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Estimated Capital Stock Values for German Manufacturing Enterprises Covered by the Cost Structure Surveys

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1. Motivation

Firm level data from official statistics in Germany are an important basis for empirical investigations of firm behaviour and performance. As a rule, participation in the surveys is mandated, and the survey is either a census or it covers a representative sample of the respective population of firms. The research potential of the data is enhanced by combining data from different cross sections to build panel data that allow to investigate firm behaviour over time and to control for time-invariant unobserved firm characteristics (see Wagner, 2000 and Konold, 2007 for manufacturing firms, Vogel, 2009 for services firms, and Vogel / Dittrich, 2008 for firms from nearly all sectors). The information content can be enhanced further by merging data from different regular surveys (see Malchin / Voshage, 2009) and by combining these panel data with firm-level information from special-purpose surveys performed by the statistical offices or from commercial data bases (see Wagner, 2010a).

As of today, these rich firm-level panel data, however, lack information on various characteristics of firms that are relevant for the empirical analysis of a large number of topics. A case in point is the capital stock employed in a firm.[1] Information on this important input is missing from the firm-level data sets based on surveys from official statistics, and the same holds for other firm-level data sets like the establishment panel of the Institute for Employment Research of the Federal Employment Agency (described in Kölling, 2000 and Fischer et al., 2009) and the Hannover Firm Panel (see Gerlach / Hübler / Meyer, 2003).

Capital stock data are needed, among others, to compute profit rates, to construct indices of total factor productivity, or to control for differences in the use of capital between firms in empirical investigations of firm performance.

[1] Another important characteristic of a firm for which no information is available in the data sets is the quality and the strategy of the management; see Bloom / Van Reenen (2010) for evidence on the importance for firm performance.

If direct information on the capital stock employed in a firm is missing investigators often construct a proxy variable for it based on information on investment that is available in many data sets, including those from official statistics in Germany. Here, either a proportionality assumption is applied (and investment is taken as proportional to the unknown capital stock) or information about investment in the past is used to estimate the capital stock today by adding up past investments and assuming a depreciation rate (the so-called perpetual inventory approach).[2]

A crucial problem with these approximation methods lies in the fact that investment at the firm level tends to be highly volatile.[3] Often very high values in some year and very low values in some other year are reported, and this leads to rather different values for the capital stock proxy variable depending on the year(s) used. A different approach that is not affected by the volatility of the investment behaviour over time is to use information on the amount of depreciation at the enterprises level, information on the average life span of capital goods (for equipments, and for buildings), and information on the composition of the capital stock at the level of two-digit industries. Section 2 describes the method applied and reports the data used to estimate the capital stock at the enterprise level for the years 1995 to 2008.

2. Estimation Approach and Results

The basic idea for the approximation of capital stock values at the firm level applied in this paper is to combine information at the level of the economy as a whole, at the level of the two-digit industry, and at the firm level. In step 1 the information on the composition of each industry's capital stock into buildings and equipments[4] and data on the average economic lives of buildings and equipments[5] for the economy as a whole is used. The harmonic mean of the economic lives of buildings and equipment gives the average economic lives of the capital stock at the industry level (identical to the reci-

[2] An example for the use of capital stock estimates based on the perpetual inventory method applied to investment data from official statistics in Germany is Bernard / Wagner (1997). See Mueller (2008) for a discussion of this method when the panel at hand is short and for a proposed solution for the IAB Establishment Panel (the establishment panel of the Institute for Employment Research of the Federal Employment Agency mentioned above).

[3] For empirical evidence for German manufacturing establishments see Wagner (2005).

[4] Data are published by the Federal Statistical Office in Fachserie 18, Reihe 1.4.

[5] Information was supplied by the Federal Statistical Office, Group III C 3, per e-mail on April 15, 2010. The following values were used: For buildings I used the value for "other buildings not to live in" (*Sonstige Nichtwohnbauten*) – 59 years for 1995 to 1999, and 58 years for 2000 to 2008. For equipments I used the value 13 years for 1995 to 1999 and 12 years for 2000 to 2008.

procal of the average linear depreciation rate in an industry; see Mueller, 2008, 360):

$$AEL_i = \frac{\mathrm{K}total_i}{(\mathrm{K}buildings_i/\mathrm{L}buildings) + (\mathrm{K}equipments_i/\mathrm{L}equipments)}$$

with K*total*$_i$ for the value of the capital stock in industry *i*, K*buildings*$_i$ for the values of the capital stock made of buildings in industry *i*, K*equipments*$_i$ for the value of the capital stock made of equipments in industry *i*, L*buildings* and L*equipments* for average economic life of buildings and equipments, respectively, in the economy as a whole (in years), and AEL_i for average economic life of the capital stock in industry i (in years).

