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MEASUREMENT OF CAPITAL STOCK IN THE BELGIAN NATIONAL ACCOUNTS

Invited Paper submitted by the National Bank of Belgium*

Introduction

1. During the compilation of national accounts, the gross capital stock (GCS) is only being used indirectly. In fact, the European System of national and regional Accounts 1995 (ESA95), which corresponds completely in this regard with the System of National Accounts 1993 (SNA93), prescribes that the consumption of fixed capital must be estimated on the basis of the GCS. The ESA95 also recommends the perpetual inventory method (PIM) for estimating the GCS if the GCS cannot be calculated from direct observation of the capital assets.

2. This paper gives a general outline of how the GCS is estimated in Belgium. To that end, the first section discusses the characteristics of the method used (PIM). The second section explains certain developments which should improve the quality of the GCS estimates in Belgium in the future.

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Estimates of GCS in Belgium

3. The GCS (and therefore also the consumption of fixed capital) is calculated in Belgium using the PIM. This is a method for estimating the GCS as the sum of fixed capital 'surviving' in the current period from earlier gross fixed capital formation, i.e. which are still in use in the current period. The following core data is essential in order to estimate the GCS using the PIM:

- historic series of data relating to gross fixed capital formation;

- information about the service life of capital assets and how the retirements of those capital assets relate to the average service life (i.e. the survival function).

4. Both the historic capital formation series and survival functions used will be briefly discussed below. This will be followed by a general explanation of the estimating of the GCS and the consumption of fixed capital using the PIM[1].

Historic series of gross fixed capital formation

5. Belgium has series of gross fixed capital formation dating back to 1853. Those series are divided into 25 industries and 3 products[2]. However, in view of the fact that national accounts have only been compiled in Belgium since 1953, the series for the period between 1853 and 1953 are calculated on the basis of supplementary source material. The main additional source data is as follows:

- scientific study by Louvain Catholic University relating to the reconstruction of the national accounts during the inter-war period (Buyst, 1985, Buyst, 1986 and Buyst, 1988);

- study by Mairesse (1972) into growth index figures for France for capital formation in buildings on the one hand and capital formation in vehicles and other materials on the other hand[3];

- for government capital formation, use has been made of studies by the Groupe d'Etudes de la Comptabilité Nationale (1961) and of the Statistiques Economiques Belges of the National Bank of Belgium.

6. It goes without saying that the use of the various sources can give problems in terms of the quality and consistency of the final series. In this

regard, it should be noted, however, that the data from the series antedating 1960 makes only a marginal contribution[4] to the calculation of the current GCS.

Service life of capital assets

7. The second component required in order to estimate the GCS using the PIM is the average service life of the capital assets in the various industries. The average service life of a capital asset indicates the average timespan after which a capital asset is retired. In the Belgian context, this is based mainly on data from the direct taxation service. However, modifications are made to these average services lives[5] for some industries on the basis of supplementary information. For example, service lives in the transport industry are changed from 30 to 70 years for buildings and from 7 to 15 years for vehicles.

8. However, the notion of average service life provides only limited information if the spread around the average of the service life is not known. For example, let us assume that a particular capital asset has an average service life of 15 years. Without additional information one can only state that those capital assets will, all other things being equal, be retired after an average of 15 years. It might therefore be the case that all capital assets are retired after exactly 15 years, but it is equally possible that half the capital assets are retired after 10 years and the other half after 20 years. In order to resolve this, additional assumptions are made about the spread of the retirements of the capital assets around their average service life. These assumptions can be represented by a density function which is called the "mortality function". A mortality function indicates what proportion of a vintage of capital assets are retired in a given period. A ‘bell-shaped’[6] mortality function is usually used to describe the pattern of retirements. A quasi-logistic[7] function is used for this in Belgium. This is a function which can be either symmetrical or skewed to the left or right, depending on the values assigned to particular parameters. In Belgium, symmetrical mortality functions are used for virtually all industries. The exceptions to this rule are the buildings in the industries “services of transport-related activities” and “non-marketable services”, and residential buildings. A right-skewed function is used for those three exceptions.

9. The mortality function indicates what proportion of a vintage of capital assets will be retired over a given period. If one then wants to know what proportion of a vintage of capital assets are still in use over a given period, one has to add up all the retirements from the preceding periods. That means that the distribution function of the mortality function must be calculated. That distribution function is also called the 'survival function'[8], and in the

Belgian (i.e. quasi-logistic) context it takes the following form:

$$g_j = \left[1 + e^{\frac{m}{L}\left(\frac{aL}{L+1-j} + \frac{bL}{1-j}\right)} \right]^{-1} \qquad (1)$$

where:
L = maximum service life of a capital asset (i.e. 2 * the average service life n[9])
m = parameter which is a function of L
a, b = parameters which define the (a)symmetry of the distribution (if a = b = 0.5 there is a symmetrical distribution)
j = age of the capital asset

10. As has previously already been indicated, the interpretation of formula (1) is as follows: g_j indicates the proportion of the vintage of capital assets acquired over the period (t – j) that is still in use in period t (i.e. after j periods).

