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German Practices in Estimating Capital Stock

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1 Introduction

In Germany the **perpetual inventory method** (PIM) is used to estimate capital stock. The first calculations were done by the German Institute of Economic Research (DIW) in the late sixties.[1] Considering the work of the DIW the Federal Statistical Office of Germany built up capital stock estimates in the beginning of the seventies.[2] First calculations were made only for five branches. Nowadays data is available for 57 branches in a breakdown by two types of assets (machinery and equipment as well as buildings and other structures). We calculate gross and net capital stock by three different price concepts (at historical costs, at replacement costs and at constant replacement costs of the year 1991).

2 Asset types covered

Capital stock includes assets that are used in production longer than one year. Acquisition of durable goods with a value of less than DM 800 will not be treated as assets but as intermediate consumption in the year of acquisition even if these goods are used in production longer than one year. The capital stock estimates for Germany cover the following types of assets:

Machinery and equipment
- Foundry products
- Structural metal products, rolling stock
- Office machinery, automatic data processing equipment
- Electrical machinery, equipment and appliances
- Other machinery
- Precision instruments, optical instruments and instruments for timekeeping
- Tools and finished metal products
- Musical instruments and sports goods
- Wood products
- Textiles (carpets)
- Road vehicles
- Water transport equipment
- Air transport equipment

Buildings and other structures
- Dwellings
- Buildings other than dwellings
- Private civil engineering works (e.g. railways, airfield runways, pipelines, telecommunication lines, electric power distribution lines, constructions for mining)
- Public civil engineering works (e.g. highways, streets, roads, bridges, tunnels, navigable canals)

Buildings cover all fixtures secured to them (e.g. elevators, heating systems). Durable military goods have been excluded from capital stock up to now. For public civil engineering works only data on gross stock is available. Net stock is not calculated because public civil engineering works are not written off according to the 1968 SNA, but will be calculated in future. Cultivated assets (e.g. livestock for breeding or dairy, vineyards, orchards) and intangible fixed assets (e.g. computer software for applications, mineral explorations) are not included in capital stock. We will enlarge our capital stock estimates in accordance with the

[1] Kirner, Wolfgang, Zeitreihen für das Anlagevermögen der Wirtschaftsbereiche in der Bundesrepublik Deutschland, DIW-Beiträge zur Strukturforschung, Heft 5, Berlin 1968.

[2] Lützel, Heinrich, Das reproduzierbare Anlagevermögen in Preisen von 1962, Wirtschaft und Statistik, 1971, pp. 593.- Lützel, Heinrich, Das reproduzierbare Sachvermögen zu Anschaffungs- und zu Wiederbeschaf-fungspreisen, Wirtschaft und Statistik, 1972, pp. 611.

definition of produced assets in the United Nations System of National Accounts (SNA 1993) until the year 2000.

3 Volume and price indices used

First we calculate capital stock at constant replacement costs of the year 1991 in accordance with PIM using long time series of gross capital formation at constant prices of the year 1991. The results will then be inflated to get data on capital stock at replacement costs of the year under review. Price indices for capital formation by branches in the breakdown by machinery and equipment as well as buildings and structures are used to revalue capital stock from constant replacement costs of the year 1991 to replacement costs of the year under review. The price indices for capital formation are so-called **"Paascheized Laspeyres" price indices.** To show the development of the volume of capital formation and capital stock, we would need Paasche price indices for deflation, but German price statistics only provide Laspeyres' price indices. Therefore the process of deflation using Laspeyres' price indices is made for capital formation in a very detailed breakdown by types of goods, about 200 types of machinery and equipment and 7 types of buildings and structures. Therefore changes in the combination of capital formation over time are taken into account. Price indices for construction work performed at buildings are used to deflate capital formation in buildings and structures. In the case of machinery and equipment, indices of producer prices are used for domestically produced assets. Similar base weighted indices for imports are used for imported assets.

4 Asset lives

First we estimate the **average service lives.** Concerning machinery and equipment, data on gross capital formation is available in a breakdown by 200 types of goods from 1960. For each of these types of assets and for each year of acquisition the average length of service life is estimated. Thereby little information is available. Most important are the depreciation rates that are used for tax purposes. Information on tax lives (AfA) is provided by the Federal Ministry of Finance for 100 branches and for generally used assets in a very detailed breakdown by types of assets.[3] To avoid the risk that assets have to be scrapped before they are written off completely, tax lives of depreciable assets are shorter than the actual service lives which should be used for national accounts purposes. Therefore we lift tax lives up by 50% to 100%. For cars we can compare actual service lives and tax lives. Statistics by the Federal Office for Motor Traffic, the office all cars are registered in Germany, show in detail stocks and retirements of cars by age structure. Using these data, the Rhenisch-Westphalian Institute of Economic Research (RWI) calculated the actual average service life of motor cars of between 10 and 12 years in the period from 1965 to 1985.[4] Relatively long-used cars of private households are included. Enterprises are allowed to write off motor cars only within five years for tax purpose. We also have information about the technical length of life of parts of buildings (e.g stonework, roof framework, windows), other structures and special equipment announced by the Federal Ministry for Regional Planning, Building and Urban Developement.[5] The technical length of life may be an upper limit for the actual length of life. For example, it is ten years for commercially used motor cars. We assume eight years as the economic average length of life of motor cars in our capital stock estimation. Statistics on the age structure of the stock of ships and dwellings as well as on the destruction of different types of buildings by age structure also help to estimate the average service lives.

