1] Our measure of intangible capital

The second potential explanation for inter-sectoral return rate differences that we particularly examine is risk. Even in a well-functioning market economy, return rates of risky sectors should include a compensating premium. Just as for intangible capital, advances in data availability have increased the potential to measure and incorporate sectoral risk. We derive our measure of sectoral risk from the variation in

[1] We will consider its significance for the measurement of our dependent variable, the rate of return on capital, in future work.

return rates among establishments of a given sector constructed from German establishment-level data.

Before we proceed to the analysis of the role of intangible capital and risk in explaining rate of return differences between sectors we first re-establish that such differences are indeed a persistent feature of the German economy. In this part of the analysis, given our medium- to long-term perspective, we study the persistence (convergence) of sectoral return rate differences based on the concepts of β-convergence and σ-convergence.

The remainder of this paper is organized as follows. We describe and discuss our empirical methodology is in section 2. We then turn to the data which we describe in section 3. Section 4 contains the results of our empirical analysis. Section 5 concludes.

2 Methodology

2.1 Convergence

Our analysis is carried out entirely at the sectoral level and proceeds in two steps. In the first stage, we use the German files of the EU-KLEMS database[2] to investigate whether there is evidence for persistent sectoral rate of return differences in Germany during the last 30 years (1970-2007). Theory suggests that such persistent differences should diminish or even be eliminated over time, i.e. that we should observe rate of return convergence. To study whether sectoral return rates are persistent or convergent we draw upon the convergence concepts developed in the literature on convergence (of income or productivity) across countries or regions. The two established concepts of convergence in this literature are σ-convergence and β-convergence. σ-convergence, in our context, refers to a decreasing variance of rates-of return across sectors. In terms of a formal test, σ-convergence thus considers the ratio of the variance in some initial period σ_1^2 and the variance in the final period σ_T^2. While our focus is not on a statistical test of the sharp null hypothesis of variance equality ($\sigma_1^2 = \sigma_T^2$, i.e. a complete absence of σ-convergence) we nonetheless employ the variance ratio as an analytical tool.

[2] Details about the EUKLEMS data and our other data sources can be found in section 3.

σ-convergence focuses on overall variability and does not consider the positions of particular sectors within the distribution. The latter perspective on the return rate distribution is taken up by β-convergence. It is based on the notion that for convergence to occur, sectors with a relatively low initial rate of return must achieve relatively fast return growth while the opposite must be true for sectors with high initial period returns.[3] Hence in case of complete convergence last period returns should not be systematically related to first period returns. Put differently, the initial position in the return distribution should not help to predict the period T position. It is thus formalized as a regression of the last period return y_{iT} on the initial period return y_{i1} (where i is indexing sectors):

$$y_{iT} = \alpha + (1 - \beta)y_{i1} + \varepsilon_i \qquad (1)$$

If β=0 then there is a very tight relationship between initial and final period return and thus no convergence. The other extreme occurs if β=1 and last period returns are not systematically (linearly) related to first period returns (complete convergence). Formal tests of β-convergence can thus be build on estimates of β derived form least squares estimates of equation (1). Again, while our focus is not on formally testing the sharp null hypothesis of no β-convergence, we nonetheless use estimates of β to discuss convergence in the sense of changes in position within the distribution.

Changes in the relative positions within the distribution associated with β-convergence have implications for the variance. The two concepts of convergence are thus related (Lichtenberg 1994). This is highlighted by test statistic for σ-convergence proposed by Carree and Klomp (1997):

$$Z_\sigma = \sqrt{n}\frac{\hat{\sigma}_1^2/\hat{\sigma}_T^2 - 1}{2\sqrt{1 - \left(1 - \hat{\beta}\right)^2}} \qquad (2)$$

[3] This has implications for the variance of the distribution. In other words, β-convergence and σ-convergence are related (Lichtenberg 1994).

