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Methodological aspects of labour market data

Capital stock approximation with the perpetual inventory method: An update

Steffen Mueller

Bundesagentur für Arbeit

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Steffen Mueller (Halle Institute for Economic Research - IWH)

Die FDZ-Methodenreporte befassen sich mit den methodischen Aspekten der Daten des FDZ und helfen somit Nutzerinnen und Nutzern bei der Analyse der Daten. Nutzerinnen und Nutzer können hierzu in dieser Reihe zitationsfähig publizieren und stellen sich der öffentlichen Diskussion.

FDZ-Methodenreporte (FDZ method reports) deal with methodical aspects of FDZ data and help users in the analysis of these data. In addition, users can publish their results in a citable manner and present them for public discussion.

Contents

Abstract

Changes in the industry classification cause problems for computing establishment level capital stock time series based on the perpetual inventory approach. This report updates FDZ-Methodenreport 02/2010 by describing a new data set containing time-consistent series of economic lives of capital goods for the years up to 2014 that can be used to create establishment level capital stock time series with the IAB Establishment Panel and the LIAB.

Zusammenfassung

Aktualisierungen von Industrieklassifikationen führen zu Problemen bei der Berechnung von zeitkonsistenten Angaben zum Kapitalstock für Betriebe mit der sog. Perpetual Inventory Methode. Dieser FDZ Methodenreport aktualisiert FDZ Methodenreport Nr. 02/2010 indem ein auf zeitkonsistenten Angaben zu Industrien beruhender neuer Datensatz mit Nutzungsdauern von Kapitalgütern bis ins Jahr 2014 angeboten wird. Anhand dieser Daten kann der Kapitalstock von Betrieben im IAB Betriebspanel und im LIAB berechnet werden.

Keywords: Capital stock, perpetual inventory method, time consistent industry classification.

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1 Background

This report updates FDZ-Methodenreport 02/2010. The key innovation of this update is the provision of a time-consistent series of economic lives of capital goods at the two digit industry level that is compatible with the time-consistent industry classification described in Eberle et al. (2011), the latter being available to RDC users of the IAB Establishment Panel and the LIAB since January 2017. The update enables researchers to run the modified perpetual inventory approach of Mueller (2008) on a time-consistent series of industry classifications and economic lives for almost the entire time span up to date covered by the IAB Establishment Panel and the LIAB, i.e. 1993-2014[1].

The modified perpetual inventory provides establishment specific capital stock time series that build upon industry specific average economic lives of capital goods (the reciprocal of the depreciation rate). The update became necessary because industry classifications changed over time (starting from WZ1993, then WZ2003, and finally WZ2008)[2] and this affects both the computation of average economic lives from official statistics (as explained in the next section) and the assignment of average economic lives to particular establishments in the IAB data. The latter is problematic as a new industry classification induces a break in establishment-specific time series of average economic lives, which may lead to measurement error and biased estimation results in particular when estimators are used that put much weight on within-establishment variation over time, e.g. fixed effects estimators or GMM-style panel estimators.

There are no methodological changes to the modified perpetual inventory approach outlined in Mueller (2008). Users aiming at constructing capital stock measures are recommended to make themselves familiar with Mueller (2008; 2010). This update will neither go into details regarding how to use the modified perpetual inventory approach nor will the Stata code provided in Mueller (2010) be replicated once again.

2 Average economic lives for WZ2008 2-digit classification

Average economic lives of capital goods are a core ingredient of the perpetual inventory approach as they are used to compute both the starting value for the establishment level capital stock time series and yearly depreciations. The (linear) depreciation rate is simply the inverse of the economic life of capital goods and computation of the establishment level starting value requires multiplying an average over investment vintages with the average economic lives of capital goods. Ideally, average economic lives would be available at the establishment level. However, as the IAB data contains no information on capital goods at establishment level, average economic lives have to be computed at the 2-digit industry level from German Federal Statistical Office data.

[1] As I will discuss later, extrapolating the time series for economic lives beyond 2014 will in many case be unproblematic.

[2] WZ1993 is comparable to NACE Rev. 1 (used from 1993 to 2002), WZ2003 is comparable to NACE Rev. 1.1 (2003 to 2007), and WZ2008 is comparable to NACE Rev. 2 (since 2008).

The industry specific average economic life of capital goods is computed as follows

$$ND = \frac{K_{total}}{\left(\frac{K_{structure}}{ND_{structure}}\right) + \left(\frac{K_{equipment}}{ND_{equipment}}\right)}$$

where K denotes capital stock and ND is the average economic life. This approach uses capital stock and average economic lives separately for structures (buildings) and equipment. For more details see Mueller (2008) or Mueller (2010).

