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Capital Stock Approximation with the Perpetual Inventory Method

Stata Code for the IAB Establishment Panel

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Abstract

The IAB Establishment Panel contains no direct information on establishments' capital stock. This report presents some advice in implementing a capital stock approximation by the perpetual inventory method as proposed by Müller (2008). STATA code is provided in the appendix.

Zusammenfassung

Das IAB Betriebspanel enthält keine direkten Informationen über den Kapitalstock der befragten Betriebe. Dieser Methodenreport beschreibt die Möglichkeit der Approximation des Kapitalstocks anhand der Methode der permanenten Inventur (perpetual inventory method), wie sie in Müller (2008) vorgeschlagen wird. Der Anhang enthält entsprechenden STATA Code.

Keywords: Capital stock, perpetual inventory method.

1 Introduction

The IAB Establishment Panel contains no direct information on establishments' capital stock. As the IAB Establishment Panel is the employer side of the Linked Employer Employee data set (LIAB) of the IAB, information on the establishments' capital stock is missing in the LIAB as well. This report presents some advice in implementing the capital stock approximation procedure proposed by Steffen Mueller (2008), and it provides STATA code.

The procedure applies the perpetual inventory method to a short panel. It requires estimating a starting value from replacement investments to start the perpetual inventory method. The estimation of the starting value further requires information on the average economic lives of capital goods. This information is taken from the national accounts or internal calculations of the federal statistical office, respectively. The choice with respect to the number of years of support for the starting value depends on the specific analysis the capital stock is needed for. Two versions for the capital stock are proposed. The relative virtues of both are discussed at the end of this text.

The considerable amount of missing values in the investment variable forces the researcher to impose some assumptions on missing values. Some suggestions are implemented in the code and described in the report.

2 Prerequisites

The STATA code can be used if the IAB establishment data is coded as a panel. The following variables from the IAB Establishment Panel have to be prepared before using the STATA code (variable name):

- total investments (inv)
- share of net investments in total investments (inv_dK)
- Dummy variables for the following categories:
    - no investments (INo)
    - investments in real estate or buildings (IPlant)
    - investments in IT and communication equipments (IIT)
    - investments in production machinery or other equipments (IProd)
    - investments in transport equipment (ITransp)
- time indicator (year)
- industry (note that the industry classification changed from wz73 to wz93 classification in the year 2000) (sectornew)

In the IAB Establishment Panel, investments are asked retrospectively – i.e. investments are asked for the previous year. In the STATA code, it is assumed that this information has been moved into the previous year by the researcher.

3 Programming steps

a. Ascribing economic lives

The STATA code starts with attributing average economic lives from the national accounts to each industry (for more details see the paper). Then, average economic lives are ascribed to the four types of new capital goods embodied in net investments (buildings, ICT, production machinery, transport equipment). In the next step, economic lives of new capital goods are averaged for firms that undertook net investments in several types of capital goods.

b. Computing the starting value

The starting value can be computed in different ways. I propose two approaches using either the average replacement investments over the whole sample period or the first three years for each firm. But first off all, it is important to stress that there are severe problems with missing data. In the code, I propose how to deal with this problem and marked each assumption that I made. The first refers to missing values in the "share of net investments in total investments". I decided to impute missing values with the within firm average.

The first version of the capital stock is computed from a starting value that is the arithmetic mean of the product of replacements and the average economic lives (*ND*) over *all* vintages (*SMAT*). As a result, a capital stock version named *KT* is computable. This version is appropriate if the capital stock is used in analyses that rely mainly on between firm information (e.g., OLS estimators) or if within firm information on investments is expected to be very noisy (e.g., if the analysis is based on small firms).