Here $\hat{\sigma}_1^2$ and $\hat{\sigma}_1^2$ are the sample variances of the rate of return distribution in the initial and final period, respectively, n is the sample size and $\hat{\beta}$ is the estimate of β from equation (1).

2.2 Explaining the inter-sectoral variation in return rates

In the second stage of our analysis, we focus on our attention on explanations for the observed rate of return differences across sectors. We consider established explanatory variables such as measures of the intensity in which tangible and human capital are employed in the sector, average firm size in a sector (to capture scale effects) and openness to trade (to capture competitive pressures). Denote our measures of these explanatory variables by the vector $\boldsymbol{x}_{it}^{e}$ (where the superscript e stands for "established"). Moreover, we consider two less-established explanatory variables: the intensity of intangible capital and the risk of a sector. Collect these two explanatory variables in the vector $\boldsymbol{x}_{it}^{k}$ (where the superscript k indicates that these are the key explanatory variables from the point of view of this paper). To investigate the importance of these factors for explaining the variation in sectoral rates of return, we run three regressions. Initially we regress y_{it}, sector i's rate of return on capital in period t, on each set of explanatory variables separately. Our complete specification, where both groups of covariates are employed, can thus be written as

$$y_{it} = \beta_0 + \beta_e \boldsymbol{x}_{it}^{e} + \beta_k \boldsymbol{x}_{it}^{k} + \varepsilon_{it} \qquad (3)$$

This regression, as well as the two "short" regressions, are estimated with data from the period 1999-2003 where information on all explanatory variables is available for all sectors.

3 Data

The central database for analysing the development of the rate return on the industry level on the long run in our first working step is the EUKLEMS database. EUKLEMS supplies information on factors of production and output for several industries. It is fully integrated into the National Accounting framework of EUROSTAT. A comprehensive description is given by O'Mahony and Timmer (2009).

We use the EUKLEMS data files for Germany from the November 2009 Release. For the historical analyse we combine this information with data which were calculated within the EUKLEMS project for the former Western Germany. The whole data used annual information for 30 industries for the period from 1970 till 2007. A list of covered industries can be found in Annex.

The EUKLEMS database also included important indicators to explain differences in the rate return between industries in our second working step. In particular, we can take into account differences between sectors in the endowment of physical capital and human capital. We use the indicators of physical capital intensity and the proportions of high and low-skilled workers. Additional industry specific information, e.g. about exports and imports, can be found in the National Accounts. Other important explanatory factors of differences in the rates of profit sectors cannot take into account with aggregated data. To detect differences in the importance of economies of scale, risk of spills and intangible capital, we need micro data of firms.

Many firm level studies rely on readily available databases such as COMPUSTAT, which is based on published balance sheets. While larger firms are reliably represented in this data set, small and medium sized firms (SMEs) are not covered; thus conclusions might be biased. In order to include SMEs in our firm level analysis, an establishment level, dataset EUKLEED for Germany is applied. EUKLEED is a comprehensive integrated micro data set including imputed employment, investment, output, and operating surplus. The dataset is based on information from the German Social Security data (Alda, Bender, and Gartner 2005; Fritsch and Brixi 2004). EUKLEED is fully integrated into the National Accounts for Germany and covers about 1.6 million establishments between 1999 and 2003 with about 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 industry level of EUKLEMS. However, some sectors are not completely represented like agriculture, real estate activities, or public administration. A detailed description of the EKLEED dataset is given in Görzig (2011).

From the micro data set can be determined directly first simple indicators of the importance of economies of scale in the industries. We use is the average firm size measured by the number of employees per establishment. It is more difficult to measure the level of risk to the expected rate of profit in the sector. As a first

approximation for risk, we can take into account the variation of the profits (McGahan and Porter 2002). In fact we use the variance of the benefit occurred within each industries.