Estimate of the Gross capital stock

11. The preceding paragraphs have described both the historic series of gross fixed capital formation and the survival function as used in Belgium. Since these are the two requirements for the use of the PIM, the GCS can therefore be calculated using this method as:

$$GCS_t = \sum_{j=0}^{L} I_{t-j} g_j \qquad (2)$$

where:
I_{t-j} = gross fixed capital formation in year t-j

Another way to present (2) is as:

$GCS_t = GCS_{t-1} + I_t - R_t$ (3)

with:
R_t = retirements in year t

After a certain amount of manipulation, formula (3) can be rewritten as:

$$R_t = \sum_{j=0}^{L} (g_j - g_{j+1}) I_{t-(j+1)} \qquad (4)$$

Since:

$$R_t = I_t - \left[\sum_{j=0}^{L} I_{t-j} g_j - \sum_{j=0}^{L} I_{t-1-j} g_j \right] \Rightarrow$$

$$R_t = I_t - \left[I_t g_0 + I_{t-1} g_1 + \ldots + I_{t-L} g_L \right] + \left[I_{t-1} g_0 + I_{t-2} g_1 + \ldots + I_{t-(L+1)} g_L \right]$$

and since $g_0 = 1$ and $g_{L+1} = 0$, formula (3) follows immediately.

12. The above formulae describe how the GCS can be calculated. However, no mention has yet been made of the estimate of the consumption of fixed capital.

Consumption of fixed capital and net capital stock

13. The difference between the GCS and the net capital stock (NCS) is the consumption of fixed capital. The calculation of the NCS is therefore similar to that of the GCS, with the difference that an additional variable is incorporated which describes the consumption of fixed capital. The formula for the NCS is as follows:

$$NCS_t = \sum_{j=0}^{L} I_{t-j} g_j d_j \qquad (5)$$

where:

d_j = proportion of the capital assets purchased in t-j and not depreciated in t

14. The value of d arises from the depreciation functions selected. Two types of depreciation function[10] are used in the Belgian context:

- geometric for other materials and vehicles

$d_j = (1 - d)^j$

where:
$j = 1, \ldots, L$
d = constant depreciation rate in the form of $d = 1 - 0{,}1^{1/n}$
n = average service life of the capital asset (note: $L = 2n$)

- straight-line for buildings

$$d_j = 1 - d*j$$

where:
$j = 1, \ldots, n$
$d = 1 / n$.

Another way to write formula (4) is:

$$NCS_t = NCS_{t-1} + I_t - D_t \quad (6)$$

where:
D_t = deprecation in year t

Just like formula (3), formula (6) can be rewritten as:

$$D_t = \sum_{j=0}^{L} (c_j - c_{j+1}) I_{t-(j+1)} \quad (7)$$

where:
$c_j = g_j d_j$

Formula (7) shows how the consumption of fixed capital can be estimated using the PIM. It should be noted that this method for estimating the consumption of fixed capital is consistent with ESA95.

Advantages and disadvantages of the Belgian method

15. The preceding paragraphs have clearly shown that the PIM is an easy and relatively cheap method for constructing estimates of the consumption of fixed capital. Those two aspects are consequently important reasons for using the PIM in practice. Nevertheless, the PIM has a number of disadvantages. At the start of this paper, it was stated that historic capital formation series and average service lives for each capital asset are required in order to use the PIM. Like most countries which use the PIM, Belgium does have reliable capital formation

series, but the average service lives for the capital assets are far less reliable. Also linked to this is the problem that the activities classification (NACE/CLIO R25) used to prepare the gross fixed capital formation series is not compatible with NACE Rev.1 as recommended by ESA95[11]. In addition, the current product detail of the capital formation series (currently 3 products) is insufficiently detailed. As a result, information technology equipment - for example - is currently assigned an average service life of 15 years. It is clear that this can give problems in terms of the accuracy of the estimate of the consumption of fixed capital.

Future developments relating to the estimates of the GCS in Belgium

16. In order to overcome the aforementioned disadvantages in estimating the GCS in Belgium, a number of projects are planned which should improve the quality of the GCS estimates in the future.

