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The Assessment of Depreciation in the Case of Intangible Assets

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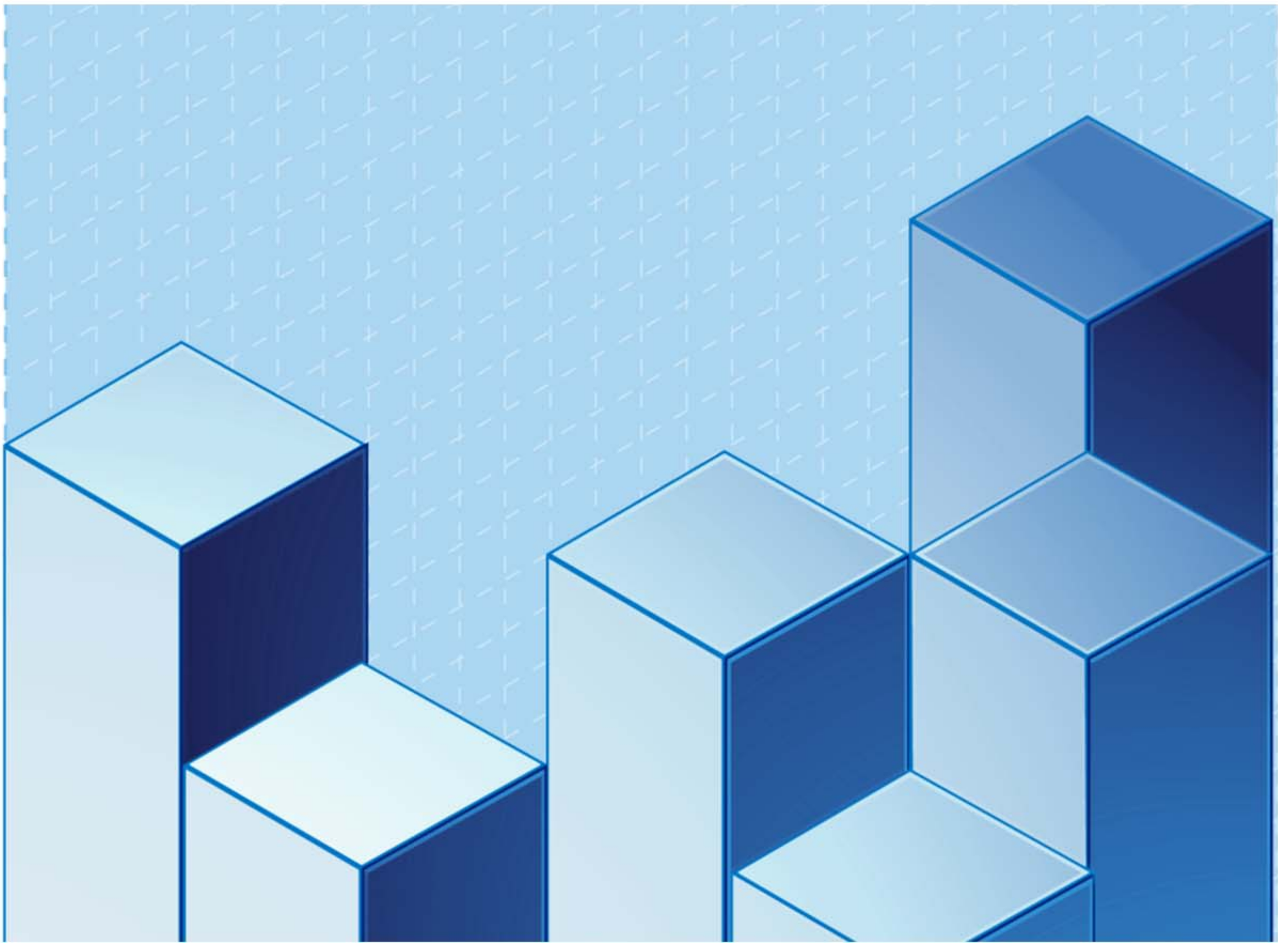

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The Assessment of Depreciation in the Case of Intangible Assets

Bernd Görzig[*]
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Abstract

A multitude of measurement issues are related to quantifying the amount of intangible assets in the public sector. In this paper we focus on the research dealing with the decrease of the value of capital stock and the depreciation of intangibles in the public sector. In the first part we discuss the influence of the assumption of normal wear and tear, obsolescence and average economic life for the calculation of depreciation rates. In particular, we evaluate the potential differences between private and public intangibles. In the second part of the paper we present an empirical case study. Here we take closer look at the team value as part of the intangibles in the field of organisational capital. Based on linked employer-employee data for Germany we analyse the unit specific quit rates that describe the loss of the capital value of a team. The results indicate large differences in the depreciation rates between private and public sector. The depreciation rate of the team value as part of the organisational capital is particularly low in the public administration and human health activities.

Keywords: Public intangibles, service life, team value, organisational capital

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1. Why service lives of assets matter

A multitude of measurement issues is related to quantify the amount of intangible assets in the public sector. Given, that intangible investment, the contribution to the increase in intangible capital stock has been measured properly, we concentrate in this paper on the opposite the decrease of the value of capital stock, the depreciation of intangibles in the public sector. Assessing depreciation for intangible assets in the public sector should not be fundamentally different from the methodology applied for tangible assets. Therefore, this paper is based on the discussion on assessing net capital stock and depreciation for tangible assets and discusses the possible and necessary deviations in the case of intangible assets. First, we deal with the question whether or how we need to consider the distinction between public and private assets. The following chapter deals with the choice of the methodology to assess appropriate values for depreciation for intangible assets, which are in line with the National Accounts conventions as suggested by ESA 2010[1]. The chapters thereafter have the focus on the different perceptions of the service life and the results for the quantified depreciation rate.

It is known (OECD, 2001) and easy to demonstrate that service life assumptions have a strong influence on capital stock and consumption of fixed capital. OECD (2009, p. 106) notes that

> *" the accuracy of capital stock estimates derived from a PIM is crucially dependent on service lives - i.e. on the length of time that assets are retained in the capital stock".*

OECD (2010, p. 128) argues

> *"The most important PIM parameter is the service life. Specifying a service life of 10 years rather than 5 years would make a huge difference to the estimates of the capital measures. Net capital stock would be approximately double, and with a typical scenario of strong growth, consumption of fixed capital would be appreciably smaller. It therefore deserves a good deal attention."*

According to ESA, service lives together with capital stock are relevant to assess depreciation. This condition is independent of the way capital stock is assessed. Also in the case that PIM is not applied to calculate capital stocks, knowledge on service life is a necessity to conform to ESA. In addition, PIM models as a rule need the knowledge on service life as a parameter.

Available studies on the use of intangible assets in the private sector assume comparatively short service lives for intangible assets (Corrado et al., 2015, p. 31). In this case, even very small differences in the service life assumption, i.e. a year (which is the lowest possible ESA time unit for investment) may have a comparatively strong impact on the level of depreciation.

[1] In the following abbreviated as ESA.

According to ESA (3.139), consumption of fixed capital (CFC), which is the National Accounts notion of depreciation *„… is the decline in value of fixed assets owned*[2]*, as a result of*

- *normal wear and tear and*
- *obsolescence." (see chapter 4.1)*

In the case of tangibles, this implies that even if goods in a proper physical shape are not necessarily counted as assets if they have no economic value.

The *"… decline in value includes a provision for …….losses of fixed assets as a result of accidental damage*[3]*"* and

"… is estimated on the basis of the

- *stock of fixed assets and the (see chapter 3.1)*
- *expected average economic life (see chapter 4.2)*
- *of the different categories of those goods." (see chapter 2.1)*

In the following chapters, we discuss the points underlined above in a different order.

2. Private and public intangibles

An important feature with respect to the levels of depreciation and net stock is the breakdowns of assets to allow for different service lives by type of asset. Breakdown in the context of service life does not mean the asset and industry breakdown for which GFCF time series are available or which have been defined in the transmission programme (ESA 2012). If we could assume the same service life for all types of assets, we would not need any further breakdown by asset type or by industry to assess the amount of depreciation. The level of overall depreciation would not be different if we make the calculations for the aggregate or for the different types of asset.

