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A Comparison of PIM Estimates with Direct Stock Information for Dwellings

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1. Introduction

One of the major sources of uncertainty in capital stock estimates stems from the use of the perpetual inventory method (PIM) in all the cases where direct stock information is not available. In the Danish capital stock estimates, it has been possible to dispense with the PIM altogether as far as buildings are concerned. Instead, an administrative register of buildings is used together with a property register and the business register to produce an exhaustive enumeration of practically all buildings in the economy broken down by industry and sector. In order to get an idea of the amount of uncertainty introduced by applying the PIM it is obvious to make a comparison of the two methods of measuring the capital stock for a type of asset like buildings for which physical quantities can be valued at current replacement cost in a reasonably reliable way. For the most important type of buildings namely dwellings the paper compares direct stock estimates derived by multiplying physical quantities (square metres) by the replacement prices per square metre with those that would result from applying the PIM to historical investment series. Dwellings are by far the most important non-financial assets in most developed economies, so the quality of the estimate for dwellings is crucial for the quality of the figure for the economy’s total capital stock.

2. Measurement methods for the capital stock

The gross fixed capital stock is defined as the value, at a point in time, of fixed assets held by producers with each asset valued at "as new" prices i.e. at the prices for new assets of the same type, regardless of the age and actual condition of the assets. It is a "gross" measure of the stock in the sense that it is calculated before deducting consumption of fixed capital, cf. Canberra Group (1999), OECD (1973). As emphasized in the draft Canberra Group manual on capital stock estimates, the gross capital stock is of little or no interest in its own right but serves as the starting point for calculating consumption of fixed capital and the net capital stock, both of which are important aggregates of the national accounts. In addition, it constitutes the point of departure for the calculation of capital services that are used in productivity studies.

Basically there are three different ways of measuring the gross capital stock. The first is by means of direct surveys of producers employing the fixed capital assets typically based on questionnaires. The second method is based on exploiting the information on fixed capital assets recorded in administrative registers. Like the first method, it is based on a direct enumeration of fixed capital assets in existence at a given point in time. Yet, unlike the survey method it is not based on statistical questionnaires. Therefore, the enumeration is usually more reliable in that it is not dependent on sampling and statistical grossing techniques. Besides, the fact that the information is used by general government for regulatory purposes plus the self-controlling effect of opposite interests of buyers and sellers of capital goods imply that also the information actually collected is likely to be more accurate. On the other hand, the information available about the different capital assets may be more limited than that which can be collected in questionnaire based surveys. The latter may for instance ask about the degree of utilisation and about historic acquisition prices, information which is usually not available in administrative registers.

The third method consists of deriving the gross capital stock by having an initial stock in the far past and then keeping track of all the additions to and withdrawals (discards or sales) from the capital stock. The method is known as the Perpetual Inventory Method (PIM). This is known as the Perpetual Inventory Method, PIM. It is an indirect way of calculating the capital stock by means of an accounting identity between stocks and flows. As the name suggests, the idea is to calculate the stock of fixed assets by viewing the capital stock like an inventory where the assets held in stock at a given point in time are calculated from observations of movements into and out of the inventory.

If the information underlying PIM is actually available as "hard" statistical information based on surveys, in principle PIM can be just as reliable as a direct observation of the capital stock. In practice, however, one or more of the variables in the accounting identity are missing. While there is generally a fair amount of information available about additions to the capital stock in the form of GFCF, i.e. acquisitions less disposals, very little if any information is available about discards. Besides, for assets with long service lives the investment series available may not be long enough to avoid the assumption about the initial stock being critical. The important point about PIM, though, is that the method can be applied in the absence of statistical information on discards by making assumptions about the retirement patterns.

This is at the same time the strength and the weakness of PIM - a strength because the method can provide capital stock estimates in an inexpensive way from long series of GFCF data alone, a weakness because of the assumptions about the survival functions, average service lives and the initial stock that have to be made and which introduce a sizeable amount of uncertainty in the estimates.

The PIM may be viewed as the default option in compiling capital stock estimates, the method to be used when it is not possible to observe the stock directly, cf. e.g. Bureau of Economic Analysis (1997). Some countries rely almost exclusively on PIM. Most countries apply PIM for at least machinery and non-transport equipment. Transport equipment appears to be the field where direct stock estimates are commonest, a fact which can undoubtedly be ascribed to the existence in most countries of administrative registers of autos, trucks, ships, aircraft etc.