17. Firstly, we are working on achieving a higher level of detail in the GCS estimate, both in terms of industries and in terms of products. For instance, by way of far-reaching integration of the GCS in the overall framework of the national accounts calculations.

18. At the moment, a more aggregated level of detail derived from NACE Rev.1 is used for calculation of aggregates for the national accounts in Belgium which consists of approximately 120 industries. In due course the GCS (and therefore also the consumption of fixed capital) will be estimated to this level of detail. However, for this to happen the historic capital formation series will need to be converted to the new classification. We are currently investigating how this can best be done.

19. In addition to the greater level of detail with regard to industries, Belgium also wants to increase the number of products. As indicated above, the current three products are not sufficient to give a true estimate of the GCS. For that reason, the number of products will also be expanded alongside the restructuring of the industries.

20. It goes without saying that if the level of detail of the capital formation series is increased with regard to both industries and products, there will also have to be a review of the current average service lives.

21. In order to realise this, use will mainly have to be made of the data from companies' annual accounts. Nearly every large and medium-sized company in

Belgium is required to file its annual accounts[12] with the Centre of Balance Sheets of the National Bank of Belgium. Those annual accounts include the following data: the total historic cost of the previously acquired capital assets still in use at the start of the financial year, the value of the purchases of capital assets during the current financial year, the retirements (valued at historic cost) of capital assets during the current financial year, the total (fiscal) depreciation in the past and the (fiscal) depreciation during the current financial year. For the large companies this information is available for six product groups of tangible fixed assets, whilst for the other companies only the total of the tangible fixed assets is known. Taken together with the data from the direct taxation service, this data will be used to estimate new average service lives, particularly for non-buildings.

Conclusion

22. This paper contains a brief description of estimation of gross capital formation and consumption of fixed capital in Belgium. This estimate is based on the perpetual inventory method (PIM). The relative simplicity of the use of PIM makes it a frequently applied method for estimating gross capital stock (and thus consumption of fixed capital), even though it still has a number of shortcomings. To meet those shortcomings, Belgium has commenced various projects to broaden estimates of gross capital stock and consumption of fixed capital which will lead to more accurate estimates of those variables in the near future.

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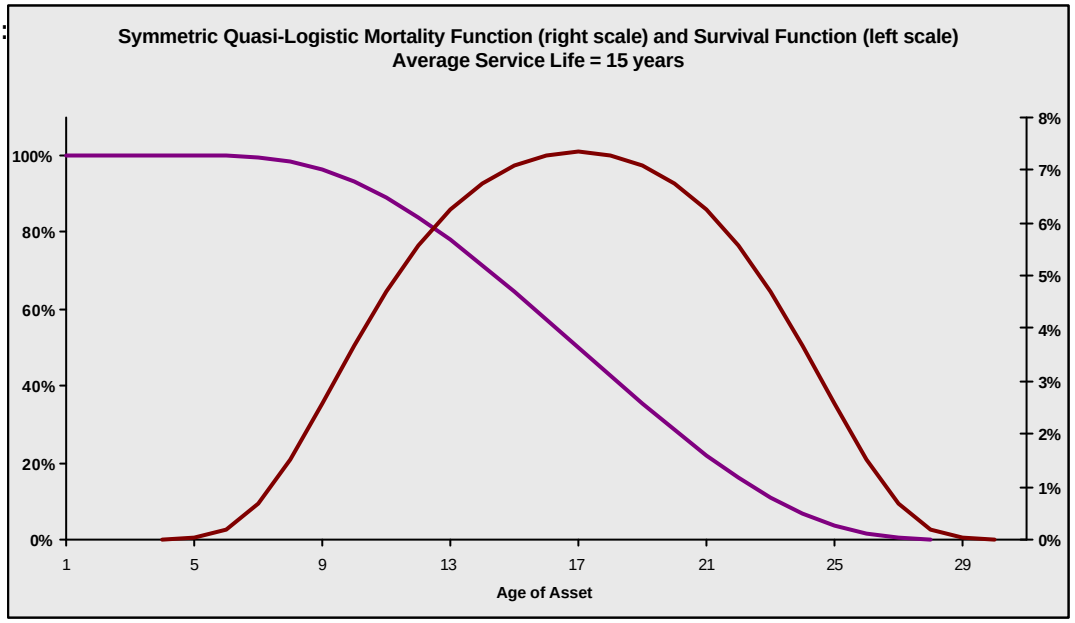
Annex I
Average Service Lives of Capital Assets