Results are reported in table 1 for the years 1995 to 2008 and for two-digit industries from manufacturing. The average economic life of the capital stock varies over the industries and over time due to differences in the composition of the capital stock into buildings and equipments between industries and between the years covered.

In step 2 the value for the average economic life of the capital stock in industry *i* in year *t* is multiplied by the amount of depreciation that is reported by the enterprise *j* for year *t* to compute an estimated value of the capital stock employed in enterprise *j* in year *t*.[6]

Information on the amount of depreciation is taken from the cost structure survey in German enterprises in manufacturing industries that is performed regularly by official statistics (see Fritsch et al., 2004). Note that this survey is not a census of all enterprises in manufacturing industries. While all large enterprises with at least 500 employees are surveyed each year, for smaller enterprises a representative sample is surveyed and the sample is replaced after four years. Enterprise level data from the cost structure survey are confidential but can be accessed by researchers in the research data centres of the statistical offices (see Zühlke et al., 2004 for details).

This approach assumes that the industry average of duration of economic life of the capital stock is a valid approximation for each firm in an industry. Given that firms are heterogeneous and that the composition of the capital stock varies between firms this is a strong assumption indeed. At least, however, the estimated capital stock values using this assumption might be considered as a useful proxy variable that is more reliable than a proxy variable based on the highly volatile investment figures.

[6] Stata code to perform these calculations is included in the appendix of the working paper version of this paper; see Wagner (2010b).

Table 1: **Average duration of economic life (in years) of the capital stock in manufacturing industries in Germany**

Industry	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
15	21.62	19.49	19.36	19.18	19.09	17.69	17.59	17.51	17.51	17.59	17.57	17.72	17.96	18.21
16	16.38	16.47	16.41	16.47	16.48	15.42	15.36	15.40	15.45	15.52	15.49	15.52	15.64	15.75
17	21.08	21.29	21.44	21.54	21.56	20.27	20.35	20.38	20.57	20.89	21.03	21.23	21.77	22.16
18	26.32	26.33	26.50	26.70	26.72	25.29	25.35	25.44	25.63	26.05	26.17	26.26	26.55	26.82
19	29.35	29.59	29.87	30.11	30.24	28.66	28.67	28.54	28.43	28.45	28.74	29.09	29.42	29.95
20	21.63	21.56	21.40	21.42	21.47	19.94	19.86	19.72	19.83	20.10	20.07	20.11	20.33	20.25
21	18.01	17.95	17.91	17.80	17.76	16.40	16.33	16.27	16.28	16.33	16.27	16.31	16.49	16.71
22	16.54	16.60	16.56	16.50	16.50	15.29	15.26	15.17	15.18	15.29	15.66	15.74	15.85	15.93
23	17.35	16.92	16.72	16.50	16.51	15.32	15.25	15.24	15.28	15.46	15.51	15.53	15.58	15.48
24	17.70	17.53	17.39	17.24	17.10	15.72	15.59	15.50	15.51	15.61	15.57	15.65	15.78	15.95
25	16.92	16.90	16.87	16.80	16.81	15.59	15.57	15.59	15.66	15.73	15.72	15.86	15.94	16.09
26	18.60	18.44	18.31	18.13	18.06	16.71	16.65	16.59	16.65	16.83	16.95	17.08	17.40	17.69
27	16.66	16.61	16.52	16.43	16.32	15.05	14.96	14.88	14.87	14.96	14.92	14.81	14.85	14.95
28	19.28	19.18	19.03	18.84	18.64	17.14	16.94	16.84	16.82	16.88	16.80	16.86	16.93	17.07
29	19.04	18.97	18.89	18.78	18.65	17.24	17.15	17.09	17.16	17.33	17.28	17.40	17.56	17.71
30	17.83	18.05	18.30	18.53	18.72	17.64	17.94	18.13	18.46	19.04	19.59	20.18	20.98	21.76
31	17.57	17.53	17.46	17.33	17.27	15.99	15.88	15.83	15.88	15.99	15.79	16.02	16.25	16.43
32	16.47	16.43	16.29	16.18	16.08	14.84	14.70	14.65	14.69	14.74	14.88	14.88	15.00	15.11
33	19.57	19.45	19.36	19.22	19.13	17.74	17.56	17.47	17.58	17.67	17.74	17.80	18.02	18.18
34	17.06	17.05	16.95	16.80	16.72	15.44	15.34	15.22	15.15	15.14	15.01	15.00	15.05	15.11
35	22.59	22.53	22.40	22.12	22.02	20.52	20.24	19.76	19.67	19.78	19.76	19.65	19.98	20.34
36	22.87	22.89	22.75	22.51	22.43	20.93	20.86	20.80	20.95	21.21	21.44	21.66	22.16	22.60

Note: For a description of the industries see Statistisches Bundesamt (2003), for the method applied see text.

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