3. A comparison of PIM with direct stock estimates

In order to gain an impression of the properties of PIM it is obvious to compare the results of PIM calculations using different assumptions about service lives, and possibly also the shape of survival functions, with the results of a direct stock calculation. However, research reported elsewhere, cf. Canberra Group (1999); Benson and Teck-Wong (1999); Biørn, Holmøy and Olsen (1989), suggests that PIM estimates are not very sensitive to the exact shape of the survival function, as long as the function is bell-shaped. That is why we have chosen in this paper to concentrate on the former aspect namely the service lives. We shall study the effect of varying both the overall service lives, when these are treated as constant, and of assuming a secular decline in service lives over the past 130 years.

A by-product of the comparison and sensitivity analysis of PIM described above is an indirect estimate of the average service lives which have to be used in any case for calculating consumption of fixed capital and hence the net capital stock. Even if the calculation of the gross capital stock of a certain fixed asset is based on a direct estimation of the capital stock, the average service life of the asset in question is needed in order to calculate consumption of fixed capital and the net capital stock. This indirect estimate of the service lives results from a sensitivity analysis of which average service lives make the PIM yield an estimate of the gross stock which is close to the one resulting from the direct calculation of the stock.

4. The central register of buildings and dwellings

4.1 Legislative and administrative framework

A central buildings and dwellings register (BDR) was established by law in Denmark in 1977. In combination with the central population register and other administrative registers the BDR is used for conducting a yearly population and housing census. The last traditional census using statistical questionnaires was carried out in 1970.

The BDR is used for a wide range of administrative purposes. It covers all buildings with the exception of small shacks. Municipalities and owners of real estate are required by law to update the register continuously. Every time a property is sold, a form requiring an updating of preprinted BDR register data for the property concerned has to be filed with the municipalities responsible for updating the register. No buyer of real estate (or his lawyer) will go through with a deal without knowing the BDR information on the property in question. The legal requirements, the administrative uses plus strong incentives on the part of buyers and sellers of real estate to correct inaccuracies imply that the register data can be considered to be of a very high quality, at least for buildings, which have been traded after 1977. The role of the register data in connection with purchases and sales of real estate introduce a certain self-policing element in that buyers and sellers (plus their lawyers) will rarely have the same interest in distorting information or failing to update the information on the register.

The BDR has essentially three types of units: the property, the building and the dwelling/business premises unit. There is thus no mixing together of dwellings and business premises. The number of square meters in a given building used for housing purposes is uniquely identified. The register contains a wealth of information about the buildings e.g. year of construction, surface and roof materials, installations and the source of heating. The units recorded in the BDR and the administrative uses of the register are illustrated in annex 1.

4.2 Square metres by type of dwelling from the BDR

With the massive amount of information in the BDR, it is possible to extract almost any information on dwellings. For the purpose of calculating the gross stock, one has therefore to consider which information is needed in order to achieve the best possible result.

First of all, the type of buildings to extract from the register must be delimited by the national accounts definition of what is included in dwellings. This means that also garages and carports should be included. Because dwellings are defined as an activity (use of premises), all units in the BDR labelled dwellings can be identified and retrieved.

Within units labelled dwellings, a further breakdown has been made. This is because of the widespread variation in different types of dwellings. In order to apply different prices to the different types of dwelling, the following categories are used:

1. Farm houses
2. One-family detached houses
3. Terraced and semi-detached houses
4. Multi-storey dwellings
5. Student residences
6. Other dwellings
7. Holiday cottages
8. Garden houses
9. Garages, carports and other small buildings
10. Not classified

Another important aspect is the construction year, i.e. vintage. Older dwellings will typically lack more amenities than newer ones. Therefore a breakdown into two groups has been made, the one with construction year before 1940 and the other with construction year from 1940 and onwards, in order to differentiate prices between the two groups. The vintage problem is discussed further in the following section about prices.

In order to get an idea of the age structure of the dwelling stock, table 1 shows the number of square metres with a breakdown into seven sub-periods of construction year. It can be seen that approximately 40% of the dwelling stock is from before the Second World War. It also shows that 1960-1979 was a period with high construction activity. In that particular period, many suburbs were projected, and families were moving from multi-story apartment buildings to newly constructed one-family houses.

Table 1: Square metres by year of construction Stock as of January 1st 1999

Vintages	Square metres per 1/1 1999
Before 1900	50.196.435
1900-1919	35.364.255
1920-1939	41.666.875
1940-1945	7.721.722
1946-1959	32.889.202
1960-1979	115.083.666
1980-1998	50.819.661
Total	**333.741.816**

Though not shown in this paper, it is also possible to make a breakdown into institutional sectors of ownership. The sectoral breakdown is important when using the (net) capital stock in national accounts balance sheets.

Register data are generally very reliable provided the register is kept updated and proved for errors of registration at regular intervals. As explained above, the BDR is to a certain extent self-controlling in the sense that the purchaser and the seller of a property both have an interest in checking the data.