Therefore, the question whether one has to assume different service lives for public intangibles in comparison with the service life assumption of private intangibles lastly is a question of the degree of breakdown by type of asset. If the asset breakdown can be deep enough in a way that the individual types of assets can be considered as homogeneous goods, then there would be no further need to distinguish between private and public assets. In this case, of course it will happen that public intangibles are related to certain industries and a number of industries are not related to public intangibles.

ESA suggests that the average economic life of a specific asset should be the regular case for all units of the economy (ESA, 3.141). The underlying idea is that there exists some kind

[2] The condition of ownership is another necessary diversion where intangible assets have to be calculated different from ESA recommendations. ESA refers to legal ownership. Suggestions have been made to refer to economic ownership (OECD, 2010).
[3] "…which can be insured against."

of homogeneous type of asset, whose loss of value is always the same independent of the surrounding of its use. The underlying idea of a unique service life for homogeneous types of asset is its model of perfect competition. The asset breakdown for GFCF as described by ESA (3.127) certainly cannot be seen to be of sufficient detail to represent homogeneous types of asset.

In practice, with respect to expenditures for tangible assets, only a few countries seem to adhere to the concept of a unique service live by type of asset. ESA does not give a specific suggestion on the necessary degree of asset breakdown for capital stock purposes. However, the ESA classification of asset types in the transmission programme with 11 different types of asset (ESA 2012, table 22) is certainly below the factual asset breakdown as practised by a number of Statistical Offices.

Görzig (2007) describes that according to a UNECE (2004) survey, in most of the old EU 15 countries, the asset breakdown for tangibles has been reported to be more or less in line or below that of the classification as given in ESA. That is the reason, why some countries, are reporting to have an additional breakdown according to the industries in which the assets are used. Reasons for an additional industry breakdown can be twofold:

- *The applied asset classification is not deep enough to cover homogeneous types of asset, or*
- *Different market structures in the industries will induce different economic service lives for the same type of asset.*

Obviously, there is a trade-off between the level of asset breakdown and the necessity to distinguish between different service lives by industry. The lower the asset breakdown the more might it be a necessity to apply different service lives by industry for a given type of asset. Table 1 informs on the breakdown of intangible assets in the private (INTAN-Invest) and public sector (SPINTAN).

Table 1: Depreciation rates for Intangibles in SPINTAN by asset type

	Private sector	Depreciation Rate Private sector	Depreciation Rate Public sector
	CHS[3]	INTAN-Invest[1]	SPINTAN[2]
Computerized information			
Software	0.330	0.315	0.315
Databases	0.330	0.315	-
Open Data	-	-	0.315
Innovative property			
Mineral exploration	-	0.075	0.075
R&D	0.200	0.150	0.150
Cultural and heritage	-	-	??
Entertainment and artistic originals	-	0.200	-
Design and other new product/systems	-	0.200	0.200
New product/systems in financial services	-	0.200	-
Economic/Societal competencies			
Brands	0.600	-	0.400
Advertising	-	0.550	-
Market research	-	0.550	-
Employer-provided training	0.400	0.400	0.240
Organizational structure	-	0.400	-
Manager capital	-	-	0.400
Purchased services	-	-	0.400

[1]INTAN-Invest: Intangible Capital and Growth in Advanved Economies:Measurement Methods and Comparative Results (Table 2). -
[2]SPINTAN: Measuring intangible investment in the Public sector (Table 6). -
[3]CHS:INTANGIBLE CAPITAL AND U.S. ECONOMIC GROWTH (Page 14).

It is certainly an important question to find the optimal asset breakdown. An idea of the magnitude of different service lives applied by firms might be given by the fact that the German tables for tax service lives cover more than 2 000 different types of assets (BMF, 2006). EU KLEMS (2007) distinguishes between 10 types of asset. For some asset types, different depreciation rates by industry are applied. The asset breakdown in the BEA (1999) estimates is about 150. For Germany, the statistical office is using more than 200 different types of assets. A survey on asset service lives (Cope, 1998) is asking for more than two hundred different types of assets. All these studies have the focus on tangible asset.

If we want to transfer the experience collected for tangible assets on intangible assets we have to consider that according to most researchers many types of intangible assets are much more firm specific than tangible assets are assumed to be in the standard setup of economic theory. From this, we would expect an even bigger variation of the service lives for intangible assets. The assumed service lives in Corrado et al. (2015) can only be understood as a mean value of the factual values.

3. Perpetual inventory methodology (PIM)

3.1 General remarks

The broadly accepted methodology to assess capital stock and hence capital services is the perpetual inventory methodology (PIM). This methodology calculates the current value of the stock by adding up the value of new assets - *“ESA: gross fixed capital formation (GFCF)”* - to the previous years’ stock and deducting the loss of value *“ESA: consumption of fixed capital (CFC)”* - of the previous years’ stock. This methodology is proposed by ESA (3.141) as the standard methodology to be applied in the National Accounts if no direct information on stocks is available.

Alternative approaches as direct estimates of capital stocks are using balance sheet information or surveys. Compared with direct estimates of capital stocks, estimates derived with the PIM have the advantage to be based on a consistent valuation concept in line with economic theory. Furthermore, the costs of collecting direct information on stocks and converting it into the appropriate values are mostly very high (OECD, 2001, chapter 8). In addition, the available valuation of the stocks collected in a direct way is mostly not appropriate and not in line with the state of the art as given by the economic theory. Most important however, these alternative methodologies can only be applied if some information on the value of stocks is available. For intangible assets, this is normally not the case. Therefore, for assessing intangible capital stock, direct estimates as a rule are not possible if there is no observable information on stocks. The PIM seems to be the only practical device to arrive at meaningful estimates for net stocks for intangible assets.

3.2 Initial stocks

The PIM affords the information on an initial stock or alternatively long series of GFCF and a model that describes the loss of value, CFC, also called depreciation of the current stock. An application of this kind of model is described in the EU KLEMS (2007, 6.1) methodology volume. Applying this methodology, intangible stocks can be calculated as follows.

The opening stock K_t, for an establishment is given with:

3-1 $$K_t = K_{t-1}(1-\delta) + I_t,$$

with I_t the capital formation of the current year t and a constant depreciation rate, δ. Initial values for capital stocks can be calculated in applying a modified version of a methodology suggested by Griffith (1999). Capital stock calculations are based on observed figures of investment and an estimate of the initial closing capital stock $K_{\theta-1}$, in the year prior to the beginning of observations in the data. Long service lives, often seen as an obstacle for capital stock estimates, can be handled with the sum formula of a geometric row (Görzig/Gornig, 2012).

We assume a constant growth of investment g, before the first year of observations. Let θ be the first observation available, then back extrapolating yields:

3-2 $$I_{\theta-1} = I_\theta(1-g)$$

with I_θ for the capital formation of the current year and a constant growth rate g for capital formation. Given the general cumulative definition of the closing stock in equation 3-1, we can apply the following equation to calculate the initial stock:

3-3 $$K_{\theta-1} = I_{\theta-1}\sum_{0}^{\infty}(1-\delta-g)^t .$$

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

3-4 $$K_{\theta-1} = \hat{I}\,\frac{1-(1-\delta-g)^{\mathrm{T}}}{1-(1-\delta-g)} .$$

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 investment value available for 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 reflecting the growth of investment in the observation period.

4. Depreciation

4.1 Wear and tear and obsolescence

Subsuming intangible assets under the broad heading of knowledge capital, the OECD (2001, p.117) suggests that the physical service life of knowledge is infinite. The only reason for retiring intangible assets is that there is no longer any demand for their services. If they have only limited service life in practice, it must be due to obsolescence. No wear and tear and no damages occur. The only impact, which shortens the service life of knowledge, comes from obsolescence. This opinion is shared by Ker (2013a) with respect to R&D assets.

The notion of obsolescence is not discussed uniquely. Diewert/Wykoff (2006) define the case of disembodied obsolescence as a result of demand shifts. An asset is not any longer needed in the production process if the demand ceases for the products that can be produced with it.