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[3] Bundesminister der Finanzen und Finanzminister (Finanzsenatoren) der Lfinder, AfA-Tabellen, Bonn 1989 and supplements.

[4] Halstrick, M., Zur Entwicklung der Neuzulassungen von Personenkraftwagen in der Bundesrepublik Deutschland bis zum Jahr 2000, RWI-Mitteilungen, 1986/87, p. 446.

[5] Kleiber, W., (editor), Sammlung amtlicher Texte zur Wertermittlung von Grundstiicken in den alten und neuen Bundeslfindern, Bundesanzeiger 22 la, K61n 1992.

The following table shows that the average length of life **has become shorter** over the last few decades. There have been different reasons for this development. Buildings constructed on the basis of pre-assembled units have become more and more important in industrial production in the last few decades. Their average service life is shorter than that of solid buildings. In addition the share of modernisation in capital formation of buildings has increased. The average service life of most modernisation work (e.g. roofs, heating systems) is shorter than that of completely new buildings. For machinery and equipment, we change the average service lives when there are changes in tax lives. For example, computer-controlled machine tools have become more and more important. Their depreciation lives for tax purposes are shorter than those of manually controlled machine tools. Assets with a relatively low average service life, particularly computers, have increasingly gained in importance in the last few decades. Their share of all capital formation in machinery and equipment increased from 2% in 1970 to 10% in 1990.

Average service lives
years

Year of capital formation	Machinery and equipment	Dwellings	Other buildings and structures[1]
1950	18	87	65
1960	15	83	62
1970	15	8O	62
1980	14	77	60
1990	13	75	56

[1] Without public engineering works.

5 Survival function

For Germany, the gamma distribution density function was selected as the appropriate retirement function. In general, its form is as follows:

(1)
$$\theta_N(n/a,p) = a^p \Gamma(p)^{-1} n^{p-1} e^{-an};\ n \geq 0;\ a > 0;\ p > 0$$

In line with the maximum likelihood principle, the following equations apply to the sample mean ($\bar{n}$)
and sample variance *(s^2)*:

(2a) $$\bar{n} = \frac{p}{a}$$

(2b) $$s^2 = \frac{p}{a^2}$$

The estimated value of parameter p ($\hat{p}$) shows the form of the function. The standard deviation becomes smaller with increasing p. If p is fixed, the estimated value of parameter a (â) only depends on the average service life ($\bar{n}$):