5. Prices of dwellings used in the direct stock estimates

The square metre prices used for the direct calculation are the same as the prices used when calculating output (but not value added) in the construction industry and investment in new dwellings. As for the square metres extracted from the BDR, the square metre prices are broken down into categories.

Table 2: 1995 square metre prices by category of dwelling. DKK.

Type of dwelling	1995-price
Farm houses	7.383
One-family detached houses	7.383
Terraced and semi-detached houses	7.383
Multi-story dwellings	9.475
Student residences	9.475
Other dwellings	9.475
Holiday cottages	6.258
Garden houses	6.258
Garages and small buildings	2.213
Not classified	7.256

Note: The 1995-price refers to dwellings with construction year after 1940

Table 2 shows the categories used and the corresponding prices. As can be seen, the square metre prices are less detailed than the classification of dwellings in the BDR. The level of detail, however, seems to be sufficient for the purpose of calculating the capital stock, as the categories are fairly homogenous.

These square metre prices are benchmarked approximately every 10 years by information collected from developers, contactors and government organisations. They are updated using indices of construction costs adjusted for productivity gains. Currently the construction cost index is adjusted downwards 1 per cent for all categories except multi-storey dwellings, which are adjusted by only 0.5 per cent. The adjustments for productivity gains are checked when two successive benchmarks and the extrapolation between them in the course of the intervening period are compared. In practice, they have been found to be relatively stable especially for residential buildings.

One may of course ask whether it is appropriate to assign basically the same square metre prices "as new" to dwellings put in place in the 1890s as to those erected in the 1990s. Are the differences with respect to installations and other aspects of quality not such that the residential buildings put in place a hundred years ago would command a lower market price per square metre if sold as new today than is the case for a comparable newly constructed building? Looking first at the installations, there is no doubt that the quality of kitchens, bathroom installations as well as electrical systems is much better in new residential buildings than in older ones which have not been modernised. The same goes for elevators, an expensive facility in multi-storey apartment buildings.

An important point here, however, is that a very large share of old dwellings in general and of old owner-occupied dwellings in particular have had alterations to the original kitchens, bathrooms and electrical installations. Indeed, nowadays it is not uncommon at least in owner-occupied dwellings to replace the kitchens and bathrooms every 20-30 years. So a very large share of the dwellings put in place in the latter half of the 19th and first half of the 20th century which are still in existence today have in fact been very significantly upgraded and may well have a standard in terms of installations approaching new dwellings. The exception is elevators in multi-storey buildings that are extremely costly to install once a building has been completed. In this respect old multi-storey residential buildings have typically not been upgraded.

Another aspect of quality would seem to speak in favour of old residential buildings and against newer ones. This is when it comes to the basic quality of materials used and the craftsmanship applied by contractors. Here, construction work carried out before the 1960s arguably outperforms modern construction standards provided, of course, that the comparison is made in terms of buildings "as new". To be sure, such a statement only pertains to the old buildings that are still in use. In the late 19th and early 20th centuries, quite a lot of cheap dwellings for poorer people moving from the rural districts to the cities in general and to the capital in particular as part of the industrialisation process were constructed by developers capitalising on this demographic change. Yet the bulk of this low-cost speculative housing had been torn down by the late 1980s which is when our direct stock estimates start. The vast majority of the dwellings from that period that still remain in the housing stock must be characterised as representing quality construction work by contemporary standards. Evidence to that effect may be found in the market prices of old dwellings which - considering the shorter remaining service lives one would normally expect compared with new houses - are remarkably high compared to newer ones.

Considering these arguments it does therefore not seem inappropriate to assign the same "as new" square metre prices to old dwellings without any lack of modern amenities (toilets, bathrooms, central heating), except possibly elevators as to newly constructed ones. On the other hand it is clear that older dwellings which have not been upgraded, and which lack one ore more of the above-mentioned amenities, should not be assigned the same "as new" square metre prices as newly constructed dwellings.

Looking at the pros and cons, it has been decided to reduce square metre prices for dwellings constructed before 1940. All prices used for dwellings constructed before 1940 are therefore only 87 per cent of the prices used for dwellings constructed from 1940 and onwards, which again are equal to the current replacement cost per square metre. This is the same adjustment as is used in the current Danish dwelling stock.

The reduction is based on the number of dwellings with a lack of amenities such as bathroom, toilet and central heating. This seems to be better than an adjustment based on square metres, as these installations are mainly related to the individual dwelling and not the number of square metres. Also, dwellings without these installations are usually small. The adjustments are based on data from 1986. From these data it is apparent that the lowest quality of dwellings are constructed before 1940, which is why 1940 is chosen as the critical year. As old dwellings are currently renovated as part of government policy, the adjustment should be kept under surveillance and maybe revised. It is clear that one of the biggest uncertainty factors in the direct estimate of the residential capital stock is the question of which quality adjustment to apply to dwellings constructed in different periods.

