Capital Stock Conference
March 1997
Agenda Item III

Definitions and methodology used in Denmark for estimating Capital stock and Consumption of fixed capital

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Paper for the conference on Capital stock to be held in Canberra, Australia, 10-14 March 1997

1. Introduction

The Danish National Accounts Division has recently - in 1995 - for the first time published data on stocks of fixed capital and consumption of fixed capital.

The work was initiated in the beginning of the nineties where the present system of national accounts based on a commodity-flow system had been in operation producing supply and use tables and investment matrices for almost twenty-five years. Only one item amongst the flow-components in this refined system of national accounts had, however, not been treated very carefully. That item was: Consumption of fixed capital.

Add to this that in a complete system of national accounts with opening and closing balances, stocks of fixed capital are of course essential. Besides capital stock figures are of great interest in itself.

On this background it was decided to make a new step forward by building a compilation system of fixed capital stocks and consumption of fixed capital.

2. Approach, sources and methods

With the aim of reaching a level of high quality of the resulting figures, some basic requirements to the compilation system were set up. Summarizing these requirements in a few entries, we would:

- make use of international standard concepts, that is Gross stocks, Net stocks and Consumption of fixed capital
- establish time series dating back to 1966, the same year as other national accounts data (the alternative was to establish figures for a late year, e.g. 1988 and from that year onwards)
- employ a detailed industry classification
- adopt a detailed approach for the calculations using our investment matrices with about 500 commodities and 50 branches allowing the use of many different average service lives and variations in these asset lives

Now, the methods to consider in the field of capital stock estimations are essentially two: direct measurement of the stock and perpetual inventory method (PIM). Presuming that the method of direct measurement is superior to PIM, the restriction of resources and the availability of primary data has caused the following framework for the compilations to be chosen:

(1) **Machinery and equipment:** PIM

(2) **Transport equipment:** Direct measurement through valuation of physical stocks yearly

(3) **Buildings:** Direct measurement through valuation of physical stocks (from a database covering residential as well as non-residential buildings) - a benchmark year combined with PIM backwards and onwards from the benchmark year

(4) **Structures:** PIM
(Livestock: Direct measurement through valuation of physical stocks - yearly)

In the following we will look somewhat deeper into the various methods, beginning with a description of the Gross stocks.

2.1 Gross Stocks

First of all let me provide an overview of the Gross Fixed Capital Formation (GFCF) data available from the functional part of the Danish national accounts.

As mentioned above the Danish system of national accounts is based on a commodity-flow system with almost 2700 products of which around 500 are used for GFCF. At first sight the ordinary supply and use table only contains information on the total volume of GFCF of a specific product. But next to the ordinary table lies an investment matrix containing a breakdown of the total GFCF by product and by industry. In fact, in the national accounts compilation process the balancing of investment matrices is an integral part.

Several arguments can be put forward in favour of the commodity-flow approach - here it should only be pointed out, that one of the main advantages of a detailed product accounting is the possibility of routing products to specific uses, such as GFCF exclusively by knowledge of the characteristics of the products.

PIM

Annual investment matrices have existed since 1966 and this of course serves as a brilliant basis for PIM-calculations, apart from the fact that the starting year for the resulting capital stock figures was chosen also to be 1966. Therefore to get sufficiently long time series investment matrices have been constructed back to 1947 and for some commodities, time series have been carried even further back - in some cases back to the nineteenth century.

Besides the new investment data, the PIM implementation requires assumptions on average service lives and survival functions, to estimate retirement patterns. With the very large amount of investment goods, there are rich possibility of differentiating the average service lives and the forms of the survival functions. But few Danish sources supply information on average service lives, so most of these parameters are based on international studies - especially United States, Canada and the Netherlands have done research in this field - or simply by reasonable estimates. An average service life is attached to every single commodity, in general independently of the branch holding the asset, and most of the service lives are assumed constant. Just to point out, this is not inconsistent with an observation of steadily decreasing average service lives in the capital stock of an industry - a shift in the composition of the investments can give that result. As far as the forms of the survival functions are concerned, these are hardly as important as the average service lives, and the common Winfrey-curves are used.

At last a remark on price indexes: The supply and use tables are balanced in current as well as in fixed prices - that holds for the investment matrices too - and the price indexes used for the deflating procedure are fixed base year indexes primarily derived from the wholesale price index. The resulting volume indexes are therefore of the fixed base year Laspeyres-type.

Direct measurement

By definition, GFCF is recorded as net-acquisitions, and very often, the sources can not give any more information than net-figures. On the other hand, PIM does not manage very well in a situation, where GFCF-figures are the outcome of a lot of buying and selling, and that is one of the main arguments for using direct measurement instead of PIM. The problem is well-known in relation to branches, but arises too in a little open economy, like the Danish. Looking at branches, the buying of new and selling of three year old passenger cars (which ends up in the households) is one example. Another is the ship- and aircraft-fleet, which is currently renewed, involving considerable transactions across the border.