It is broadly accepted that estimates on the use of intangible capital in firms are extremely difficult. Corrado, Hulten, and Sichel (CHS 2004) suggest how to quantify the impact of intangibles. In the INNODRIVE[4] project the size and the impact of organisational 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 and, and to some extent also 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, Webster, and Whyatt 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 practised both in the National Accounts 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 as intangible investment, a broad consensus exists that these intangibles are not exhaustive and omit, in particular, organisational capital.

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 organisational 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.

Frequently own account capital formation is estimated using the expenditures for labour input afforded to produce it. Based on employment characteristics as types of

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

occupation and education, INNODRIVE defines three groups of employees in a firm, whose labour input can contribute to intangible capital formation:

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

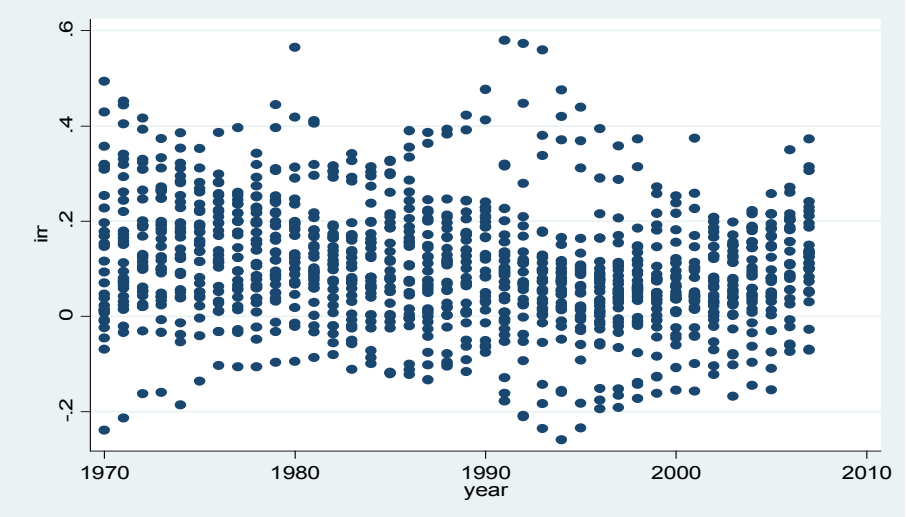
INNODRIVE assumes that, from these types of labour input, only a certain proportion, depending on the type of good, is engaged in the production of new intangible goods. The remaining employees of each respective type of labour are engaged in current production. In addition to these groups of employees, 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 evaluates the value of intermediate and capital cost in addition to the labour 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. For more details show Görzig, Piekkola, and Riley (2011) and Görzig and Gornig (2011).

4 Empirical results

4.1 Sectoral convergence

A first visual impression of the development of the distribution of sectoral rates of return on capital can be obtained from the following scatter plot.