Embodied obsolescence occurs if new knowledge deteriorates current knowledge. The impact of new knowledge on the depreciation of current knowledge is also articulated by Alston et al. (1998). According to Grubler/Nemet (2012) obsolescence occurs either as technological obsolescence by innovation or *"..due to turnover of the holders of that knowledge"*. Knowledge can get lost by staff turnover is argued by Arnulf/Nemet (2013). This is also the position of Squicciarini/Le Mouel (2012) who derive depreciation rates of organisational capital from job turnover data. In this paper (Chapter 6), we present an example, how knowledge capital in the shape of the capital value of a team can be destroyed

Assuming complementarity between capital stock and its operating factors of production, Bliss (1965) found that obsolescence results if costs to operate the capital stock are higher than the return from the stock. Given the parameters of the production function, Görzig (1973) shows that the return depends on the price of the good produced with the asset in question while the costs depend on the price of the operating factor of production. If product prices develop differently across firms, then even with the same cost prices a given type of asset will have diverging service lives. This would of course be only the case if imperfect competition prevails.

In economic models, depreciation is modelled time dependent. Different models are suggested. ESA (3.143) proposes a straight-line development. Most economic models prefer geometric schedules. The assumption of time dependency can be seen as a pragmatic aggregation of the multitude of influences, which can affect the "*loss of value*". Wear and tear might follow from the use of an asset. It therefore determines depreciation over time. Obsolescence on the other hand is not necessarily increasing over time, since it depends on economic factors, which can change speed and direction of the depreciation. If prices are changing, even assets, which have been discarded, can be reanimated. In the above-mentioned case of embodied obsolescence, depreciation on existing assets may also depend on the velocity, that new assets with different features are becoming available. This might also be a relevant issue for information assets.

4.2 Service life

Population statistics defines the average life (expectancy) as the average age a member of a certain population can be expected to reach[4]. It denotes the average number of years; an individual will stay in the population. Formally, the average life expectancy can be calculated as the sum of all observed annual survival rates in a population. If direct observation of the age structure of a stock is available, the average life can be calculated from the observed values. A model, estimating the stock would use the observed average life as a parameter in calculating the survival rates of the members of the stock. This model should generate an age structure of the members of the stock, which would exactly return the observed value for the life expectancy.

Models to calculate capital stock are making use of this notion of service life. The classical example in capital stock calculations is the well-known "one hoss shay" survival curve[5]. Here, the assumption is that all but the last survival rate are 100%. In this case, the assumed average service life in the capital-stock model and the resulting average lifespan of an asset in the stock are the same by definition.

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[4] Different from population statistics, we do not deal with the service life of observable units. Instead, we look at the service life of assets in these units. In assessing these service lives from observed stocks, we have to consider the survivor bias, induced by the fact that stocks of firms that have been closed are no longer observable.

[5] Based on an Irish folk song.

Different notions of service lives are in use for models, which apply geometric depreciation. In the BEA calculations, the service life assumption is mainly a denominator, needed for calculating the depreciation rate (BEA, 1999, p. 32).

4-1 $\delta = R / T$

The assumption on the declining balance rate *R* together with the service life assumption *T* determines the – constant – depreciation rate δ, which in turn lastly is relevant for the size of the calculated net capital stock and the level of consumption of fixed capital (depreciation). In this case, the assumption on service life does not describe the average lifespan of assets in net capital stock. Obviously, there is a trade-off between the two parameters for service life and declining balance rate. High values for the declining balance rate and high values for the service life yield the same depreciation rate and finally the same amount of depreciation as lower values for both. The service life assumption applied in the above described geometric depreciation formula is not necessarily comparable with the notion of average service life in the sense of average life expectancy[6].

4.3 Depreciation rate

The discussion on depreciation rates has to distinguish between the rate as descriptive number, which can be calculated as the relation between the value of depreciation and the value of net capital stock and the depreciation rate as a parameter in a depreciation model. Depreciation rates are inversely related with the service life of an asset.

ESA recommends a linear or straight-line depreciation model but acknowledges also geometric depreciation if appropriate. Except for this, ESA does not give any recommendation on the depreciation rate. In fact, the straight-line recommendation implicitly results in an increasing descriptive depreciation rate over time.

A capital stock model based on PIM with geometric depreciation pattern is commonly applied by many researchers[7] for tangibles as well as for intangibles. Note that also with straight-line depreciation pattern for individual assets the resulting depreciation rate for the aggregated depreciation curve (OECD, 2009, p. 41) can be convex. OECD (2009, p. 99) describes a number of formal advantages which result from the application of geometric depreciation schedules.

According to OECD (2009, p. 99), econometric estimates of the as constant assumed depreciation rate are rare. One procedure to arrive at results here is the double declining balance rate. In commercial uses of geometric depreciation, the declining-balance rate frequently is assumed to have a value of 2. This is for instance the standard value, which is used in spread-sheet applications like MS Excel. The US Bureau for Economic Analysis (BEA. 1999), which applies geometric depreciation for most assets, assumes in general a factor of 1.65. For some assets, as for instance CT equipment, the value of the declining

[6] In fact, if geometric depreciation is assumed together with an infinite serving period, the average life expectancy M of an asset in net capital stock converges with an increasing serving period to the reciprocal of the depreciation rate. This can easily be calculated with the sum formula for geometric rows.

[7] For instance EU KLEMS (2007), Corrado et al. (2009), Piekkola et al. (2011), Corrado et al. (2012)

balance rate goes up to a value of more than two. In other cases, it is around 0.9, as in the case of dwellings and other kinds of buildings (BEA, 1999, p. 29).

Economists agree that depreciation/service life is an economic notion. From this, one could expect that depreciation rates depend on the different economic conditions in a firm or industry. Principally, they could differ even across the smallest observable decision units. Where micro level studies are available (Görzig/Gornig, 2012), they show a rather wide spread of depreciation rates. This is independent from the question, whether we look at tangible or intangible assets. In the case of intangible assets, this is supported by the general opinion that these are in many cases own account assets, which are assumed to be firm specific.

As discussed in chapter 2, in the case of tangible assets, National Statistical offices try to do calculations on a rather disaggregated level by type of asset, such that one can assume rather homogeneous units for which a – mostly – invariant depreciation rate is assumed. Another methodology is to assess industry specific variances in the depreciation rate.

5. Assessing service lives

5.1 Model based explanations

Given the commonly accepted PIM, the question of net stocks is mainly a question of appropriate depreciation rates applied for intangible assets. One of the basic differences with tangible assets is the fact that for intangible assets there exist no physical stocks. The question of depreciation as a measure of the loss of value can only be handled by applying standard economic theory.

Available models that explain service lives rely heavily on the return rate. In the case of public intangibles, the return rate is rather difficult to evaluate. Most economists agree that the economic service life of an asset ends if there is no return on that asset. An economic value can only be associated with those goods, which are able to deliver a return. Principally, the return should not necessarily be a return in money, however in the generally applied accountancy schemes, it is. Within the definitions of ESA, it becomes rather difficult to assess the return on public assets Service life for public intangible assets based on this methodology cannot rely on the conventional ESA system (see WP 2 and the discussion in Corrado et al., 2015, chapter 2.5). The following models can only give an impression how these relationships could be assumed.

Modelling obsolescence - Bliss (1965)

Given a putty clay production function, Bliss shows that the optimal service life of an asset depends on the expected increase in real cost of operating the asset. Furthermore, in his simultaneous non-linear model he derives equilibrium values for the planned capital labour intensity and the internal rate of return if the real price of operating input is given exogenously. The model describes that high planned service lives are the result of an expected slow increase in the real price for the operating costs and vice versa. The model has originally been developed for the market sector economy and needs reliable information on capital compensation as an input. Furthermore, it deals only with one type of asset. Therefore, it is not directly applicable for the question of this paper.

A forward-looking profit model - LI (2014)

Li develops a model to estimate the depreciation rate of organizational capital. The core idea of the model is that business intangible capital depreciates because its contribution to a firm's profit declines over time. As the Bliss model, this model refers to the private sector of the economy and deals with one type of asset only[8]. In the present form, it cannot be applied to solve the questions of this paper.

5.2 Empirical sources

Statistical sources to get information on the service life for a particular type of asset are suggested by OECD (2009, chapter 13.1):

- *Tax-live, administrative records, survey on discards of assets or age structure, company accounts, other countries estimates*

In the case of tangible assets, all these sources are applied by National Statistical Offices to assess depreciation in the National Accounts. However, little is known to what extent service lives for intangible assets can be derived from these sources.

Tax service lives do not necessarily represent the factual economic service lives. They are very often governed by policy goals. Furthermore, they are based on agreements between industry representatives and the tax authorities. In general, industry representatives urge to apply low service lives in the balance sheets. Case studies have shown that tax service lives for tangible assets might represent the lower margin of possible service lives. Depending on the country's taxation-system, the diversion from the economic service live differs across countries.