The second version computes a starting value that is based on the average replacements (times *ND*) of the first three years an establishment is in the sample (*SMA3*). As the starting value determines the level of the capital stock, it is important to be precise in computing it. *SMA3* is the average of replacements after correcting for replacements that may be necessary for the net investments of the current year.[1] The resulting capital stock version *K3* may be appropriate if within estimators are used in the analysis. The optimal choice between the two versions is discussed at the end of this report and in more detail in the paper.

c. Perpetual Inventory

Once the starting value SMAT is created, it can be renamed as KT for the first year – i.e. the capital stock for the first year is equal to the starting value SMAT. In order to perform perpetual inventory, the depreciation DEPT has to be approximated. Assuming linear depreciation rates, this is $SMAT_{t-1}$ / ND_{t-1}.

[1] If one assumes that there are no depreciations on the net investments of the current year, this correction is not necessary.

The change in capital stock (dKT) is replacements minus depreciations plus net investments minus depreciation on net investments (for more details see the paper). Hence, $KT_{t+1} = KT_t + dKT_{t+1}$.

A missing value in the investment variable will end perpetual inventory even if there are valid observations in later periods. The researcher may decide to impute *KT* for the year with missing investments in order to continue with perpetual inventory. Several assumptions for imputation are possible, I decided to assume no change in *KT*, i.e. setting *dKT* = 0, and proceed with perpetual inventory. Further, I decided to only impute in the situation where information on investments are available in the subsequent year – i.e. perpetual inventory ends if investments are missing in two subsequent years.

As *SMA3* is the average over the first three years, it would be correct to start perpetual inventory beginning with the second year and to skip the first year. However, as observations are valuable, I start it from the first year by setting the capital stock *K3* = *SMA3* for the first year. Again, depreciations (*DEP3*) and changes in capital stock (*dK3*) are computed and perpetual inventory starts with the second year. The treatment of missing values is analogous to the *KT* version.

Caution: a perpetual inventory method cannot take into account events that change capital stock but cannot be seen in the investment data. For instance, spinning off parts of the plant as a new plant could reduce capital stock of the old plant without being visible as a negative investment. The reverse will be true if plants are incorporated into an existing plant. One way to deal with this is to exclude such firms from the sample.

4 Which version is best?

K3 may outperform *KT* when the capital stock variable follows a trend. Consider, for instance, a positive trend. Here, the *KT* series starts with a value that is too high and, consequently, *DEPT* will be overestimated and *dKT* will be underestimated. An underestimation of changes in *KT* is most problematic if within estimators are used. *K3* avoids this problem by starting, on average, with the correct starting value even if a trend is present. Unfortunately, due to zeros and lumps in the investment series, the variance in the level of *K3* may be large which makes it less appropriate for estimators that also rely on between information. However, the perpetual inventory routine will slowly correct a wrong level of *K3*.

Hence, the choice between the two versions for the capital stock depends crucially on the estimator to be used in the analysis. If OLS is used, *KT* will be almost always better. In case of within estimators, the relative importance of noise in the investment series to the severity of a time trend in the capital stock should guide the choice between *KT* and *K3*.