Figure 1

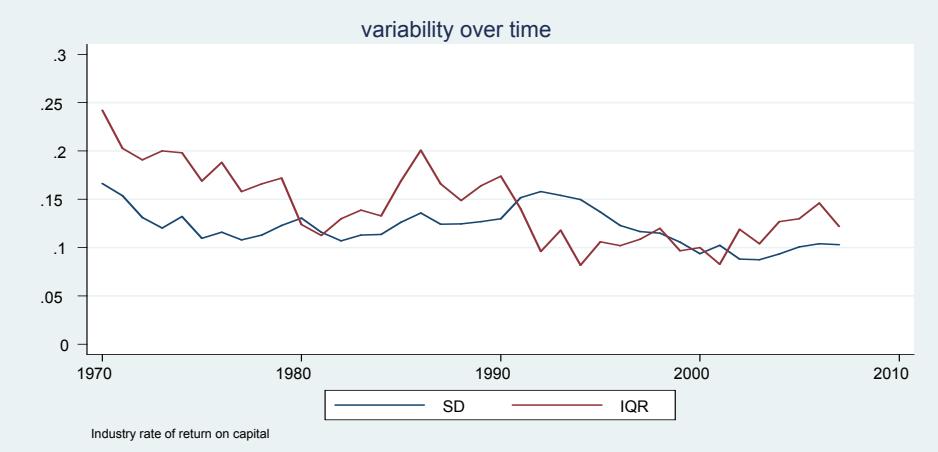


For each year, from 1970 to 2010, the observed rates of return of each of the 20 sectors are plotted vertically. There does not appear to be a pronounced monotonous reduction in the variation in return rates over this period of almost 40 years. There are, however, visible movements in the tails of the distribution. In particular, a gradual disappearence of the strongly negative rates of return in the early seventies can be observed. There is, on the other hand, a clearly visible increase in rather extreme return rates at either end of the distribution just after German reunification in the early nineties. Apparently, some sectors were able to particularly capitalize on the opportunities offered by the fall of the iron curtain while others were pushed into the negative direction by this large economic shock.

While there were pronounced movements at the extremes, the average level of the rate of return on capital remained fairly stable: it is almost 15% in the early seventies and still amounts to 12% 2007, the most recent year of our observation period in stage 1. There was, however, an interim period of about ten years between 1995 and 2005 were the average rate of return dropped to a level as low as 5%.

Turning our attention again to the variability in return rates, the following graphs shows the development over time of the variability in rates of returns across the 30 sectors.

Figure 2



We employ and graph two measures: the standard deviation (SD) and the interquartile range (IQR). Both measures suggest that there is no uniform monotonous tendency for the variability to decline. However, the level of the inter quartile range is consistently lower after reunification. The standard deviation shows

a visible decline in the seventies and in the early nineties. It has however remained constant thereafter.

We have also conducted formal test for σ-convergence based on the test statistic given in equation (2). Under the null hypothesis of no convergence (i.e. of variance equality between the period T variance and the period 1 variance) the test statistic has an asymptotic N(0,1) distribution. However, since the alternative hypothesis is a reduction in the variance the test is carried out as a one sided test where large positive values are regarded as evidence against H_0. We have carried out the test for multiple choices of period 1 (1970-1980) and for a given period T (2007). Results are reported in the table 1 below that also gives the p-values.

Table 1

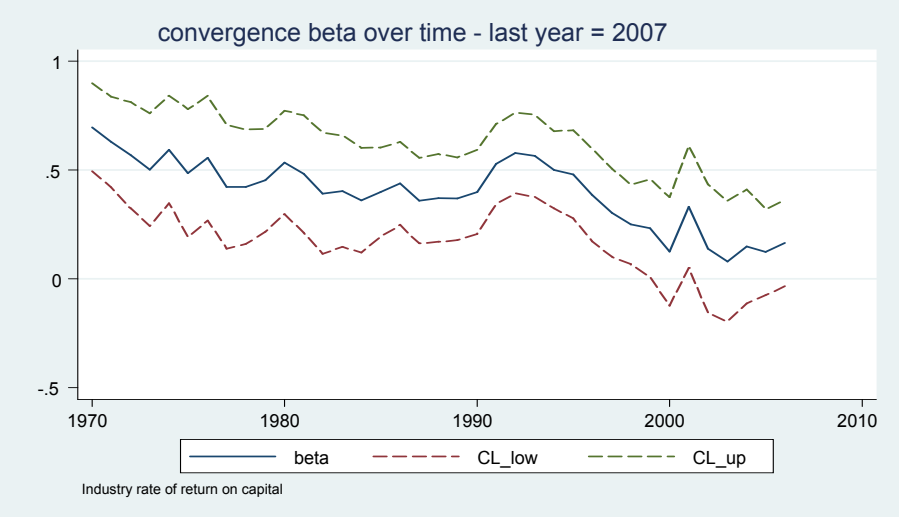
Year	Z_σ	**p-value**
1970	4.54	<0.001
1971	3.55	<0.001
1972	1.86	0.032
1973	1.13	0.130
1974	1.91	0.028
1975	0.38	0.350
1976	0.79	0.214
1977	0.31	0.380
1978	0.66	0.256
1979	1.36	0.087
1980	1.84	0.033

It can be seen that the sharp null hypothesis of variance equality (no convergence) is rejected in some years but there are also various years where the p-values are quite large and the hypothesis cannot be rejected at conventional significance levels.