Information on tax service lives for intangibles is rare and can in the best case assessed by an indirect methodology. In some countries, for instance Germany, the firm value - as the difference between the asset value as given by the accountancy, adequately valued, and the market value, as given by the purchasing price of a firm - can be subject to depreciation.

In the case of tangible assets, frequently use is made of administrative data. With respect to intangible assets, estimates of R&D service lives frequently are based on patent statistics (Ker, 2013b).

Surveys on service lives have to distinguish between surveys on discards (Bobbio et al., 2014) or on the age structure of the capital stock. Such surveys have been proofed a reliable source in the case of tangible assets. However, for intangible assets such surveys are not possible if the information on stocks is lacking. Surveys that ask for the expected service life of current investment have been conducted on R&D for the business sector (Awano et al., 2010; Ker, 2013c). They show that these service lives can vary considerably. They seem to indicate that the range is determined by additional factors like industry, sample, and the type of depreciation model. In any case, a survey asking directly for the expected service life needs a very detailed asset breakdown. To cover homogeneous assets, the necessary breakdown would have to be considerably deeper than the classification suggested by ESA

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[8] Calculations have been made separately for R&D and organisational capital.

for gross fixed capital formation (GFCF) by type of asset or the one in the transmission programme of Eurostat.

Another method to get information on service lives is asking for the age structure of the current stock, preferably the gross stock. In this case, values, which are available in the companies' accounting system can be aggregated and reported. Since accounting values are normally reported at historic acquisition prices, additional assumptions and a valuation at current replacement costs will be needed. Age structure based service live estimates suffer from a survivor bias, since stocks of closed firms might not be included, except in the case that these stocks have been purchased by still existing firms. This implies the possibility of overestimating the service live. As discussed before, this methodology is not applicable for intangibles if their stocks cannot be observed.

Other countries estimates are usually applied by smaller countries that do not have the resources to conduct surveys by their own. In addition, datasets on international comparable data as EU KLEMS make use of the assumption that the service life of a certain type of asset is the same in all countries considered. In the case of intangible assets, Eurostat (2014) recommends:

> "Service Life estimates used in the calculations of R&D should be based on dedicated surveys or other relevant research information, including information of other countries with comparable market/industry characteristics. In case, where such information is not available, a single average Service Life of 10 years should be retained."

OECD (2009) argues that producer of assets might have reliable insight to assess the probable service life of the assets they produce, such that they give experts' advice in this matter. This might be a possible source in the case of tangible assets, when producer have knowledge on stocks and replacements of their customers. With respect to intangible assets again the knowledge on stocks becomes difficult even if one considers that an important part of the intangibles can usually be assumed to be own produced.

6. Depreciation rates for organisational capital - the team value

6.1 What is organisational capital?

It does not seem that there is a convincing agreement on the nature of organisational capital. Corrado et al. (2009) see organisational competencies as part of the firm specific resources. Corrado et al. (2015) argue that organisational capital of public sector is knowledge capital and part of the societal competencies. Researchers seem to agree on the tacit, team related, and firm specific nature of organisational capital. Chen (2012) argues that the "firm-embodied concept of organizational capital enjoys popular support among scholars", referring to Evenson and Westphal (1995):

> *"…it is an agglomeration of knowledge that is used to combine human skills and physical capital into systems for producing and delivering want-satisfying products"*

Other approaches rely on the economics and management literature, where organisational capital is defined as a firm-specific knowledge asset embedded in a firm's employees (Squicciarini/Le Mouel, 2012).

CHS (2009) refer to microdata evidence by Abowd (2005) suggesting that organisational practices (proxied by firm-level distributions of human capital) are strongly related to outcomes such as revenue per worker and market valuation. Chen (2012) discusses the question to what extend organisational capital can be seen to be embodied either in people or in firms. Because of the strong relation between organisational capital and the firms' outcome, he relies on the firm specific aspect of organisational capital.

6.2 The capital value of a team

We concentrate in this study on a specific element of organisational capital. This we call the "team value". We assume a capital value for a team, which is determined by the knowledge on the behaviour of the other members of the team as part of the societal knowledge (Corrado et al., 2015) in a firm. The interaction between the team members creates a capital value that develops *from "..the match between employees working in teams"* as Prescott and Visscher noted in 1980. Since then, other authors have emphasized that the capital value of a team represents a dominant part of organisational capital (O'Mahony et al., 2014). It is part of the own account produced assets of a firm. If such a team value exists, it is related to the employees who constitute the team. We understand that the capital value of a team is more than the sum of capital values of the individuals in the team. For instance, the team value of a soccer team is not the sum of the individual transfer values of the players. Moreover, the team value is part of the competitive power, which resides in the people who constitute the team that is governing the unit in question.

This chapter follows the basic concept of Squicciarini/Mouel (2012) in assuming that a loss in the team value of a production unit will occur if members of the management team are leaving it. The capital value of the team will be reduced twofold.

- *First: the societal knowledge of the quitting team member gets lost.*
- *Second: the societal knowledge of the other members of the team with respect to the leaving member becomes obsolete.*

We calculate unit specific quit rates that describe the loss of the capital value of a team. Hence, these quit rates can be taken as proxies for the depreciation rate of the team value. In the simplest model, the quit rate is calculated as number of employees leaving the unit related to the stock of employees in the unit. In more demanding models we use wage weighted quit rates.

6.3 The Eukleed database

Eukleed is a comprehensive integrated micro data set on employment, investment, and output for about 1.6 million German establishments, with around 40 million employment cases per year. The Eukleed database has originally been applied in the INNODRIVE project (Piekkola et al., 2011) to assess organisational capital for the market sector. Here, the analysis is extended to cover also the units of the SPINTAN related industries. Its panel structure allows that for every unit the exact entry and exit days for each individual employee is available. The main source for Eukleed is a linked employer employee data set (LEED) derived from the German social insurance system (SIS). It supplies firm level[9] information with respect to employment, employment characteristics, labour compensation by type of labour, and establishment characteristics.

To calibrate the firm level information with the aggregated data of the National Accounts two additional sources are used: The National Accounts data for 70 industries and 16 Federal States.

6.4 The German Social Insurance System (SIS)

SIS is based on the register for all persons obliged to pay social security contributions. It supplies a nearly complete coverage of all German employees. Merely some governmental personnel and a number of low-income recipients are excluded. For each employee, information is available for the day a particular job began and when it has been finished, including the income received during that period. Among others, information is supplied upon the type of the job performed and the educational skill of the person doing the job and the establishment where the person is employed. This implies that the industry where a person is working is available. A full overview of SIS is given by Fritsch/Brixy (2004).

The micro data of SIS are subject to very restrictive disclosure rules. In recent years, access has increasingly been made possible by the Research Data Centre (http://fdz.iab.de) of the Federal Employment Agency (BA) at the Institute for Employment Research (IAB), which prepares individual datasets developed in the sphere of social security and in employment research and makes them available for research purposes – primarily for external researchers. An overview on the current situation with respect to data availability from this source can be found in Bender/Möller (2009).

SIS data are collected for administrative purposes. This implies that they are not necessarily in line with statistical rules for surveys. For the purpose of the Eukleed database, the SIS data had to be corrected by eliminating erroneous entries or entries that are induced by corresponding labour market laws. For example, employees with no income are registered because women in pregnancy vacation are defined in SIS according to the law as employees.