5 Appendix

5.1 STATA code

By copy and paste you can easily put the following code into a do file.

```
****************************************************************************
* Capital Stock Approximation with the IAB Establishment Panel
* When applying the method please refer to:
* Mueller, Steffen (2008), "Capital Stock Approximation Using Firm Level
* Panel Data", Jahrbücher für Nationalökonomie und Statistik, 228(4)
* The paper may help you in understanding this program.
****************************************************************************

****************************************************************************
* Prerequisites:
* IAB establishment data as a panel data set
* All variables that refer to the previous year (e.g. investments) but are asked
* in the current year have to be moved to the previous year.
* Please make sure that the industry codes for all years of panel participation
* are translated into the wz93 industry codes that are used from year 2000 on.
****************************************************************************

****************************************************************************
* This program follows paper and Section 3 above and is organized as follows:
* 1. import the average economic lives of industry capital stock (ND) from the
*    national accounts
* 2. generate economic lives for net investments with information from the German
*    federal statistical office
* 3. multiply the replacement investment for each firm-year observation with the ND
* 4. create a starting value for perpetual inventory and perform perpetual
*    inventory
* 4.1 Version I for estimators that rely mainly on between-firm information
*     (e.g. OLS)
* 4.2 Version II for estimators that use only within-firm information (e.g. Fixed
*     Effects, First Differences, GMM-Diff, GMM-SYS)
****************************************************************************


****************************************************************************
* 1. import the average economic lives (in years) of industry capital stock (ND)
*    from the national accounts

*variables from the IAB Establishment Panel:
* sectornew is the industry code of the wz93 classification, in the IAB
* Establishment Panel routinely coded from 2000 on
* year is the year of observation, 96 = 1996, 97 = 1997, ..., 107 = 2007

gen ND = .
replace ND = 24.8 if sectornew==1 & year == 96
replace ND = 24.0 if sectornew==2 & year == 96
replace ND = 18.2 if sectornew==3 & year == 96
replace ND = 21.0 if sectornew==4 & year == 96
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replace ND = 24.6 if sectornew==24 & year == 105
replace ND = 24.6 if sectornew==25 & year == 105
replace ND = 34.1 if sectornew==26 & year == 105
replace ND = 46.2 if sectornew==27 & year == 105
replace ND = 13.7 if sectornew==28 & year == 105
replace ND = 25.9 if sectornew==29 & year == 105
replace ND = 20.0 if sectornew==30 & year == 105
replace ND = 65.2 if sectornew==31 & year == 105
replace ND = 12.7 if sectornew==32 & year == 105
replace ND = 29.7 if sectornew==33 & year == 105

replace ND = 26.6 if sectornew==1 & year == 106
replace ND = 26.5 if sectornew==2 & year == 106
replace ND = 17.9 if sectornew==3 & year == 106
replace ND = 23.4 if sectornew==4 & year == 106
replace ND = 16.2 if sectornew==5 & year == 106
replace ND = 20.5 if sectornew==6 & year == 106
replace ND = 15.8 if sectornew==7 & year == 106
replace ND = 16.0 if sectornew==8 & year == 106
replace ND = 17.3 if sectornew==9 & year == 106
replace ND = 14.9 if sectornew==10 & year == 106
replace ND = 18.6 if sectornew==11 & year == 106
```

```