6. Long investment series used for the comparison

6.1 Statistical data 1930-1998

The comparison uses investment series for PIM covering the period 1930-1998 except for the World War II years 1940-45 for which there is no breakdown of gross fixed capital formation by type. The investment series at current and constant prices together with the deflators used are shown in annex 2. The time series for gross fixed capital formation in dwellings for the period 1946-1998 stem from published figures, including under this heading the data from the databank of Statistics Denmark's macro econometric model. No independent research into the basic statistics of the years before 1966 has been undertaken, except for the use of quantity indicators for the years 1930-46 reported below. For the years 1966-1998 the data are the official national accounts figures under the present compilation system based on SNA93/ESA95. These figures have been carried backwards using the evolution in residential investment in the national accounts published for that period. For the years 1948-1965 the investment series used for the retropolation have been taken from the databank of the macro econometric model where the retropolation has been balanced against supply from the construction industry. For the years 1946-1947 the basis for the retropolation has been residential investment according to the published national accounts of this early period which included a breakdown of investment in buildings into residential and non-residential buildings. The official statistical publications from which the historical data used have been taken are shown in the list of references.

Data for residential investment are absent for the World War II years 1940-45. For that period, only some summary national accounts without any breakdown of gross fixed capital formation are available. A data series for those years at constant prices has been constructed by carrying back the 1946 level by means of a quantity indicator, which is the number of square metres of new dwellings completed. Statistics on the number of square metres of dwellings completed were begun in 1938 and were published in the statistical yearbooks from the period.

For the years 1930-39, published national accounts are available but due to the interruption of the compilation for the years during World War II, these very first estimates were never really linked to the figures published from 1948 onwards. It turns out that the data for residential investment at constant prices for the year 1939 is much lower than the level arrived at by extrapolating the

1946 figure backwards by means of the series for the number of square meters of new dwellings completed. This contradiction between the two sets of data sets was investigated in order to find an appropriate data series for residential investment in the 1930s

First, the 1946/1939 deflator was checked. This deflator is broadly confirmed by the construction cost index for dwellings which was compiled from 1939 onwards and published in the statistical yearbooks of the period. There is thus no indication that it is the deflator which causes the discrepancy. Secondly, the square metre series was checked against another, cruder quantity indicator namely the number of completed dwellings. That volume indicator gives roughly the same conclusion as the square metre statistics. On the basis of this evidence it was concluded that the figures for residential investment at current prices in the national accounts for 1930-39 are much too low. As a consequence it was decided to use the level at constant prices for 1939 which results from retropolating the 1946 level by means of the square metre volume indicator and to use the published national accounts for 1930-39 only to determine the changes, i.e. to carry the 1939 level back to 1930. In the table in annex 2 this is indicated by showing the numbers derived from the national accounts for 1930-39 in italics. The same volume development is assumed for new dwellings and for alterations. This is equivalent to using the 1966 ratio all the way back.

The resulting figures for the 1930s may offhand appear to be high compared to the 1940s and 1950s. This, however, is what would be expected given the physical data on the housing stock. Even though the 1930s in Denmark, like in almost all western countries, was a period of severe economic crisis, it was nevertheless a decade of high construction activity. Besides public works programmes to further employment, which mostly did not involve dwellings, this was largely due to very low nominal interest rates. These low interest rates in conjunction with the deflation of the 1920s made the rent levels in newly constructed dwellings highly competitive compared to the levels in the existing stock of dwellings, and thus made it profitable for developers as well as owner-occupiers to invest in new dwellings. For those reasons residential investment had a sizeable stabilising effect on the Danish economy during the depression.

For the years 1966-1996, residential investment in new dwellings on the one hand and in additions plus alterations on the other is available from the supply and use tables or input-output tables. For 1997-1998 for which the supply and use tables have not been finalised, the 1996 figures have been carried forward assuming the same proportion between new construction and additions and alterations as in 1996.

Whereas the retropolation for the period prior to 1966 must be considered as relatively reliable as far as new dwellings (including additions) are concerned, the figures calculated for alterations (improvements counted as investment) are considerably less reliable. For the period 1948-1965, where the data used for the extrapolation has been taken from the databank of the econometric model, no published data are available on additions and alterations to dwellings. The data series in the databank has been constructed using published figures for residential investment in new dwellings in the national accounting system in place for the years 1947 to 1965. In that system all repair and maintenance to dwellings, including routine repair and maintenance, was counted as gross fixed capital formation, but published residential investment only included new dwellings. Repair and maintenance for the economy as a whole was shown as a total without any breakdown. The data series in the databank has therefore essentially been constructed starting from an assumption of a constant 1966-ratio between new construction and alterations for the period 1948-1965 but with a balancing against the supply of construction output which has modified the assumption in the light of differences between estimated supply and demand. For the years 1948-65, both of our investment series have been carried back using the evolution in the single series for residential investment in the databank. This is equivalent to using a constant 1966-ratio.