Industries	Products		
	Buildings	Other materials	Vehicles
Agricultural, forestry and fishery products	30	15	7
Fuel and power products	40	20	10
Ferrous and non-ferrous ores and metals, other than radio-active	40	20	10
Non-metallic minerals and mineral products	30	15	7
Chemical products	30	15	7
Metal products, except machinery and transport equipment	30	15	7
Agricultural and industrial machinery	30	15	7
Office and data processing machines, precision and optical instruments	30	15	7
Electrical goods	30	15	7
Transport equipment	30	15	7
Food, beverages and tobacco	30	15	7
Textiles and clothing, leather and footwear	30	15	7
Paper and printing products	30	15	7
Rubber and plastic products	30	15	7
Other manufactured products	30	15	7
Building and construction	30	15	7
Recovery and repair services, wholesale and retail trade services	30	15	7
Lodging and catering services	30	15	7
Inland transport services	30	15	7
Maritime and air transport services	30	15	15
Auxiliary transport services	70	15	15
Communication services	30	15	7
Services of credit and insurance institutions	30	15	7

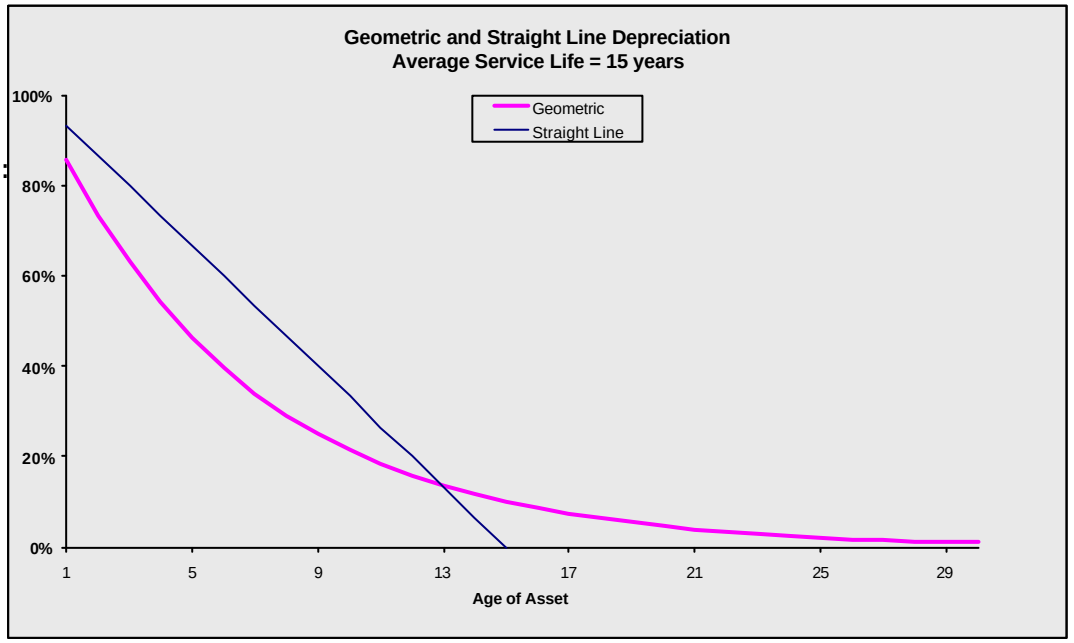
Dwellings	50	0	0
Other market services	50	15	7
Non-market services	60	15	7

Annex II
Graphical Presentations

Graph 1:



Graph 2:



ENDNOTES

[1] This paper will only deal with estimation of gross capital stock of S.13 (General Government). Although capital stock estimates for this sector are also based on PIM, another survival function (c.q. simultaneous exit) as well as other service lives are being used.

[2] See annex 1 for details of these divisions.

[3] On the assumption that the periodic cycles of industrial capital formation in France were roughly similar to those in Belgium.

[4] Calculations have revealed that the capital formation series antedating 1960 only determined 4.5% of the total consumption of fixed capital in 1998.

[5] A full list of the average service lives of the capital assets in the various industries is given in annex 1.

[6] See for example chapter 3 of OECD (1993) for a list of possible mortality functions.

[7] The quasi-logistic distribution is an approximation to the log-normal distribution. For more information about this see Lützel (1977).

[8] A graphical presentation of the mortality and survival functions used in Belgium is given in graph 1 of annex 2.

[9] The average age of the capital assets can be expressed as: $\ell = \frac{1}{GCS_t} \sum_{j=0}^{L} I_{t-j} g_j (j+1)$

[10] See graph 2 in annex 2 for a graphical presentation of both depreciation functions.

[11] NACE Rev.1 also serves as the basis for the activities classification used in preparing the national accounts in Belgium.

[12] There are around 230,000 companies in Belgium which must file their annual accounts with the Balanscentrale every year. Of these, nearly 18,000 are large companies.