replace ND = 17.1 if sectornew==12 & year == 106
replace ND = 17.6 if sectornew==13 & year == 106
replace ND = 15.1 if sectornew==14 & year == 106
replace ND = 20.0 if sectornew==15 & year == 106
replace ND = 16.2 if sectornew==16 & year == 106
replace ND = 18.1 if sectornew==17 & year == 106
replace ND = 22.2 if sectornew==18 & year == 106
replace ND = 20.4 if sectornew==19 & year == 106
replace ND = 20.4 if sectornew==20 & year == 106
replace ND = 24.6 if sectornew==21 & year == 106
replace ND = 22.9 if sectornew==22 & year == 106
replace ND = 22.4 if sectornew==23 & year == 106
replace ND = 24.7 if sectornew==24 & year == 106
replace ND = 25.7 if sectornew==25 & year == 106
replace ND = 34.8 if sectornew==26 & year == 106
replace ND = 46.8 if sectornew==27 & year == 106
replace ND = 13.7 if sectornew==28 & year == 106
replace ND = 26.0 if sectornew==29 & year == 106
replace ND = 20.1 if sectornew==30 & year == 106
replace ND = 65.3 if sectornew==31 & year == 106
replace ND = 12.7 if sectornew==32 & year == 106
replace ND = 30.4 if sectornew==33 & year == 106

replace ND = 26.6 if sectornew==1 & year == 107
replace ND = 27.1 if sectornew==2 & year == 107
replace ND = 18.1 if sectornew==3 & year == 107
replace ND = 24.0 if sectornew==4 & year == 107
replace ND = 16.3 if sectornew==5 & year == 107
replace ND = 20.8 if sectornew==6 & year == 107
replace ND = 15.9 if sectornew==7 & year == 107
replace ND = 16.1 if sectornew==8 & year == 107
replace ND = 17.6 if sectornew==9 & year == 107
replace ND = 14.9 if sectornew==10 & year == 107
replace ND = 18.9 if sectornew==11 & year == 107
replace ND = 17.1 if sectornew==12 & year == 107
replace ND = 17.8 if sectornew==13 & year == 107
replace ND = 15.2 if sectornew==14 & year == 107
replace ND = 20.4 if sectornew==15 & year == 107
replace ND = 16.4 if sectornew==16 & year == 107
replace ND = 18.3 if sectornew==17 & year == 107
replace ND = 22.7 if sectornew==18 & year == 107
replace ND = 20.9 if sectornew==19 & year == 107
replace ND = 20.9 if sectornew==20 & year == 107
replace ND = 25.0 if sectornew==21 & year == 107
replace ND = 23.2 if sectornew==22 & year == 107
replace ND = 22.8 if sectornew==23 & year == 107
replace ND = 24.8 if sectornew==24 & year == 107
replace ND = 25.8 if sectornew==25 & year == 107
replace ND = 36.3 if sectornew==26 & year == 107
replace ND = 47.1 if sectornew==27 & year == 107
replace ND = 13.7 if sectornew==28 & year == 107
replace ND = 26.3 if sectornew==29 & year == 107
replace ND = 20.6 if sectornew==30 & year == 107
replace ND = 65.3 if sectornew==31 & year == 107
replace ND = 12.7 if sectornew==32 & year == 107
replace ND = 31.7 if sectornew==33 & year == 107


****************************************************************************
* 2. generate economic lives for net investments

*variables from the IAB Establishment Panel:
* inv = total investment
* IPlant = Dummy = 1 if investments in real estate or buildings
* IIT = Dummy = 1 if investments in IT or communication equipments
* IProd = Dummy = 1 if investments in production machinery or other equipments
```

```
* ITransp = Dummy = 1 if investments in transport equipment


*for every year the same average life of a certain new capital good is inserted
*(numbers taken from internal computations of the federal statistical bureau)
*Dummy Value is replaced with average economic life if the Dummy was == 1 before

replace IPlant = 66 if IPlant==1
replace IPlant = 0 if IPlant==.
replace IIT = 7 if IIT==1
replace IIT = 0 if IIT==.
replace IProd = 15 if IProd==1
replace IProd = 0 if IProd==.
replace ITransp = 12 if ITransp==1
replace ITransp = 0 if ITransp==.