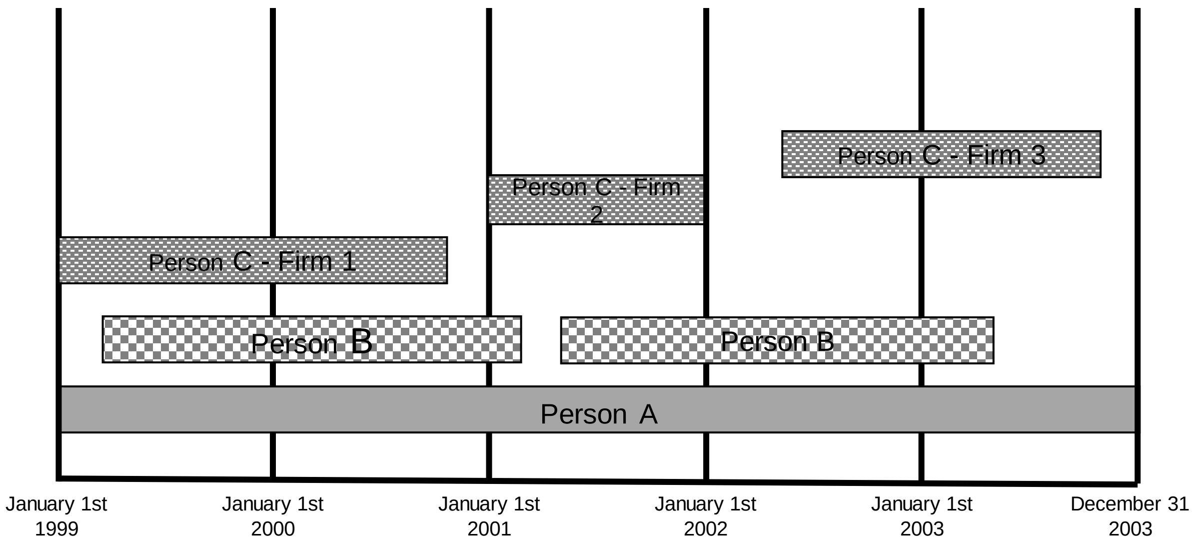
Number of employees

ESA describes employment as the average stock of employed persons over the year. In the Eukleed database for each person, information is available on the first day and on the last day of the persons' employment. Here, this fact is called employment case. An employment case can be a person that works only for one day or it could be a person that works all the days of the year (Figure 1). The same person may consist of several employment cases. From these facts, we can calculate employment days for each employee. In figure 1, person A is an employment case working the full observation period of 5 years. Person B constitutes two employment cases working with interruptions in the same unit/establishment. Person C covers three employment cases working in three different units/establishments. Principally, the same person can constitute several employment cases at the same time. To make this

[9] If not noted otherwise, firm is used synonymously with establishment, the local production units.

information comparable, the employment cases are converted into individual employment days, which can be summed up to higher aggregates. This can be the units/establishments in question or the SPINTAN related industry levels. Calculations have been made separately for employees, who entered the unit during the year, left the unit before the end of the year, entered and left the unit during the year, and those who stayed in the unit for all the days of the year

Figure 1: Employment patterns over the year



In the abstract figure 1, we have no quits in 1999 and in 2002, 1 quit in 2000, 2 quits in 2001, and 2 quits in 2003. Quit rates per unit cannot be calculated, since no information is given on the units/establishment.

Divergences between Eukleed and National Accounts data with respect to the industry's employment figures are caused by the fact that National Accounts data refer to enterprises, the legal units as the smallest entity; SIS data are only available for establishments, which are comparable to the local KAU (**K**ind of **A**ctivity **U**nit) in ESA (1.56). For some industries, the number of employees in establishments is higher than in the enterprises of these industries because these industries consist mainly of local establishments of enterprises, whose main activity is in other industries. Eukleed does not cover

- *certain types of civil servants in institutional sectors S.14/S.15 with an impact for Nace 2 industries O, P, and Q,*
- *self-employed,*
- *very low-income recipients (i.e. less than 400€ per month).*

Furthermore, we are not able to distinguish between market and non-market sector. With respect to all employed people, the coverage is around 70%. A relation that is valid within certain margins also for the income data. For the public sector, the degree of coverage is lower, since certain types of civil servants who do not pay social security contributions are not included.

Table 2: Coverage of SIS compared with Labour Force Survey and National Accounts

2001	Labour force survey	National accounts[2]
	mill. persons[3]	
Total	36.8	38.9
Self-employed	4.1	4.1
Employed	32.7	34.8
Civil servants	2.3	2.3
Others	30.5	32.6
SIS members	27.1	27.1
Minor income jobs etc.[1]	3.4	5.5

[1] Residual: Less than 400 € per month, less than 15 working hours per week, temporary jobs - [2] Based on the definitions of ESA'95 in 2001. - [3] Differences in the sums due to rounding. - *Sources:* National Accouts, Labour Force Survey.

Quits

Quits can be calculated with the Eukleed database from those employed persons who have been observed during the year and are not anymore observable in the end of the year. All employment cases of a year can be described either as pure entries ($EntryDays_{j,i}$), pure exits ($ExitDays_{j,i}$), entries and exits ($TempDays_{j,i}$), or permanent staff ($PermDays_{j,i}$). A units' *i* total employment in a year then is given as

6-1 $$E_i = \sum_{j,t} EntDays_{j,i,t} + \sum_{j,t} ExDays_{j,i,t} + \sum_{j,t} TempDays_{j,i,t} + \sum_{j,t} PermDays_{j,i,t}$$

t indicating the days of a year, i. e. 365 days, or 366 days in the leap year 2002.

The quit rate δ_i for a unit/establishment *i* then is calculated as

6-2 $$\delta_i = (\sum_{j,t} ExDays_{j,i,t} + \sum_{j,t} TempDays_{j,i,t})/E_i$$

The not weighted industry specific quit rate is the mean of the quit rates of all units in the industry *i*.

The weighted industry *I* specific quit rate δ_I is calculated as:

6-3 $$\delta_I = (\sum_{j.i,t} ExDays_{j,i,t} + \sum_{j,i,t} TempDays_{j,i,t})/ \sum_i E_i$$

Both rates will differ if the quit rates are different by size of the units in question.

Wage expenditures

Wages in the SIS database do not include social security contributions completely. Furthermore, they are censored for low incomes and for high incomes depending on the region and the year considered. To be more precise, in this sample we do not have sufficient information on employees with a monthly wage below 400 Euro. The coverage for this type of employees is very low in some cases. The number of people covered has varied over time due to changes in the respective legislation.

At the upper end, the wage income reported is censored according to the law for the social insurance contributions. All other characteristics of employees in the SIS are available also for these employees. A wage function is applied to estimate all wages outside the upper wage limits given by the data set, using fixed effect regressions with about 20 different explaining variables. Since the LEED data set is very big, comprising about 140 million employment cases for the period considered, a multitude of explaining variables could be included both of the firm-specific and person-specific type (Görzig, 2011).

Grossing up wages and days worked to the industry levels as given by the National Accounts, we can calculate average wages per day for each industry. The average wage per day of SIS is adapted to the respective value in the National Accounts. Multiplying daily wages for all employees in the firm by the days worked results in total wage expenditures of the firm, which is a central variable for the subsequently described estimates. The coverage of wage expenditures is with 80% higher than the findings for employment, since the very low income employees are not covered in the SIS database.

Industries

Eukleed data are available in the 2-digit Nace 1 industry classification. Using the 5-digit Nace 1 classification of SIS, a conversion table at the level of the 2-digit Nace 2 SPINTAN related industries can be calculated.

Table 3: Concordance table Nace 1 to Nace 2 for SPINTAN related industries – employment averages 1999 - 2003

Activities	EU KLEMS	(AO)	I	K	L	M	N	O	All industries (EU KLEMS)
	Nace 2								
"All other activities"	**(AO)**	100.0	99.6	89.2	1.6	-	0.5	85.7	76.6
Scientific research and development	**MB**	-	-	4.8	-	-	-	-	0.5
Public administration, defence; compulsory social security	**O**	-	-	-	96.4	-	-	-	6.3
Education	**P**	-	0.4	6.0	-	100.0	-	0.8	4.5
Human health activities	**QA**	-	-	-	-	-	58.8	-	6.7
Residential care, social work activities	**QB**	-	-	-	0.1	-	40.7	-	4.6
Creative, arts, entertainment activities; libraries, archives museums, other cultural	**R (1)**	-	-	-	1.9	-	-	6.0	0.4
Gambling, betting activities; sports, amusement, recreation	**R (2)**	-	-	-	-	-	-	7.5	0.3
All industries (Nace 2)		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Sources: Eukleed, Own calculations.

Observation period

Eukleed is a true panel. It covers all days between 1999 and 2003. The first day is January 1st 1999 and the last day is December 31th 2003. Note that 2002 is a leap year and has 366 days instead of 365 days.