Turning now to the areas where direct measurement through valuation of physical stocks are used, it should be emphasized that a proper valuation is only possible if the recordings of physical stocks also includes a registration of the construction year (as well as the investment year - this distinction is essential) of the assets in focus. The reason for this is quality changes and it is not any different than a PIM-calculated stock by nature consist of numerous different vintages of a certain type of asset.

While the PIM is based directly on deflated GFCF-figures, direct valuation means first of all application of historical prices and secondly a recalculation with the help of price indexes to derive estimates in constant prices. Thus, price indexes must be adjusted, thereby securing that increases in the quality of products are reflected as increases in quantity - e.g. measured in constant prices in the gross stock of 1995, automobiles of vintage 1985 may represent a lower value compared to automobiles of vintage 1993.

Alternatively, trying to disaggregate the physical stock data as much as possible may be beneficial, not only in relation to the quality aspect, but also with respect to a more precise description of the survival functions. In the borderline case where disaggregation means accounting completely specific equipment, the survival function is almost identical with one of the suden-death type, e.g. various locomotives among the rolling stock of the Danish state railways.

Transport equipment

In the present case, a very disaggregated approach to the transport equipment calculations is used. This means operating with many more types of assets than immediately appears from the classification of commodities in the above mentioned investment matrices; that goes for ships, aircraft and the rolling stock of railways, where either existing official registers have been used or new ones have been built up during the work with the capital stock compilations.

Heading now for the most common directly measured asset, namely automobiles, Denmark, like other countries, does possess a central register for motor vehicles. But unlike other countries this register is probably much more intensively used for statistical purposes. Not least in the national accounts compilations, where extracts from the register provide foundation for the determination of many items on the expenditure side.

A very important characteristic of the register is an owner identification, which makes it possible to combine the motor vehicles with our business register thereby distinguishing household-owned autos from those used in business. Furthermore, knowledge of high

accuracy of the business-autos is obtainable, concerning branch-specific information on number, type, original registration year etc.

Buildings

Let us now proceed with the capital stock of Buildings, where the method of directly measuring physical stocks is also applied.

With respect to buildings, Denmark is presumable in an outstanding position too, since an official register covering residential and non-residential buildings has been set up in 1977 and the very same register is entirely available for statistical purposes. The register contains information on every single building including size, building year, technical installations and principal use. It was evident to exploit this extraordinary source and, at the same time, a very challenging task of the capital stock compilations.

Looking at the buildings by principal use, makes it possible to divide the buildings into dwellings and non-dwellings and furthermore to divide the last ones into broad categories like: farms, factories, workshops, buildings for administration etc. But this, of course is inadequate in relation to a detailed industry classification and to cope with that problem, just like the motor vehicles register, the register covering residential and non-residential buildings had to be connected with our business register. In this way we have found the correspondence between each building and each individual enterprise, and consequently a quite accurate distribution of the non-residential buildings by branch. Now, although the procedure indeed sounds straightforward, it should be stressed, that connecting registers and yielding plausible results by no means is a simple task. In fact, this part of the capital stock compilations was so comprehensive that succeeding in doing it once was seen as an objective in itself.

When it comes to valuation of the (existing) buildings, it was natural to apply the same method like the one currently used for valuing the buildings under construction, that is the production activity, where buildings square meters of a given type are multiplied by type specific square meter prices. Supplying with the heroic assumption, that every square meter of a given type could be valued at a uniform replacement cost regardless of the construction year, finally gave us the gross stock of buildings by January 1st 1988 - the benchmark year. After all, uniform prices were only attached to non-dwellings - differences in the quality of dwellings according to age could not be ignored, and therefore two sets of square meter prices were used: prices for dwellings constructed before and after 1940.

Now, especially buildings are very long-living assets and the stock consist of a considerable amount of vintages, which are constructed with quite different building techniques and at quite different quality. In this light, maybe, the assumption of a uniform replacement cost for a building square meter, seems hazardous, but the idea is that major renovations and improvements to older buildings has raised them to a quality level, embodied in new construction. This again, is modified with respect to dwellings where we know for sure that a certain amount of the stock is still lacking proper heat installation, bath installation etc.

Well, from the benchmark value in 1988, completely divided into vintages, time series dating back to 1966 are constructed with the help of a reversed PIM-calculation. Once again we turn to the national accounts investment matrices to get some reliable GFCF-figures, but here it is worth to point out, that GFCF both consist of new building

and major repair and maintenance on existing buildings.