The preceeding analysis in the spirit of σ-convergence focuses on a reduction in the overall variability and does not consider the positions of particular sectors within the distribution. It is therefore not sufficient for answering the question regarding persistent rate of return differences across sectors. Persistency requires not only that the variance does not vanish but also that relative positions within the distribution are maintained. The latter aspect is considered by β-convergence to which we now turn

in the following graph (figure3). In this graph we show estimates of β obtained from least squares regressions based on equation (1) where we fix the final period (i.e. T=2007 throughout) but vary the initial period. We thus plot the estimates of β obtained by successively regressing y_{i2007} on y_{i1970}, y_{i1971},… and finally y_{i2006}.

Figure 3



The blue line shows the estimates of β plotted against initial year of the corresponding regression along with 95% confidence intervals (dashed lines). As is to expected, estimated β values are largest (and closest to the complete convergence value of 1) for the most distant initial years (early 70s). Similarly, it is not surprising that the estimated β values approach the no-convergence value of 0 if we take very recent years as the initial years in regression (1). Except for the early 70s though, the estimated β is below or close to 0.5 with a temporary increase for the years just after reunification. This overall pattern is confirmed if we also vary the period of the final year (results not shown). We thus conclude from this analysis that there is some convergence but that relative positions are also fairly stable as initial year rates have in general have some predictive power for final period returns.

This overall conclusion is confirmed by taking the data from all years (1970 – 2007) and by carrying out an F-Test of the hypothesis that there are no differences in average returns between sectors. The corresponding ANOVA table is given below.

Table 2

Source	Partial SS	df	MS	F	p-value
Sectors	11.168	29	0.38511	62.62	<0.001
Residual	6.826	1110	0.00615		
Total	17.994	1139	0.01580		

The F-Test clearly rejects the null hypothesis. That is, the variation across sectors is large enough relative to the within-sector variation to conclude that there are thus significant differences in average returns across sectors.

4.2 Explaining the inter-sectoral variation in return rates

The evidence from the medium to long-term analysis presented in the previous section has shown that while there is movement within the inter-sectoral return distribution there are still persistent differences across sectors. There is thus transitory and permanent variation in sectoral rates of return to capital. In the second stage of our analysis we attempt to explain this variation. We have to restrict this part of our analysis to the period from 1999 to 2003 because some of our explanatory variables are based on establishment-level EUKLEED micro data that covers these periods only. For the same reason, we have to focus on 25 of the 30 sectors used in the first stage.[5]

In our attempt to explain the observed variation we proceed as outlined in section 2. The results of our three regressions are reported in the table 3. Column (1) contains the estimates of the initial regression where only the more established explanatory factors are included. Our right hand side variables are measures of tangible capital (tangible capital relative to employment), human capital (fraction of workers who have either have obtained tertiary education or who have completed Germanys “dual system” of vocational education), openness (exports plus imports in a sector divided by sectoral output) and scale (average establishment size in the sector). The results

[5] Excluded sectors: Agriculture, Mining, Real estate activities, Public administration, and Education

from this regression show that these factors neither are able collectively (as indicated by the low R^2) nor individually to account for the observed variation in sectoral return rates. Only our measure for the competitive pressures deriving from the openness of a sector to international trade has the expected significant negative effect.

Results of the regression that only includes the novel explanatory variables considered in this paper, the intensity of intangible capital and the risk of a sector, are given in column (2). This specification provides a considerably better fit and can account for 46% of the inter-sectoral return rate variation.