Team definition

The management employees (basic staff) as defined in the INNODRIVE project (Piekkola et al., 2011) are taken as a starting definition for the team. For each employee, a number of personal characteristics are reported in the SIS database. From this, a combination of kind of occupation based on the 3-digit BA key with more than 350 different occupations and 2 different types of education has been chosen to distinguish between management and non-management employees. All employees, who are working in one of the occupations described in Table 4 by BKdl88, are principally producers of organisational capital if they have a higher education. A higher education is assumed if these employees have visited a secondary school with vocational training, or if they have a college or university degree. Exemptions from this are agricultural engineers and administrators, and chief executives, consultants, tax advisers, and similar occupations, where all employees are treated as management staff. All other employees are assumed non-management staff.

Table 4: Basic Team - management staff definition in INNODRIVE

BKdl88[1]	description[2]	Management staff
31-32	Agricultural engineers and administrators, a.s.	All
601-612	Engineers, physicists, mathematicians, a.s.	High
681	Wholesale, retail trade agents, purchasing agents, a.s.	High
682-688	Sales assistents, a.s.	High
691-692	Banker, a.s.	High
703	Advertising specialists, a.s.	High
751-763	Chief executives, consultants, tax adviser, a.s.	All
771-773	Financial officers, chief accountants, a.s.	High
781-782	Office executives, a.s.	High
784-794	Office clerks, a.s.	High
862-863	Chief executives, consultants of social institutions, a.s.	High
911	Directors of hotels, restaurants, a.s.	High
921	Home economy administrators, a.s.	High

[1]German classification of occupations (IAB 2008; chapter 5). - [2]Translated from
Sources: IAB 2008, INNODRIVE 2011

6.5 Results

Calculations are made for all 300 thousand units that are covered by the SPINTAN related industries (Corrado et al., 2015, table 1), applying the same methodology as for the 1.5 mill. units of the Non-SPINTAN related industries. Note that although it can be assumed that the share of non-market sector units is above average in the SPINTAN related industries, the results can only be a proxy for the public sector.

The average employment number in the units in the SPINTAN related industries is 19, which is more than 50% higher than in the Non-SPINTAN related industries. The share of management employees on the other hand is with 8% only 2/3 of the value in the Non-SPINTAN related industries (Table 5).

In the average, the (employment-) weighted quit rate of the team value for the units of the SPINTAN related industries results in 13%. This is the same magnitude as for the Non-

SPINTAN related industries. With 18%, the non-weighted quit rate is higher since in general smaller firms have higher quit rates.

Note that this paper only deals with own account produced assets and does not include purchased assets. Therefore, the results are not fully comparable with other findings, which include also the purchased parts of organisational capital. The rates found, are considerably lower than depreciation rates for organisational capital in the market sector by INTAN-Invest (Corrado et al., 2012, table 6: 40%) or in INNODRIVE (Piekkola et al., 2011, table 1: 25%). Rooijen-Horsten (2008) assume for the Netherlands a service life of 5 years for all organisational capital. This implies a depreciation rate between the values of INNODRIVE and those of INTAN-Invest.

Table 5: Aggregated results

	Averages 1999-2003	SPINTAN related industries[1]	All other industries
Establishments	million	0.301	1.473
Employees	million	5.641	18.492
Management staff[2]	million	0.462	2.259
Management quits	million	0.059	0.295
Average establishment size	employees	19	13
Average management share	per cent	8	12
Average management quit rate	per cent	13	13

[1] Nace 2 industries MB, O, P, Q, R. - [2] As defined in INNODRIVE (see table 5). - *Sources:* Eukleed, Own calculations.

The quit rate of the team value varies considerably with respect to the industry in question. It is rather high in P (17%) and low in O (10%) and QA (10%). The difference between the weighted and not-weighted quit rates is rather high in MB and R-1 and low in O and in QB (Figure 2). This indicates that the level of the quit rate in MB and R-1 depends to some extend on the size of the units, as measured by the number of employees and that the variation of the quit rate in these industries is comparatively high.

Figure 2: Quit rates for SPINTAN related industries

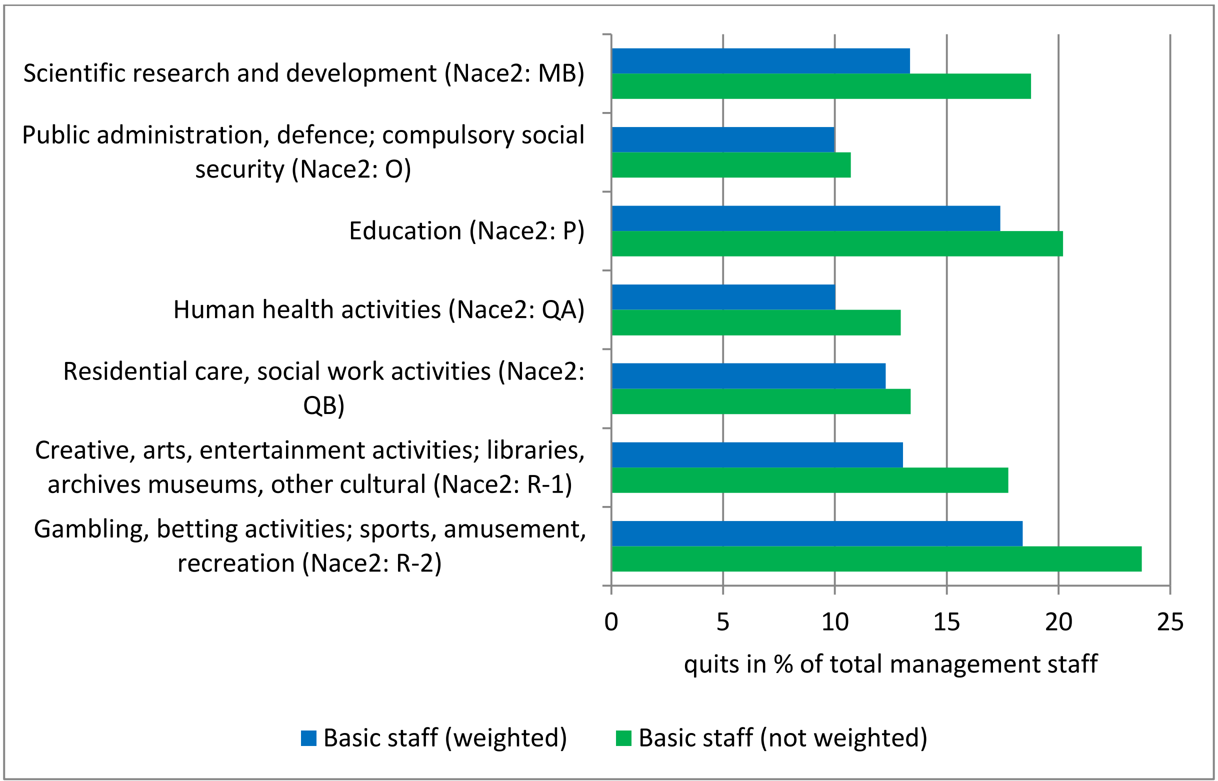
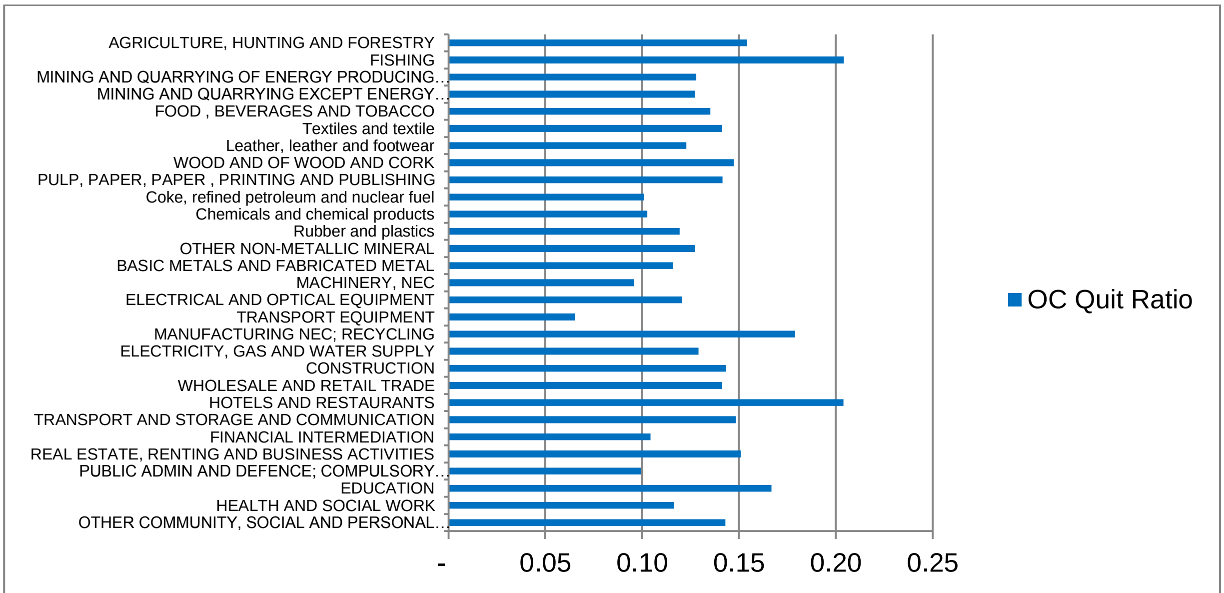