*generate variable ND__InvNet containing the avarage life of net investments
* Note: Each Combination of IPlant+IIT+IProd+ITransp gives an unique identification
* of which type of net investment actually took place

**Example:
* IPlant+IIT+IProd+ITransp==19 means that there were investments in IIT and ITransp
* and no investments in IPlant and IProd the mean of econ. lives of IIT and ITransp
* == (7+12)/2 = 9.5

gen ND__InvNet = ND
replace ND__InvNet = 7    if IPlant+IIT+IProd+ITransp==7
replace ND__InvNet = 12   if IPlant+IIT+IProd+ITransp==12
replace ND__InvNet = 15   if IPlant+IIT+IProd+ITransp==15
replace ND__InvNet = 66   if IPlant+IIT+IProd+ITransp==66
replace ND__InvNet = 9.5  if IPlant+IIT+IProd+ITransp==19
replace ND__InvNet = 11   if IPlant+IIT+IProd+ITransp==22
replace ND__InvNet = 13.5 if IPlant+IIT+IProd+ITransp==27
replace ND__InvNet = 11.3 if IPlant+IIT+IProd+ITransp==34
replace ND__InvNet = 36.5 if IPlant+IIT+IProd+ITransp==73
replace ND__InvNet = 39   if IPlant+IIT+IProd+ITransp==78
replace ND__InvNet = 40.5 if IPlant+IIT+IProd+ITransp==81
replace ND__InvNet = 28.3 if IPlant+IIT+IProd+ITransp==85
replace ND__InvNet = 29.3 if IPlant+IIT+IProd+ITransp==88
replace ND__InvNet = 31   if IPlant+IIT+IProd+ITransp==93
replace ND__InvNet = 25   if IPlant+IIT+IProd+ITransp==100

*recode the Dummies as ND__Invnet now is created
replace IIT = 1 if IIT == 7
replace IPlant = 1 if IPlant==66
replace IProd = 1 if IProd==15
replace ITransp = 1 if ITransp==12



****************************************************************************
* 3. multiply the replacement investment for each firm-year observation with the ND

*variables from the IAB Establishment Panel:
      *inv_dK = percentage of net investments in total investment (0 - 100)


*First assumption on missing values:

****there are numerous missing values in the variable inv_dK
****the Researcher may decide to make assumptions about the missing data and impute
****plausible values
****one possibility is the following:
****impute missing information on the share of net investments with the firm-
****specific average if investments are known:
```

```
sort idnum year
by idnum: egen meaninv_dK = mean(inv_dK)
replace inv_dK = meaninv_dK if inv_dK == . & inv !=.

*End assumption on missing values in inv_dK


* generate level of net investments
gen InvNe = inv*(inv_dK/100)

* generate level of net replacements
gen InvRe = inv*(100-inv_dK)/100



******************************************************************************
* 4.1 Version I for estimators that rely mainly on between-firm information
*     (e.g. OLS)

*4.1.1
**multiply replacements with economic lives for each year
gen K = InvRe*ND


*4.1.2
**generate the within firm average over that value to obtain the starting
* value (SMA) based on T years
sort idnum year
by idnum: egen SMAT = mean(K)
drop K


*4.1.3
*KT is the capital stock for Version I
**the capital stock for the first observation for each firm is set equal to SMAT
gen KT = .
sort idnum year
replace KT = SMAT if idnum[_n-1] != idnum


**start perpetual inventory from KT
*i. compute expected depreciation for the first year that the respective firm is
*   in the data
sort idnum year
gen DEPT = .
replace DEPT = KT[_n-1]/ND[_n-1] if idnum[_n-1] == idnum


*ii. compute expected change in capital stock, given total investments and
*    depreciation on last years capital and on half of this years net investments
gen dKT = .
replace dKT = (InvRe-DEPT)+InvNe-(0.5*(InvNe/ND__InvNet))
sort idnum year
replace KT = KT[_n-1] + dKT if idnum[_n-1] == idnum


*iii. the routine has to be repeated iteratively because for each year first