The average economic lives of structures and equipment are provided by the German Federal Statistical Office[3]. However, due to changes in the industry classifications over time, a long-running time series of industry level capital stock for structures and equipment is not readily available. Fortunately, the Statistical Office calculates time-consistent 2-digit industry classifications using the current WZ2008 industry classification scheme and provides time-consistent capital stock series for structures and equipment using this consistent classification. With this at hand we apply the above mentioned formula and arrive at a dataset with yearly average economic lives on WZ2008 2-digit level for the period 1991 – 2014[4]. The latter dataset we made available to the IAB RDC users to enable them computing the capital stock with IAB establishment panel data or LIAB data using the code outlined in Mueller (2010)[5].

3 How to use this update

The dataset with yearly average economic lives contains industry classification (w08_2), year (year), and average economic lives (ND) and can be merged to the IAB establishment panel or the LIAB cross-sectional model via Stata by using the standard `merge m:1 w08_2 year` command. Please note that the variable w08_2 is not included per default in the IAB Establishment Panel and the LIAB data. It has to be computed by the user from time consistent WZ2008 industry data (w08_3_gen), which is only available upon a reasoned request in the application for data access.[6]

At the moment, economic lives are provided up to 2014. Table 1 makes clear that the standard deviation in the industry specific time series for economic lives is very small, which means that

[3] Schmalwasser and Weber (2012).

[4] Note that for making the classification time-consistent, the Statistical Office in some cases had to group WZ2008 2-digit industries at a higher level (for example the divisions: 10 “Manufacture of food products”, 11 “Manufacture of beverages” and 12 “Manufacture of tobacco products” are summarized in one division as “Manufacture of food products, beverages and tobacco products”). For these sectors we calculate the economic lives on the aggregated level and assign them to every sub-industry within that aggregate (see Table 1 for some examples).

[5] It is also possible to work with the aggregated 43 industries according to the IAB establishment panel questionnaire. The correspondence tables between WZ2008 and these 43 industries are provided in the appendix of this report. To come up with one unique economic life per aggregated industry, economic lives provided in this report have to be weighted.

[6] Further information on the application process to obtain time consistent industry classifications are provided separately for the IAB Establishment Panel and the LIAB on the FDZ web site: http://fdz.iab.de/.

economic lives change only slowly over time. Depending on the question at hand, the researcher may therefore decide to extrapolate economic lives into the future. E.g. for the OLS estimation of a standard Cobb Douglas production function based on a reasonable large sample, my experience is that extrapolating economic lives for, say two years, is not affecting the results to any economically meaningful extent.

References

Eberle, Johanna; Jacobebbinghaus, Peter; Ludsteck, Johannes; Witter, Julia: Generation of time-consistent industry codes in the face of classification changes * Simple heuristic based on the Establishment History Panel (BHP). FDZ-Methodenreport, 05/2011. 2011, Nürnberg.

Müller, Steffen: Capital Stock Approximation using Firm Level Panel Data: A Modified Perpetual Inventory Approach, in: Jahrbücher für Nationalökonomie und Statistik, Vol. 228 (4), 2008, S. 357-371.

Müller, Steffen: Capital stock approximation with the perpetual inventory method * stata code for the IAB establishment panel. FDZ-Methodenreport, 02/2010. 2010, Nürnberg.

Schmalwasser, Oda; Weber, Nadine: Revision der Anlagevermögensrechnung für den Zeitraum 1991 bis 2011, Statistisches Bundesamt, Wirtschaft und Statistik, 2012, S.933-946.

Appendix

Download of the Stata do-files
• http://doku.iab.de/fdz/reporte/2017/MR_05-17_EN_data.zip

Table 1: Summary of average economic lives over WZ2008 2-digit divisions (1991 - 2014)