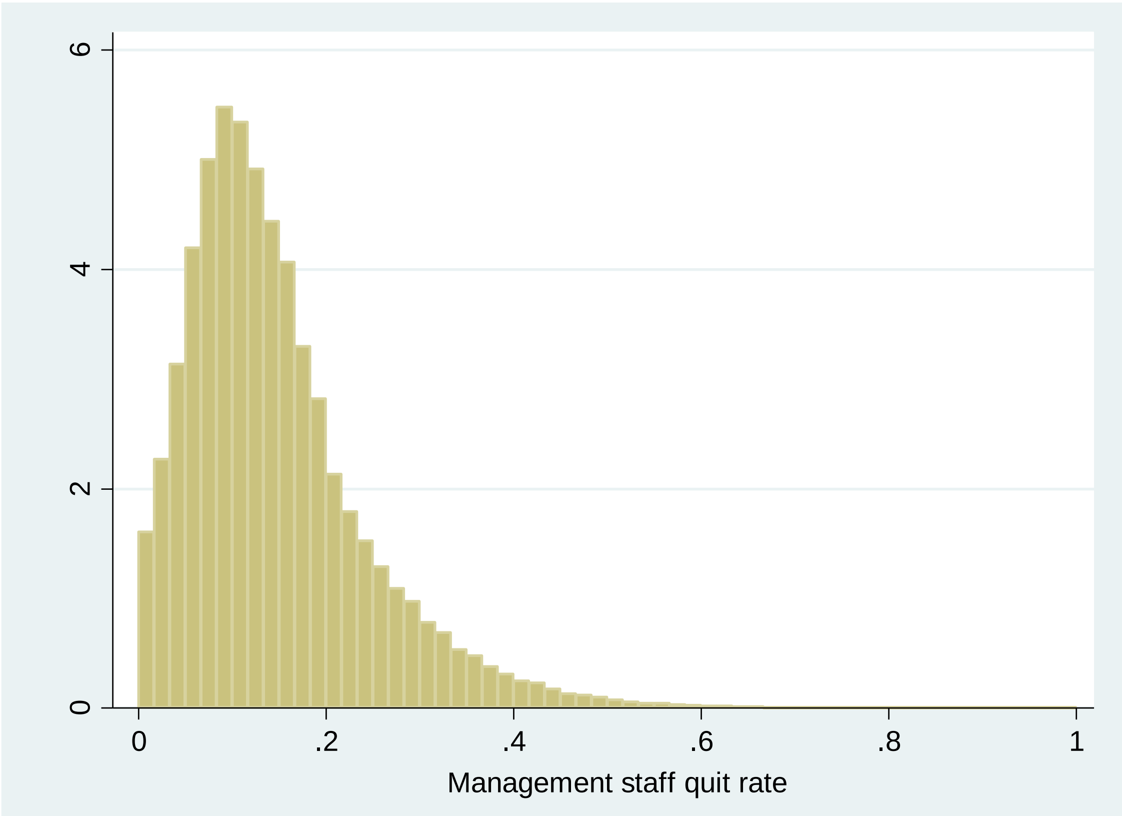
Figure 3 displays the quit rates by Nace 1 industries. Significant differences between the industries can be observed. High quit rates in *hotel and restaurants* and low rates in *transport equipment* can be identified.

Figure 3: Quit rates for Nace 1 industries



In the average, management wages per head are 20% higher compared with those employees who are not managers. However, it is worth to note that there is wide variation of the unit specific quit rates across all the units of the SPINTAN related industries (Figure 4). This supports the assumption that depreciation rates of organisational capital are to a high extend firm specific and any fixed rate used in modelling it can only be seen as a mean value across the wide spread of firm level depreciation rates. One could expect a scaling down of the observed spread if one could distinguish between several types of organisational capital.

Figure 4: Density distribution of quit rates in SPINTAN related industries – 1999 – 2003



Many employees who are member of the management staff have a wage income per head below that of non-management employees as can be seen in Figure 5. Non-management wage rate is much more concentrated than the management wage rate. Nevertheless, the peak of the distribution of the management wages is just a bit to right compared with the non-management distribution of wage rates. This suggests that not all employees, which have been formally defined as management people in INNODRIVE can be classified as members of a team that is governing the unit in question. Therefore, it may make sense to reduce the team definition to those employees who get a wage rate above the average.

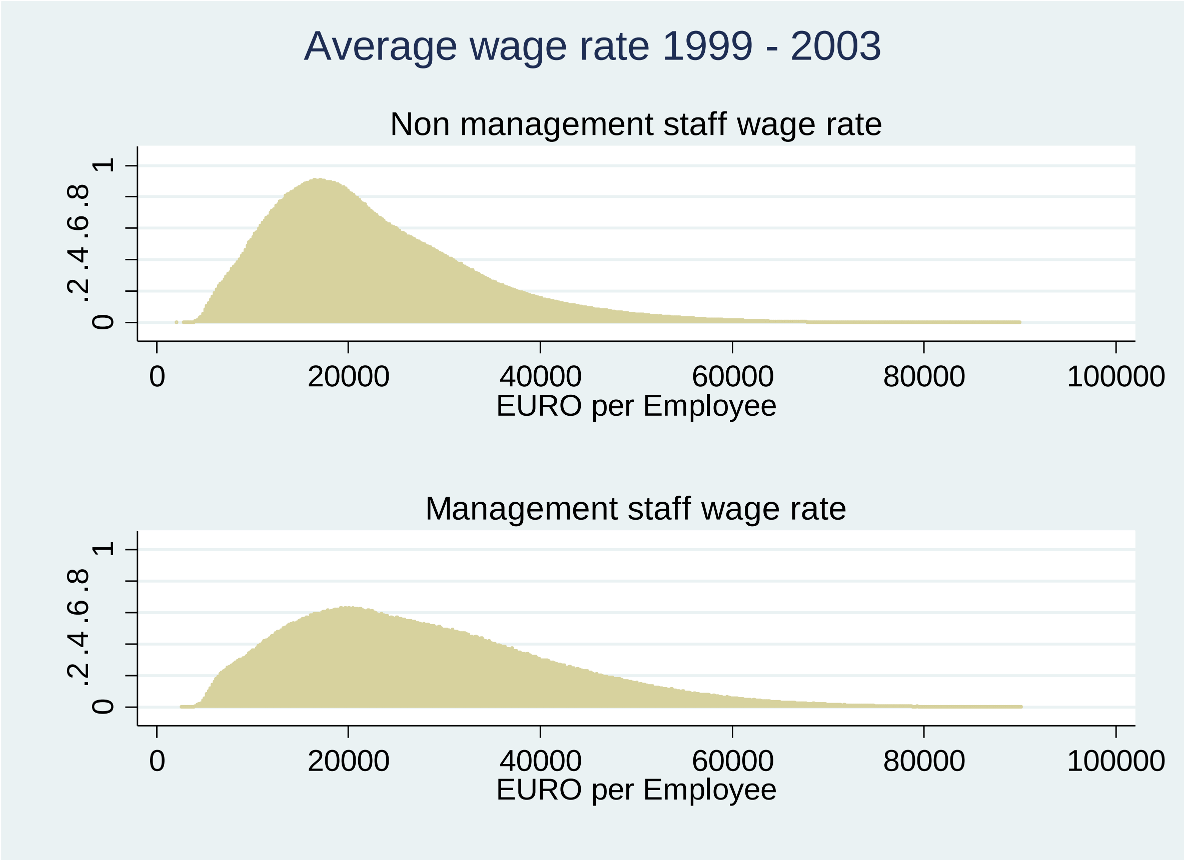
Another important result from the micro data analysis is that more than 5% of the management staff consists of people that stay only less than a year in the same unit. Many small units do not have any management employees at all and do not exist over the total observation period. We therefore tried another team definition where only employees are seen as members of the management team that stay at least one year in the unit in question.