For the period from 1948 back to 1930, the series for investment in both new construction and alterations have been carried backwards using the evolution in investment in new dwellings. This again is equivalent to assuming a constant 1966-ratio between the two components of investment in dwellings.

It should be noticed that the weight of improvements in total residential investment is much smaller in the earlier years than has been the case in the more recent period. Therefore, the uncertainty introduced by the need to estimate alterations for the years up to and including 1965 is relatively limited.

The deflators for the year 1966 have been carried backwards using the deflators for residential investment in the databank of the econometric model and published national accounts for the years back to 1946. For the years 1930-1939, no published deflator is available for residential construction. The evolution in the published deflator for total gross fixed capital formation has been used instead.

6.2 Constructed data 1870-1929

Supposing one would have to derive capital stock estimates for dwellings from the investment series going back to 1930 with a big gap during the Second World War, how would one go about it? Clearly, it would be out of the question to disregard dwellings completed before 1930. It is seen from table 3 that 31 per cent of the square metres of dwellings in existence as of January 1st 1999 originate from before 1930. Disregarding the oldest dwellings would introduce a big downward bias in the estimated capital stock. One way or another the oldest dwellings would have to be accounted for in the PIM estimates.

Table 3: Square metres before and after 1930.
Dwelling stock as of January 1st 1999

Year of construction	Square metres	Per cent
Before 1930	103.297.309	31
1930 onwards	230.444.507	69
Total	333.741.816	100
1940-45	7.721.722	

The way chosen here to account for the oldest dwellings in the PIM estimates is to estimate an initial 1930 stock of dwellings and to make an assumption about the historical investment that has given rise to the initial stock. The latter is necessary in order to estimate the discards in PIM.

The initial 1930 stock has been estimated firstly by calculating a net capital-output ratio and then to assume that this net ratio is identical to the gross ratio. The net capital/output ratio is defined as the ratio between the net capital stock and net output where net output is gross output less consumption of fixed capital. The net capital/output ratio has been calculated for the year 1932 for which there was a general valuation of all properties for real estate tax purposes. The numerator is calculated as the taxable value of all residential buildings (including residential buildings comprising business premises like shops) less the taxable value of the land belonging to the properties. The denominator is the gross output of dwelling services less consumption of fixed capital published in Statistics Denmark (1948). This net capital/output ratio for 1932 is then assumed to be equal to the gross capital/output ratio for 1930. The initial 1930 stock at current prices is then derived by multiplying published gross output of dwelling services in 1930 by the estimated capital/output ratio. This figure is then inflated to 1995-prices by means of the deflator for new dwellings. The estimated initial 1930 gross capital stock of dwellings at current prices is estimated at 3.6 billion crowns corresponding to 70 per cent of GDP for 1930 as published in Statistics Denmark (1948). The value at 1995-prices is 167 billion crowns. The capital-output ratio in this calculation, and hence the initial, capital stock, is very low. The capital-output ratio is only 7.5. The resulting PIM figures are consequently termed the "low case".

Whether this low capital-output ratio is due to a huge undervaluation in official real estate valuations for tax purposes, or whether it reflects an economic reality, is not known. However, since the capital-output ratio implied by these tax statistics is far below that resulting from a direct calculation of the capital stock in a later period, the presumption must be that the tax-based figures have a very strong downward bias.

For that reason an alternative calculation of the initial capital stock has been done with the much higher capital-output ratio for recent years implied by the direct stock calculation. The capital-output ratio used in the alternative calculation is that for 1995 which is the base year for the constant price calculation. The gross capital-output ratio for that year amounts to 23.6. With that much higher capital-output-ratio, the initial 1930 gross capital stock of dwellings at current prices is estimated at 11.5 billion crowns corresponding to 221 per cent of GDP for 1930 as published in Statistics Denmark (1948). The value at 1995-prices is 527 billion crowns.

Obviously, this higher capital-output ratio would not be available to statisticians who had to rely solely on PIM for the calculation of the stock of residential capital. Yet, a ratio of the same order of magnitude might be derived from looking at the relationship between residential investment and the *change* in the output of dwelling services using an assumption about discards. Therefore, it is relevant to present this alternative calculation. The results derived using this much higher capital-output ratio, and hence initial capital stock in 1930, is dubbed "the high case" in the rest of this paper.