wz08_2	Description	mean	standard deviation
1	Crop and animal production, hunting and related service activities	28.86	0.69
2	Forestry and logging	43.47	0.28
3	Fishing and aquaculture	33.11	1.20
5	Mining of coal and lignite	18.97	0.38
6	Extraction of crude petroleum and natural gas	18.97	0.38
7	Mining of metal ores	18.97	0.38
8	Other mining and quarrying	18.97	0.38
9	Mining support service activities	18.97	0.38
10	Manufacture of food products	20.12	0.51
11	Manufacture of beverages	20.12	0.51
12	Manufacture of tobacco products	20.12	0.51
13	Manufacture of textiles	24.13	0.41
14	Manufacture of wearing apparel	24.13	0.41
15	Manufacture of leather and related products	24.13	0.41
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	21.55	0.45
17	Manufacture of paper and paper products	18.91	0.32
18	Printing and reproduction of recorded media	18.17	0.11
19	Manufacture of coke and refined petroleum products	18.17	0.42
20	Manufacture of chemicals and chemical products	17.19	0.41
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	16.17	0.28
22	Manufacture of rubber and plastic products	17.78	0.26
23	Manufacture of other non-metallic mineral products	19.03	0.18
24	Manufacture of basic metals	17.89	0.09
25	Manufacture of fabricated metal products, except machinery and equipment	18.90	0.55
26	Manufacture of computer, electronic and optical products	16.51	0.15
27	Manufacture of electrical equipment	17.91	0.18
28	Manufacture of machinery and equipment n.e.c.	17.97	0.39
29	Manufacture of motor vehicles, trailers and semi-trailers	16.77	0.48
30	Manufacture of other transport equipment	17.67	0.53
31	Manufacture of furniture	21.41	0.76
32	Other manufacturing	21.41	0.76
33	Repair and installation of machinery and equipment	17.73	0.34
35	Electricity, gas, steam and air conditioning supply	28.18	1.36
36	Water collection, treatment and supply	37.10	1.56
37	Sewerage	46.53	1.35
38	Waste collection, treatment and disposal activities; materials recovery	46.53	1.35
39	Remediation activities and other waste management services	46.53	1.35
41	Construction of buildings	20.36	1.15
42	Civil engineering	20.36	1.15
43	Specialised construction activities	20.36	1.15
45	Wholesale and retail trade and repair of motor vehicles and motorcycles	26.58	0.37
46	Wholesale trade, except of motor vehicles and motorcycles	25.06	1.03
47	Retail trade, except of motor vehicles and motorcycles	24.67	1.63
49	Land transport and transport via pipelines	26.34	3.93
50	Water transport	15.62	0.16
51	Air transport	16.04	0.19
52	Warehousing and support activities for transportation	38.24	2.02
53	Postal and courier activities	27.80	2.01
55	Accommodation	28.61	1.74
56	Food and beverage service activities	28.61	1.74

wz08_2	Description	mean	standard deviation
58	Publishing activities	19.48	0.29
59	Motion picture, video and television programme production, sound recording and music publishing activities	17.68	0.29
60	Programming and broadcasting activities	17.68	0.29
61	Telecommunications	26.98	1.17
62	Computer programming, consultancy and related activities	16.75	0.16
63	Information service activities	16.75	0.16
64	Financial service activities, except insurance and pension funding	35.88	3.68
65	Insurance, reinsurance and pension funding, except compulsory social security	44.05	1.45
66	Activities auxiliary to financial services and insurance activities	15.00	0.00
68	Real estate activities	52.65	0.03
69	Legal and accounting activities	24.38	2.06
70	Activities of head offices; management consultancy activities	24.38	2.06
71	Architectural and engineering activities; technical testing and analysis	18.34	0.95
72	Scientific research and development	18.10	0.46
73	Advertising and market research	15.81	0.38
74	Other professional, scientific and technical activities	19.47	1.46
75	Veterinary activities	19.47	1.46
77	Rental and leasing activities	15.89	0.06
78	Employment activities	17.17	0.59
79	Travel agency, tour operator and other reservation service and related activities	20.38	0.42
80	Security and investigation activities	20.76	1.74
81	Services to buildings and landscape activities	20.76	1.74
82	Office administrative, office support and other business support activities	20.76	1.74
84	Public administration and defense; compulsory social security	40.22	1.35
85	Education	36.87	0.22
86	Human health activities	32.61	0.39
87	Residential care activities	33.91	0.60
88	Social work activities without accommodation	33.91	0.60
90	Creative, arts and entertainment activities	36.21	0.89
91	Libraries, archives, museums and other cultural activities	36.21	0.89
92	Gambling and betting activities	36.21	0.89
93	Sports activities and amusement and recreation activities	45.66	1.15
94	Activities of membership organisations	38.22	0.64
95	Repair of computers and personal and household goods	18.93	0.65
96	Other personal service activities	23.18	0.48

Notes: Computation of economic lives based on Statistisches Bundesamt, Fachserie 18, Reihe 1.4, 2015

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Corresponding author:
Professor Dr. Steffen Müller
Leibniz-Institut für Wirtschaftsforschung
Halle (IWH)
Kleine Märkerstraße 8
D-06108 Halle (Saale)
Phone: +49 345 7753-708
Email: Steffen.Mueller@iwh-halle.de