While new buildings are statistically well covered, information on repair and maintenance on existing buildings is sparse, not least that part of repair and maintenance, which is recorded under GFCF. Nevertheless holding the distinction in the calculations between new buildings - that is new square meters - and major alterations on existing square meters, is crucial since the average service life on the two investment-goods can be very different.

In the present case the problem is handled by spreading out major improvements on the existing square meters - older than twenty-five years. In this way, we secure that only the new square meter part of GFCF is recorded as a new vintage, whereas the major improvement part is recorded as an addition in value to existing vintages.

Finally, arranging data - from the register covering residential and non-residential buildings - in life tables, allows estimation of specific survival functions on dwellings, farms and factories. These survival functions are used in the reversed PIM-calculation and in the ordinary PIM, which, without mention it until now, of course serves as the instrument applied forwards from the benchmark year.

2.2 Net Stocks and Consumption of fixed capital

While some parts of the Gross stocks almost can be compiled without any assumptions on average service lives, Net stocks and Consumption of fixed capital, on the other hand, can not be estimated without survival functions and assumptions on depreciations.

Thus, for transport equipment, knowledge of average service lives and survival functions is required, but as mentioned above, it appears possible to derive these survival functions very precisely by observing time series of vintage-divided stocks, recorded in connection with the gross stock compilations.

Consumption of fixed capital is compiled - according to the international guidelines - with the help of a conventional straight-line depreciation profile.

Now, PIM is a framework with built-in consistency as regards the relationship in fixed prices between the net stock at the end of the period, the net stock at the beginning of the period, GFCF and consumption of fixed capital. But when it comes to direct measurement through valuation of physical stocks, the relation can not be expected to hold in a first step. This stems merely from the fact, that investments implicitly derived from the changes in stocks, may differ from the GFCF-data in the national accounts. So with direct measurement, there is a second step in the compilation procedure, where decisions is taken on how to deal with the discrepancies.

3. Accuracy

The time has come for some concluding remarks on the reliability of the capital stock estimates. This could conveniently be done under the headings: Major strength and major weaknesses.

Major strength:

- substantial methods other than PIM are used, first and foremost valuation of physical stocks, to a high degree coming from existing registers (or new ones built up with the capital stock compilations)

- in return, the established system of directly measurement has given the possibility of deriving GFCF-figures more in line with the stock-figures. It is without doubt desirable to achieve a higher degree of simultaneity in the national accounts compilation process, because stocks and flows in the end must be connected

- average service lives and survival functions for transport equipment and buildings are empirically supported

- establishing a very detailed compilation system, in principle at least, makes it possible to attach more reasonable average service lives to the various capital goods. Besides, the resulting capital stock figures exist at the same level of detail, that is classified by 50 branches and around 500 commodities (for publication purposes these are aggregated to the common types: Buildings, Machinery and equipment, Transport equipment, and Other Structures)

Major weaknesses:

- to use PIM at all could be regarded as a weakness in itself, because PIM somehow presupposes that GFCF entirely consist of new capital goods, and these in addition never leaves the branch, that initially invested them. In any case, PIM cannot make any better results than the GFCF-figures promises, and the sources for GFCF in Denmark are not too good. Although the commodity-flow method in this respect is very helpful, it can never counterbalance missing data

- absence of specific Danish information on average service lives and survival functions on machinery and equipment

- the capital stock is a mix of owner/user data. GFCF-data on machinery and equipment are recorded according to a owner-criteria, whereas transport equipment and buildings in principle are recorded according to a user-criteria. On the opposite, register-based data on motor vehicles and on non-residential buildings are in fact established on owner-branches. To achieve consistency with the GFCF-data, it was necessary to make more or less arbitrary corrections to the stock recordings

- buying and selling of existing capital goods between branches and across the national border is not appropriate dealt with in relation to buildings (and machinery end equipment)

- at present, the capital stock figures are not in accordance with the recommendations in SNA93 and ESA95 (European Accounts System). However, one of the major changes, that consumption of fixed capital should be compiled on roads, bridges, dams etc. is implemented in advance

Appendix. Average service lives and survival functions

	years		**function**
Machinery and equipment:	3-30	widely spread	Winfrey S3
on average	13	ranging from 3-4 years for hand tools and over 30 years for certain engines and turbines	
Transport equipment:			
Motor vehicles	10-15		Specific
non-standard			
Ships	11-30		Winfrey S3 and S2
Aircraft	16		Winfrey S3 and L3
Railroad equipment	25-30		Specific
non-standard			
Buildings:			
Dwellings	105-80	steadily decreasing from 1935-1965	Winfrey R5
Farms	125-80	steadily decreasing from 1840-1940	Log-normal
Non-dwellings	85-55	steadily decreasing from 1910-1960	Log-normal
Structures:	40-50		Winfrey S3 and L3