We define additional constellations of the management team.

- *Only those „basic“ staff members that earn a higher income per day than the average daily income (High wage staff)*
- *Only those „basic“ staff members that work for more than one year in an establishment (High tenure staff)*

Assuming, that employees with higher income contribute more to the team value we also investigated whether the results change if the team is defined either by employment or by income shares.

Figure 5: Density distribution of annual wage rates



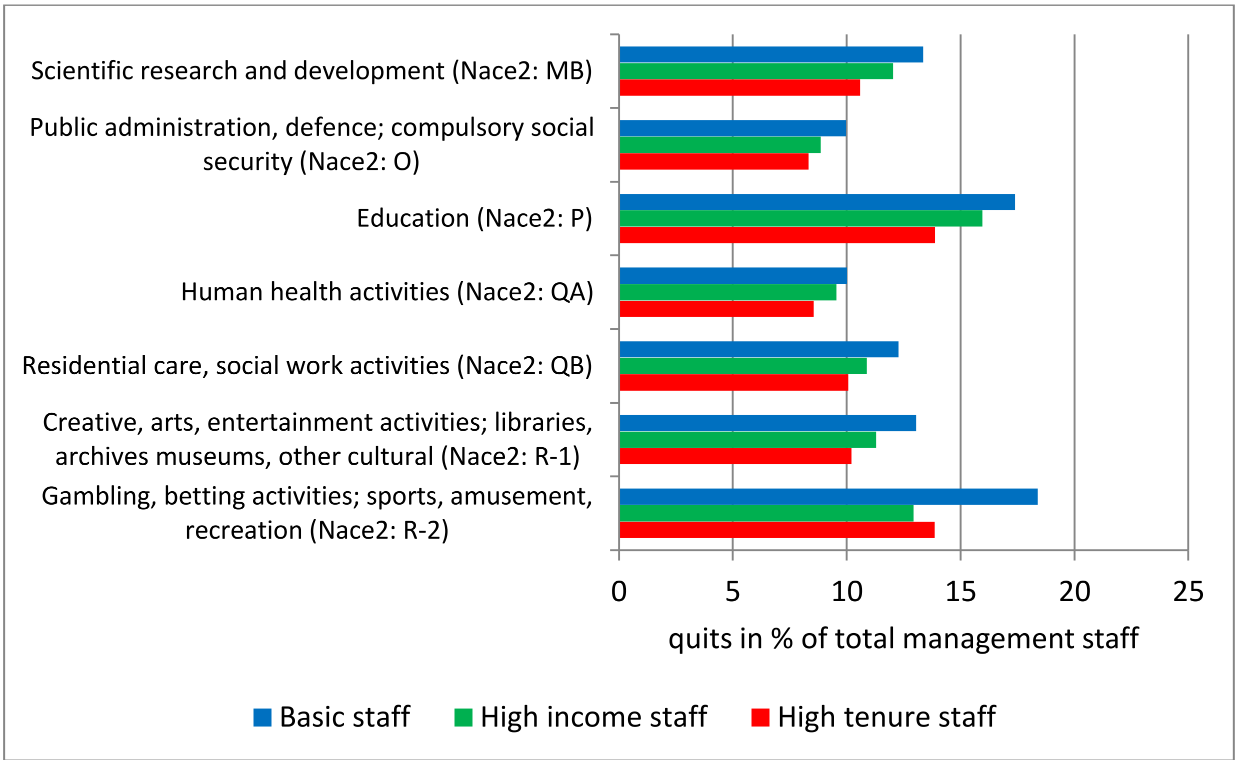
The impact from these revised definitions on the average quit rate is rather small. Defining the management staff to consist only by those employees who have an above average wage rate will reduce the quit rate from 13% to 12%. The same happens if the employees are weighted with their income. Including in the management team only those employees, who have stayed more than a year in the team results in a stronger reduction of the quit ratio (10%) in the average. There are distinct differences in the results if we look at the SPINTAN related industries. Both alternative team definitions result in a strong effect in R-2, an industry where one can expect a higher share of private sector units.

Table 6: Results for alternative team definitions

	Employees	Wage sum
	million	million €
Management staff		
Basic management staff[1]	0.462	17 020
High wage staff[2]	0.297	12 176
High tenure staff[3]	0.426	15 912
Quits		
Basic management staff	0.059	2 008
High wage staff	0.034	1 367
High tenure staff	0.044	1 566
Quit rates		
Basic management staff	0.13	0.12
High wage staff	0.12	0.11
High tenure staff	0.10	0.10

[1] As defined in INNODRIVE (see table 5). - [2] Basic management employees with an income above the average. - [3] Basic management employees who work more than a year in the same unit. - *Sources:* Eukleed, Own calculations.

Figure 6: Quit rates for high tenure and high income staff



Results for the US published by Squicciarini/Le Mouel (2012) are displayed in an industry breakdown according to the US-NAICS classification. This classification is not directly comparable with the Nace 2 classification applied on the German data. According to Eurostat (2010), a rough concordance at the 2-digit level is possible if the *primary links* between these two classifications are considered. In Table 7, results for both countries are displayed side by side for the SPINTAN related industries, considering all *primary links* between these two classifications, except for Nace industry 72, which covers only part of the primary links for US-NAICS industry 54.

Considering the well-known differences in labour market organisation between Germany and the US higher depreciation rates in the US are not a surprise. The higher depreciation rates for Germany in *Education* and *Public administration* can be explained that in SIS an important fraction of civil servants with a principally high tenure is not covered. Apart from this it should be considered that the applied database are different in structure.

Table 7: Comparisons of depreciation rates for SPINTAN related industries

<table>
<tr><th colspan="2" rowspan="2">SPINTAN related industries - Nace 2</th><th colspan="2">Depreciation rates in % of the team value</th><th colspan="2" rowspan="2">US NAICS 2007 - NACE Rev. 2 CORRESPONDENCE TABLE AT TWO-DIGIT LEVEL - primary links only[2]</th></tr>
<tr><th>Ger-many</th><th>US[1]</th></tr>
<tr><td>Scientific research and development</td><td>72</td><td>19</td><td>20</td><td>54</td><td>Professional & technical services</td></tr>
<tr><td>Public administration, defence; compulsory social security</td><td>84</td><td>11</td><td>9</td><td>92</td><td>Public administration</td></tr>
<tr><td>Education</td><td>85</td><td>20</td><td>18</td><td>61</td><td>Educational services</td></tr>
<tr><td>Human health activities</td><td>86</td><td>13</td><td>17-18</td><td>62</td><td>Heath care services, hospitals, and social asistance</td></tr>
<tr><td>Creative, arts, entertainment activities; libraries, archives museums, other cultural, gambling, betting activities; sports, amusement, recreation</td><td>90-93</td><td>24</td><td>25</td><td>71</td><td>Arts, entertainment & recreation</td></tr>
<tr><td colspan="6">[1] Squicciarini/Le Mouel (2012), table 5. - [2] Commission of the European Communities (2010).- Own calculations.</td></tr>
</table>

7. Conclusion

Following ESA, service lives of assets are a prerequisite to determine depreciation. This is independent from the methodology applied to estimate the level of net stocks. The question whether one has to assume different service lives for public intangibles in comparison with the service life assumption of private intangibles lastly is a question of the degree of breakdown by type of asset. If the asset breakdown can be deep enough in a way that the individual types of assets can be considered as a homogeneous goods, then there would be no further need to distinguish between private and public assets.

If we want to transfer the experience collected for tangible assets on intangible assets we have to consider that according to most researchers many types of intangible assets are much more firm specific than tangible assets are assumed to be. From this, we would expect an even bigger variation of the service lives for intangible assets. One of the reasons for this is that product prices develop differently across firms, such that even with the same cost prices a given type of asset will have diverging service lives. Therefore, the assumed service lives for intangible assets in Corrado et al. (2015) can only be understood as a mean value of the factual values. The case study for organisational capital also lets hypothise that depreciation rates might be lower than assumed in this study.

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