Table 3
Dependent Variable: Rate of Return on Capital

Explanatory variables	(1)	(2)	(3)
Capital Intensity	-0.00000052		-0.00000072
	(1.95)		(3.18)***
Average Firm Size	-0.000022		-0.000033
	(1.56)		(2.93)***
Openness	-0.002		-0.002
	(3.59)**		(3.59)***
Fraction of Educated	0.112		-0.124
	(0.39)		(0.55)
Intangible Capital Intensity		-0.00000064	0.00000498
		(0.56)	(3.06)***
Risk		0.040	0.037
		(9.95)**	(9.88)***
Constant	0.456	0.245	0.399
	(2.31)*	(6.39)**	(2.63)***
R^2	0.17	0.46	0.56
N	125	125	125

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Annual data on 25 sectors from 1999 - 2003; t-ratios in parentheses

However, only the risk variable has the expected significantly positive “risk-premium” effect while the coefficient of the intangible capital variable is slightly negative and insignificant.

The best results are achieved if we include both sets of regressors, Results for this comprehensive specification are reported in column (3). This regression provides the best overall fit as it is able to account for 56% of the variation in returns. Also, several variables are statistically significant, particularly, out two key explanatory variables. The risk variable again has the expected positive effect but now that we also control for the more conventional determinants, the intangible capital intensity also has the expected significant positive effect. Regarding the more established explanatory variables, openness is again estimated to exert the expected negative effect on the rate of return. The estimated coefficients of the (tangible) capital intensity and size variable are also negative and significant, which may be regarded as evidence for diminishing returns.

5 Conclusions

This paper presents the results from a two-stage analysis of sectoral rates-of return in Germany. In the first stage, we use EU-KLEMS data for Germany to investigate whether there is evidence for persistent or convergent sectoral rate of return differences during the last 30 years (1970-2007). Our analysis along the lines of both β-convergence and σ convergence show that there is some convergence but that relative positions are still fairly stable and persistent. The variation of return rates across sectors thus has both transitory and permanent components.

In the second stage of our analysis, we attempt to explain this variation by considering both more established factors such as the sectoral intensities of tangible and human capital, scale (size) and openness but also more novel explanatory variables in the form of sectoral risk and intangible capital intensity. We find that the more traditional explanatory variables have less explanatory power than their more recent counterparts. In particular, sectoral risk is found to have a strong and robust positive effect on the rate of return to capital of a sector.

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7 Annex

Classification of Industries

EUKLEMS industry	EU KLEMS No.
*Agriculture, Hunting, Forestry, and Fishing**	AtB
*Mining and Quarrying**	C
FOOD , BEVERAGES AND TOBACCO	15t16
TEXTILES, TEXTILE , LEATHER AND FOOTWEAR	17t19
WOOD AND OF WOOD AND CORK	20
PULP, PAPER, PAPER , PRINTING AND PUBLISHING	21t22
Coke, refined petroleum and nuclear fuel	23
Chemicals and chemical	24
Rubber and plastics	25
OTHER NON-METALLIC MINERAL	26
BASIC METALS AND FABRICATED METAL	27t28
MACHINERY, NEC	29
ELECTRICAL AND OPTICAL EQUIPMENT	30t33
TRANSPORT EQUIPMENT	34t35
MANUFACTURING NEC; RECYCLING	36t37
ELECTRICITY, GAS AND WATER SUPPLY	E
CONSTRUCTION	F
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	50
Wholesale trade and commission trade, except of motor vehicles and motorcycles	51
Retail trade, except of motor vehicles and motorcycles; repair of household goods	52
HOTELS AND RESTAURANTS	H
TRANSPORT AND STORAGE	60t63
POST AND TELECOMMUNICATIONS	64
FINANCIAL INTERMEDIATION	J
*Real estate activities**	70
Renting of m&eq and other business activities	71t74
*Public Administration and Defence, Compulsory Social Security**	L
*Education**	M
HEALTH AND SOCIAL WORK	N
OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES	O

** Not used in the regression analysis.*