In order to apply PIM, the initial 1930 stock has to be broken down into vintages. Otherwise the discards cannot be estimated. This is done by assuming that the initial 1930 capital stock was the result of a long history of residential investment growing by 2.5 per cent a year in real terms with no discards prior to 1930. More specifically, the resulting series has been truncated in 1870 which implies that 5.65 per cent of the stock of dwellings in 1930 is assumed to result from investment prior to 1871, which by the truncation is allocated to the year 1870.

After the gaps in the statistical investment series have been filled with these "modelled" data a very long series for investment in dwellings covering the whole period 1870-1998 is available as input to the PIM calculation. All the calculations are performed on the series at constant 1995-prices.

7. Service lives and survival patterns

When using the PIM, one has to make assumptions about service lives and survival patterns. In Denmark, very few dwellings are currently discarded not least due to a policy of preservation of the environment of city centres. Partly as a consequence of that policy the average age of dwellings is fairly high. Before the 1980s, on the other hand, there appears to have been important discards amounting to around 0.5 per cent of the stock each year, cf. Andersen (1992).

When deciding the service lives, it is important to look at the expected service lives at the time of investment. This means that one cannot look at buildings that may be about to be discarded today and which are, say, 100 years old and conclude that service lives are approximately 100 years. That is because some buildings erected 100 years ago have already been discarded. Therefore, when the Danish dwelling stock today seems to attain a very high service life before scrapping, this is partly because only the high-quality part is left.

In this paper the benchmark service life for new dwellings is 80 years and for alterations 35. The service lives used in the sensitivity analysis are shown in table 4.

Table 4: Service lives used in the PIM

	New	Alterations
Benchmark	80	35
Very long	100	40
Long (benchmark)	80	35
Medium	70	30
Short	60	20
Very short	50	15

The sensitivity analysis also looks at the effect of differentiating service lives depending on year of construction. Two scenarios are studied:

1. "Big decline": Up to construction year 1935: 100 years, 1935-50: 90 years, 1950-66: 80 years.
2. "Small decline": Up to construction year 1935: 100 years, 1935-50: 75 years, 1950-66: 60 years.

To connect the service lives, linear interpolation is used. For instance, the service life of 100 years in 1935 is connected to 90 years in 1950, and the 90 years in 1950 is connected to the 80 years in 1966 using an assumption of linear decline. The service lives chosen are further discussed in section 8.

In the PIM estimation of the stock of dwellings a Winfrey S3 survival function is used, cf. Winfrey (1939). There are several types of Winfrey survival functions, but they are all bell-shaped. The Winfrey S3 is a "medium peaked" symmetrical function[1]. It would be possible to do the calculations using other functions than the S3 type, but in order to keep the amount of data down, it was decided to use only the S3 type for the analyses in this paper.

There are other survival functions than Winfrey, e.g. Weibull (which is also bell-shaped), linear retirement and delayed linear. However, the Winfrey survival function seems to be the one most commonly used in countries that apply PIM to calculate the capital stock. Furthermore, as already mentioned, the exact shape of the survival function does not seem to matter much, as long as it is bell-shaped. For that reason we have chosen to concentrate the sensitivity analysis in this

[1] The Winfrey survival functions are grouped by skewness and peakedness. Skewness is grouped into left, symmetrical and right skewed and peakedness from 0 to 6 where 0 is the flattest and 6 the most peaked.

paper on the average service lives rather than the shape of the survival function. All the experiments with PIM in the paper are carried out using the Winfrey S3 survival function.

Table 5. Closing stock of dwellings 1988-1998. Direct stock calculation. Current prices and 1995-prices.