*     depreciation and the capital stock has to be computed
replace DEPT = KT[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEPT==.
       //works only if KT[_n-1] (== second year) and ND[_n-1] exist
replace dKT = (InvRe-DEPT)+InvNe-(0.5*(InvNe/ND__InvNet)) if dKT==.
       //works only if investments are known, and DEPT and ND__InvNet exist
replace KT = KT[_n-1] + dKT if idnum[_n-1] == idnum
       //writes KT into the next line if dKT exists


*Second assumption on Missing Values
```

```
**a missing value in inv will end perpetual inventory even if there are valid
* observations in later periods
**the researcher may decide to impute KT for the year with missing inv in order to
* continue with perpetual inventory
****one possibility is to replace inv==. with inv==0 and continue with perpetual
*   inventory; however, this is a strong assumption
****another possibility is to replace KT with KT[_n-1] and to continue
*****this assumption is more natural because it means to assume no changes in KT,
*    while setting inv==0 means a decrease in KT
******My approach here: replace KT with previous year's KT if KT==. and inv==. and
*     the same firm has valid information on inv in the next year
sort idnum year
replace KT = KT[_n-1] if idnum[_n-1] == idnum[_n+1] & KT==. & inv==. & inv[_n+1]!=.
     // works not: if KT[_n-1] is missing, or if this is the last year of the firm,
     // or if inv is missing in the next year

*End Second assumption on missing values


*** then, perpetual inventory is repeated for each year of panel participation
*** while treating missing values as mentioned above, i.e.:

*** 3rd year of panel participation
sort idnum year
replace DEPT = KT[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEPT==.
replace dKT = (InvRe-DEPT)+InvNe-(0.5*(InvNe/ND__InvNet)) if dKT==.
replace KT = KT[_n-1] + dKT if idnum[_n-1] == idnum & KT==.
replace KT = KT[_n-1] if idnum[_n-1] == idnum[_n+1] & KT==. & inv==. & inv[_n+1]!=.

*** 4th year of panel participation
sort idnum year
replace DEPT = KT[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEPT==.
replace dKT = (InvRe-DEPT)+InvNe-(0.5*(InvNe/ND__InvNet)) if dKT==.
replace KT = KT[_n-1] + dKT if idnum[_n-1] == idnum & KT==.
replace KT = KT[_n-1] if idnum[_n-1] == idnum[_n+1] & KT==. & inv==. & inv[_n+1]!=.

*** 5th year of panel participation
sort idnum year
replace DEPT = KT[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEPT==.
replace dKT = (InvRe-DEPT)+InvNe-(0.5*(InvNe/ND__InvNet)) if dKT==.
replace KT = KT[_n-1] + dKT if idnum[_n-1] == idnum & KT==.
replace KT = KT[_n-1] if idnum[_n-1] == idnum[_n+1] & KT==. & inv==. & inv[_n+1]!=.

*** 6th year of panel participation
sort idnum year
replace DEPT = KT[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEPT==.
replace dKT = (InvRe-DEPT)+InvNe-(0.5*(InvNe/ND__InvNet)) if dKT==.
replace KT = KT[_n-1] + dKT if idnum[_n-1] == idnum & KT==.
replace KT = KT[_n-1] if idnum[_n-1] == idnum[_n+1] & KT==. & inv==. & inv[_n+1]!=.

*** 7th year of panel participation
sort idnum year
replace DEPT = KT[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEPT==.
replace dKT = (InvRe-DEPT)+InvNe-(0.5*(InvNe/ND__InvNet)) if dKT==.
replace KT = KT[_n-1] + dKT if idnum[_n-1] == idnum & KT==.
replace KT = KT[_n-1] if idnum[_n-1] == idnum[_n+1] & KT==. & inv==. & inv[_n+1]!=.

*** 8th year of panel participation
sort idnum year
replace DEPT = KT[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEPT==.
replace dKT = (InvRe-DEPT)+InvNe-(0.5*(InvNe/ND__InvNet)) if dKT==.
replace KT = KT[_n-1] + dKT if idnum[_n-1] == idnum & KT==.
replace KT = KT[_n-1] if idnum[_n-1] == idnum[_n+1] & KT==. & inv==. & inv[_n+1]!=.