(3a) $\hat{a} = \frac{\hat{p}}{\bar{n}}$

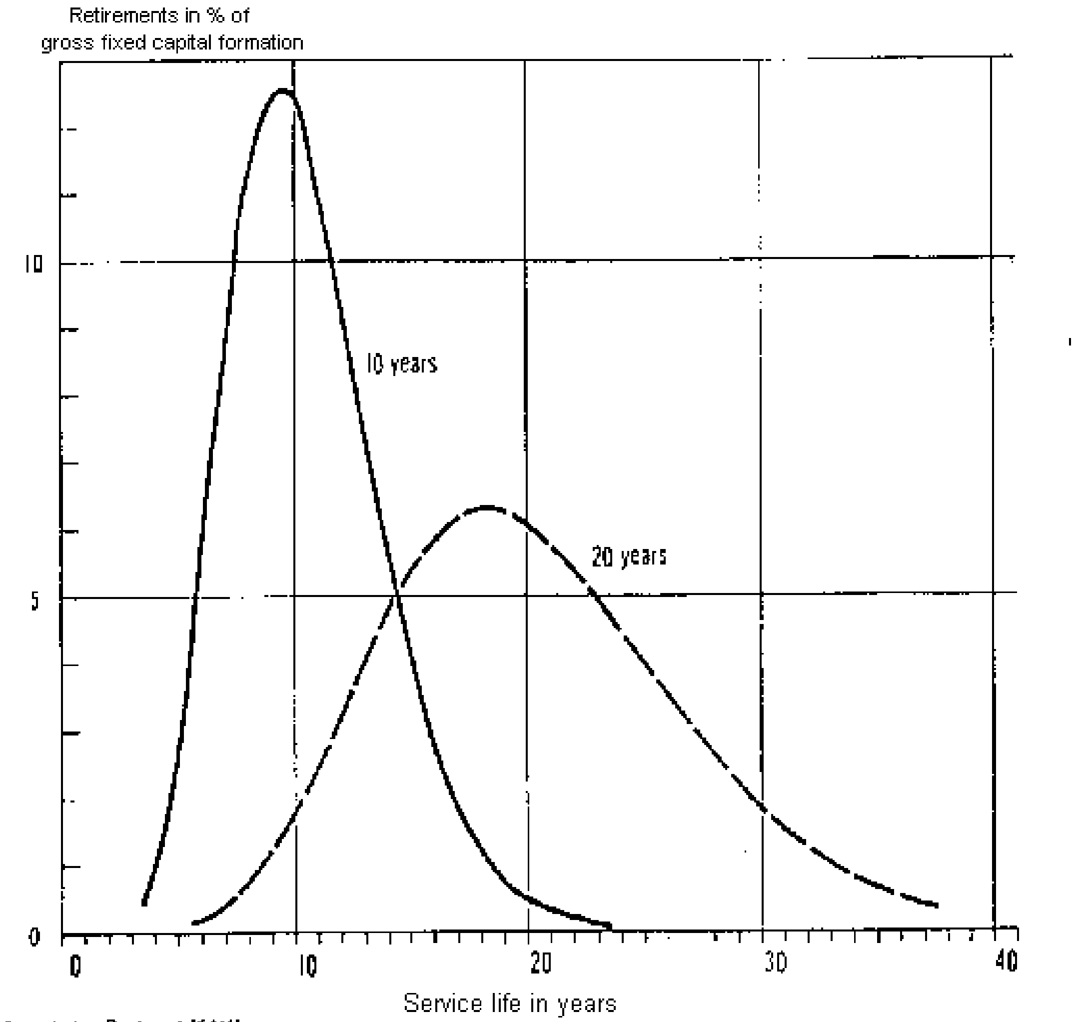
(3b) $s = \frac{\bar{n}}{\sqrt{\hat{p}}}$

Different distribution density functions could only be tested for motor vehicles using the data on stocks and retirements of motor vehicles from the Federal Office for Motor Traffic mentioned above. The gamma density function with $\hat{p} = 9$ fitted best for vehicles. We use $\hat{p} = 9$ for all assets, except dwellings, public buildings and buildings of private organisations serving households. We use $\hat{p} = 7$ in these cases. If parameter p is fixed, the retirement function will only depend on the average length of life (*n*). With $\hat{p} = 9$ it is:

(4) $$f(n/\bar{n}, 9) = 9^9 (8!)^{-1} \bar{n}^{-9} n^8 e^{-\frac{9n}{\bar{n}}};\ with\ s = \frac{1}{3}\bar{n}$$

The following figure shows the retirement curve of capital stock with an average length of life of 10 and 20 years:

RETIREMENT CURVE OF CAPITAL GOODS WITH AN AVERAGE SERVICE LIFE OF 10 AND 20 YEARS



Capital formation in the year i (I_i) is composed of groups of assets with different average service lives *n* ($I_{i,n}$). The retirement function of the capital formation of the year i as a whole is $f_i(n)$:

(5) $$f_i(n) = \sum_{\bar{n}} \frac{I_{i,\bar{n}}}{I_i} f(n/\bar{n}, \hat{p});\ \hat{p} = 7,9;\ n = 1, 2, 3, \ldots$$

We assume that there are no retirements in the year of acquisition.

The **survival function** $u_i\ (m)$ shows the share of capital formation of the year i, that is used longer than m years:

(6) $$u_i(m) = 1 - \sum_{n=1}^{m} f_i(n), \quad m, n = 1, 2, 3, \ldots$$

6 Depreciation function

We use the straight-line method of depreciation for all assets. If the length of live is n for a special asset, the depreciation rate will be 1/n every year over the whole service life. In the year the asset is invested and in the year it retires we assume the depreciation rate is only half as high as in the years between. The depreciation function $g_i(t)$ shows the share of capital formation in the year i that is depreciated in the year t:

(7)

$$g_i(t) = \sum_{n \geq -i} d_t(n) f_i(n); \quad with\ d_t(n) = \frac{1}{2n}\ if\ t = i;\ t = i + n;$$

$$d_t(n) = \frac{1}{n}\ if\ i < t < i + n$$

7 Conclusion

In the last few years the main problem with the German capital stock estimates was the integration of the capital stock acquired in the former German Democratic Republic (GDR). There was detailed information about capital stock by types of assets and age-structure regularly collected by the statistical office of former GDR. However a lot of this capital stock became obsolete with the change of the political system. It was very difficult to get information about that part of the capital stock from the former GDR, which can still be used. Another problem was to revalue capital stock from prices in Mark of the former GDR to DM. The value in DM often is much lower than it was in Mark of former GDR because of bad technical standard.