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Mill. DKK											
Total											
Current prices	1.670.870	1.773.513	1.856.571	1.949.927	2.059.143	2.081.332	2.147.742	2.212.180	2.269.522	2.330.628	2.407.611
Constant 95-prices	2.080.123	2.102.381	2.123.446	2.138.661	2.154.251	2.166.387	2.180.421	2.195.019	2.215.500	2.234.124	2.256.365
Breakdown into type of dwelling											
Current prices											
Farm Houses	133.351	139.658	143.136	148.808	154.407	153.799	157.031	160.952	160.894	160.441	160.892
One-family detached houses	749.206	790.499	815.000	851.311	894.337	895.070	919.802	949.543	978.332	1.009.579	1.046.727
Terraced and semi-detached houses	138.693	152.417	163.112	173.840	186.073	188.143	194.326	201.168	206.426	212.067	218.391
Multi-story dwellings	466.788	493.793	526.493	554.824	586.994	600.846	624.398	640.479	651.988	668.984	691.112
Student residences	7.203	7.865	8.498	8.995	9.645	9.975	10.415	10.733	10.951	11.362	11.772
Other dwellings	62.495	66.598	69.925	72.574	76.201	76.989	79.240	79.911	80.730	82.029	83.601
Holiday cottages	48.257	53.219	57.475	62.447	68.704	72.284	74.731	77.386	79.840	82.214	84.890
Garden cottages	2.099	2.185	2.416	2.591	2.811	3.028	3.116	3.255	3.617	3.675	3.818
Garages, carports, other small build.	62.686	67.245	70.507	74.530	79.969	81.196	84.682	88.752	96.743	100.275	106.406
Not classified	91	33	7	7	4	2	1	1	1	3	1
95-prices											
Farm Houses	161.134	160.971	160.910	160.845	159.830	159.671	159.570	159.601	156.764	153.716	151.061
One-family detached houses	905.301	911.132	916.201	920.172	925.746	929.241	934.677	941.572	953.220	967.262	982.767
Terraced and semi-detached houses	167.589	175.677	183.366	187.902	192.608	195.326	197.469	199.479	201.127	203.178	205.046
Multi-story dwellings	605.700	610.476	616.552	621.757	624.637	628.541	632.577	636.482	639.337	642.407	645.883
Student residences	9.346	9.724	9.952	10.080	10.263	10.435	10.551	10.666	10.739	10.911	11.002
Other dwellings	81.093	82.335	81.886	81.329	81.087	80.538	80.278	79.413	79.163	78.770	78.130
Holiday cottages	71.108	71.753	72.480	73.025	73.983	74.973	76.007	76.530	77.451	78.333	79.219
Garden cottages	3.092	2.947	3.047	3.030	3.027	3.140	3.169	3.219	3.508	3.502	3.563
Garages, carports, other small build.	75.640	77.326	79.043	80.515	83.066	84.518	86.122	88.056	94.189	96.044	99.694
Not classified	119	41	9	8	4	2	1	1	1	3	1

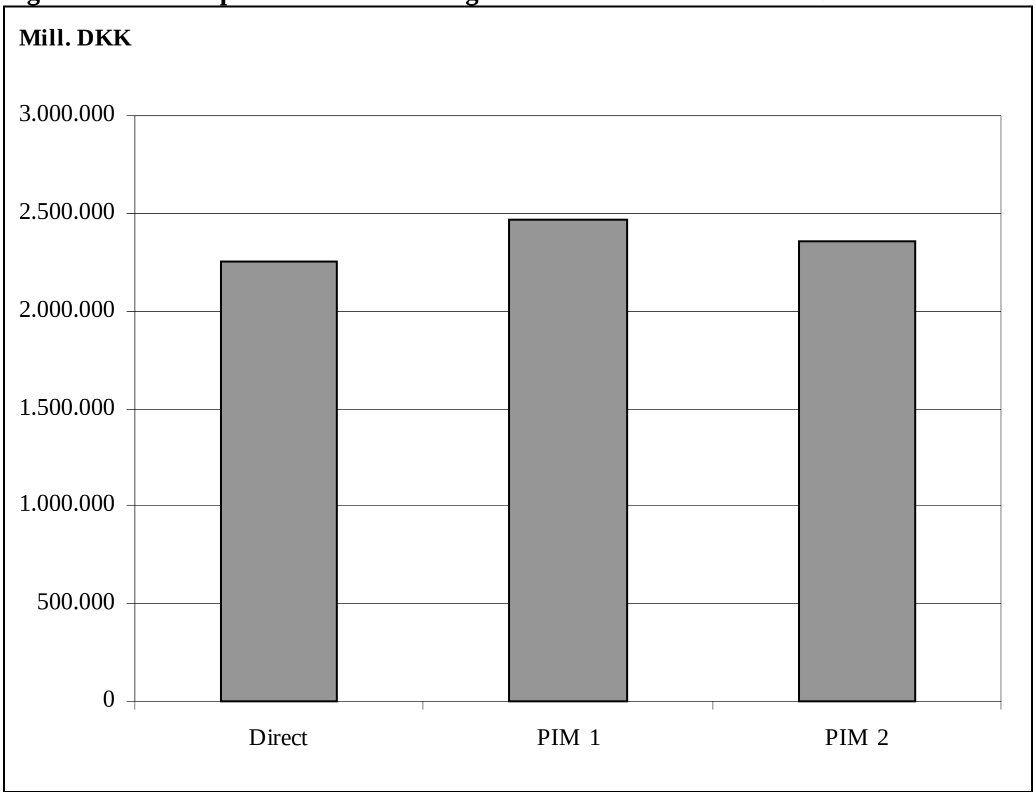
8. Results

The direct closing stock calculations for all the years 1988-1998 with a breakdown by type of dwelling are shown in table 5 at both current prices and constant 1995-prices.

The figures are obtained by multiplying the number of square metres for each category of dwelling by the corresponding square metre prices, where the latter are differentiated for dwellings erected before and after 1940. It should be noticed that in 1995, the current and constant price values are not the same. This is because the current price value must be calculated using prices observed at the point in time which the stock refers to, i.e. the end of the period, whereas at constant prices, the prices used are the average prices for the reference year.