*** 9th year of panel participation
sort idnum year
```

```
replace DEPT = KT[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEPT==.
replace dKT = (InvRe-DEPT)+InvNe-(0.5*(InvNe/ND__InvNet)) if dKT==.
replace KT = KT[_n-1] + dKT if idnum[_n-1] == idnum & KT==.
replace KT = KT[_n-1] if idnum[_n-1] == idnum[_n+1] & KT==. & inv==. & inv[_n+1]!=.

*** 10th year of panel participation
sort idnum year
replace DEPT = KT[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEPT==.
replace dKT = (InvRe-DEPT)+InvNe-(0.5*(InvNe/ND__InvNet)) if dKT==.
replace KT = KT[_n-1] + dKT if idnum[_n-1] == idnum & KT==.
replace KT = KT[_n-1] if idnum[_n-1] == idnum[_n+1] & KT==. & inv==. & inv[_n+1]!=.

*** 11th year of panel participation
sort idnum year
replace DEPT = KT[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEPT==.
replace dKT = (InvRe-DEPT)+InvNe-(0.5*(InvNe/ND__InvNet)) if dKT==.
replace KT = KT[_n-1] + dKT if idnum[_n-1] == idnum & KT==.
replace KT = KT[_n-1] if idnum[_n-1] == idnum[_n+1] & KT==. & inv==. & inv[_n+1]!=.


****************************************************************************
* 4.2 Version II for estimators that use only within-firm information
*     (e.g. Fixed Effects, First Differences, GMM-Diff, GMM-SYS)

*takes the arithmetic mean of the replacements of the first three years
*the firm is in the data as a starting value

*4.2.1
**multiply replacements with economic lives for each year
gen K = InvRe*ND

*4.2.2
* generate SMA3 (starting value with 3 years of support) for the second
* observation of that firm
gen SMA3 = .
sort idnum year
replace SMA3 = (1/3)*(K[_n-1] + K + K[_n+1]) ///
               if idnum[_n-2] != idnum & idnum[_n-1] == idnum[_n+1]
drop K

* insert SMA3 into the first year of panel participation  as capital stock
* value and in order to gain one observation for perpetual inventory
gen K3 = .
sort idnum year
replace K3 = SMA3[_n+1] if idnum[_n-1] != idnum & idnum == idnum[_n+1]

*4.2.3
*i. start perpetual inventory, analogue to KT, here compute depreciation
sort idnum year
gen DEP3 = .
replace DEP3 = K3[_n-1]/ND[_n-1] if idnum[_n-1] == idnum


*ii. compute expected change in capital stock, given total investments and
*   depreciation on last years capital and on half of this years net investments
gen dK3 = .
replace dK3 = (InvRe-DEP3)+InvNe-(0.5*(InvNe/ND__InvNet))
replace K3 = K3[_n-1] + dK3 if idnum[_n-1] == idnum


*iii. the routine has to be repeated iteratively because for each year first
*    depreciation and the capital stock has to be computed
sort idnum year
replace DEP3 = K3[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEP3==.      //works
only if K3[_n-1] (== second year) and ND[_n-1] exist
replace dK3 = (InvRe-DEP3)+InvNe-(0.5*(InvNe/ND__InvNet)) if dK3==.
```

```
       //works only if investments are known, and DEP3 and ND__InvNet exist
replace K3 = K3[_n-1] + dK3 if idnum[_n-1] == idnum
       //writes K3 into the next line if dK3 exists


*Second assumption on Missing Values analogue to KT
sort idnum year
replace K3 = K3[_n-1] if idnum[_n-1] == idnum[_n+1] & K3==. & inv==. & inv[_n+1]!=.
      //works not: if K3[_n-1] is missing, or if this is the last year of the
      // firm, or if inv is missing in the next year


*** then, perpetual inventory is repeated for each year of panel participation
*** while treating missing values as mentioned above, i.e.:

*** 3rd year of panel participation
sort idnum year
replace DEP3 = K3[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEP3==.
replace dK3 = (InvRe-DEP3)+InvNe-(0.5*(InvNe/ND__InvNet)) if dK3==.
replace K3 = K3[_n-1] + dK3 if idnum[_n-1] == idnum & K3==.
replace K3 = K3[_n-1] if idnum[_n-1] == idnum[_n+1] & K3==. & inv==. & inv[_n+1]!=.

*** 4th year of panel participation
sort idnum year
replace DEP3 = K3[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEP3==.
replace dK3 = (InvRe-DEP3)+InvNe-(0.5*(InvNe/ND__InvNet)) if dK3==.
replace K3 = K3[_n-1] + dK3 if idnum[_n-1] == idnum & K3==.
replace K3 = K3[_n-1] if idnum[_n-1] == idnum[_n+1] & K3==. & inv==. & inv[_n+1]!=.

*** 5th year of panel participation
sort idnum year
replace DEP3 = K3[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEP3==.
replace dK3 = (InvRe-DEP3)+InvNe-(0.5*(InvNe/ND__InvNet)) if dK3==.
replace K3 = K3[_n-1] + dK3 if idnum[_n-1] == idnum & K3==.
replace K3 = K3[_n-1] if idnum[_n-1] == idnum[_n+1] & K3==. & inv==. & inv[_n+1]!=.

*** 6th year of panel participation
sort idnum year
replace DEP3 = K3[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEP3==.
replace dK3 = (InvRe-DEP3)+InvNe-(0.5*(InvNe/ND__InvNet)) if dK3==.
replace K3 = K3[_n-1] + dK3 if idnum[_n-1] == idnum & K3==.
replace K3 = K3[_n-1] if idnum[_n-1] == idnum[_n+1] & K3==. & inv==. & inv[_n+1]!=.

*** 7th year of panel participation
sort idnum year
replace DEP3 = K3[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEP3==.
replace dK3 = (InvRe-DEP3)+InvNe-(0.5*(InvNe/ND__InvNet)) if dK3==.
replace K3 = K3[_n-1] + dK3 if idnum[_n-1] == idnum & K3==.
replace K3 = K3[_n-1] if idnum[_n-1] == idnum[_n+1] & K3==. & inv==. & inv[_n+1]!=.

*** 8th year of panel participation
sort idnum year
replace DEP3 = K3[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEP3==.
replace dK3 = (InvRe-DEP3)+InvNe-(0.5*(InvNe/ND__InvNet)) if dK3==.
replace K3 = K3[_n-1] + dK3 if idnum[_n-1] == idnum & K3==.
replace K3 = K3[_n-1] if idnum[_n-1] == idnum[_n+1] & K3==. & inv==. & inv[_n+1]!=.

*** 9th year of panel participation
sort idnum year
replace DEP3 = K3[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEP3==.
replace dK3 = (InvRe-DEP3)+InvNe-(0.5*(InvNe/ND__InvNet)) if dK3==.
replace K3 = K3[_n-1] + dK3 if idnum[_n-1] == idnum & K3==.
replace K3 = K3[_n-1] if idnum[_n-1] == idnum[_n+1] & K3==. & inv==. & inv[_n+1]!=.

*** 10th year of panel participation
sort idnum year
replace DEP3 = K3[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEP3==.
```

```
replace dK3 = (InvRe-DEP3)+InvNe-(0.5*(InvNe/ND__InvNet)) if dK3==.
replace K3 = K3[_n-1] + dK3 if idnum[_n-1] == idnum & K3==.
replace K3 = K3[_n-1] if idnum[_n-1] == idnum[_n+1] & K3==. & inv==. & inv[_n+1]!=.

*** 11th year of panel participation
sort idnum year
replace DEP3 = K3[_n-1]/ND[_n-1] if idnum[_n-1] == idnum & DEP3==.
replace dK3 = (InvRe-DEP3)+InvNe-(0.5*(InvNe/ND__InvNet)) if dK3==.
replace K3 = K3[_n-1] + dK3 if idnum[_n-1] == idnum & K3==.
replace K3 = K3[_n-1] if idnum[_n-1] == idnum[_n+1] & K3==. & inv==. & inv[_n+1]!=.
```

5.2 Variables produced by the STATA code

KT	Capital stock from a starting value with T years of support
K3	Capital stock from a starting value with 3 years of support
dKT	Absolute yearly change in KT
dK3	Absolute yearly change in K3
SMAT	Starting value with T years of support
SMA3	Starting value with 3 years of support
meaninv_dK	Within-firm average of the percentage of net investments in total investment
DEPT	Expected depreciation of KT
DEP3	Expected depreciation of K3
ND	Average economic live of capital stock
ND_InvNet	Average economic live of net investment
InvNe	Net investments
InvRe	Replacements

6 References

Steffen Müller (2008), Capital Stock Approximation Using Firm Level Panel Data, Jahrbücher für Nationalökonomie und Statistik, 228(4).

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