The constant price values are exhibiting a slow growth during the 10 year period shown, a fact which reflects a low level of construction of new dwellings. Over the past decade, a very high share of total residential investment has come in the form of renovations and improvements to the existing stock of dwellings. To a certain extent this is the outcome of a deliberate political choice with the aim of preserving the neighbourhoods of existing city centres by channelling a big part of public funding into improvements rather than new construction. By far the largest part, however, is private investment mainly by owner-occupiers.

Figure 1: Gross Capital Stock of Dwellings End-1998. Direct Estimates Versus PIM



Note: PIM 1 High initial 1930 stock, service lives 80/35
PIM 2 Low initial 1930 stock, service lives 80/35

Figure 1 shows a comparison of a direct calculation of the closing stock of dwellings in 1998 at 1995-prices with the result of a PIM calculation for two scenarios concerning the initial stock in 1930, namely the "low" and the "high" cases as regards the initial stock in 1930. The PIM calculations shown in figure 1 are based on service lives of 80 years for new dwellings and 35 years for alterations. The estimated service life of 80 years for new dwellings is the one we would expect knowing the assumptions used in similar countries as well as our own experience. For alterations it is in reality no more than a guess inspired by some common sense considerations about the frequency of renewing roofs, windows, kitchens and bathrooms, those types of replacements being among the most important alterations, plus what is assumed in other countries. The margin of error on the service life for alterations is definitely big. Those two service lives we would regard as the a priori most informed guess possible based on the existing evidence.

As a reference, GDP in 1998 at 1995-prices is 1095 billion crowns. The gross capital stock of dwellings is thus more than twice GDP. As mentioned in the introduction, dwellings are by far the most important type of non-financial asset in the economy. Consequently, measurement errors concerning the stock of dwellings will have large consequences for the accuracy of the estimate of the total capital stock.

Looking at table 5 and figure 1, which show a gross closing stock of dwellings in 1998 of about 2.3 trillion crowns at 1995-prices, in combination with table 3 make clear that it is the "high case" scenario regarding the initial 1930 capital stock which is the more realistic one. Indeed, the initial 1930 stock at 1995-prices of 527 billion estimated in the case where the initial stock is estimated using a capital-output ratio of 23.6 corresponds to 23 per cent of the 1998 stock when the latter is directly estimated from stock information. Table 3 shows that dwellings dating from before 1930 account for 31 per cent of the square metres in existence. Allowing for the discards that have occurred in the intervening period, this comparison with physical data shows that even what we have dubbed the "high case" for the initial 1930 stock is probably underestimated. It takes some rather high reduction factors for lower quality of dwellings dating from before 1930 to reconcile the physical data with even the "high" estimate of the value of the initial stock of residential capital in 1930.

Based on the above reasoning, the analyses in the sequel will proceed from the "high case" in regard to the initial stock and dismiss the "low case" as unrealistic, assuming this would be recognised in an independent application of PIM. On the other hand, we do not consider an even higher initial capital stock, as the information from the direct stock estimate would normally not be available to national accountants having to resort to PIM. The capital-output ratio of 23.6 and the "high case" is considered in this paper as the scenario most favourable to PIM.

The reason that even what we call the "high case" for the initial 1930 stock of dwellings may give rise to an underestimation could be thought to be that the figure for output of dwelling services in 1930 is too low. In order to calculate the initial stock in the "high case" the capital output ratio of 23.6 is applied to the figure for the output of dwelling services in 1930 published in Statistics Denmark (1948). The output consists of actual rents and imputed rents of owner-occupied dwellings. The latter might a prori be thought to be too low, considering the difficulties inherent in imputing rents to farm houses for which there is no market for rented dwellings. The weight of farm houses and other houses in rural districts was much higher in 1930 than nowadays, and farm houses etc. therefore had a significant impact on the estimate of total rents. Nevertheless, we do not change the initial 1930 capital stock in the "high" case in the application of PIM in this paper. If one did not have the direct stock information and had to rely solely on PIM, the "high case" initial 1930 capital stock would probably be the best possible estimate. Moreover, the published figure for the output of dwelling services in 1930 (487.1 million) makes up 9.4 per cent of GDP. This figure in no way appears to be suspiciously low. It was consequently decided to accept the figure in the calculation of the initial capital stock.

It is seen from figure 1 that both the "low case" and the "high case" PIM estimates are above the direct stock estimate. Since the initial 1930 stock is in all likelihood understated even in the "high" case, the pattern in figure 1 can be taken as circumstantial evidence that a service life of 80 years for new dwellings and additions and 35 years for alterations is too high.

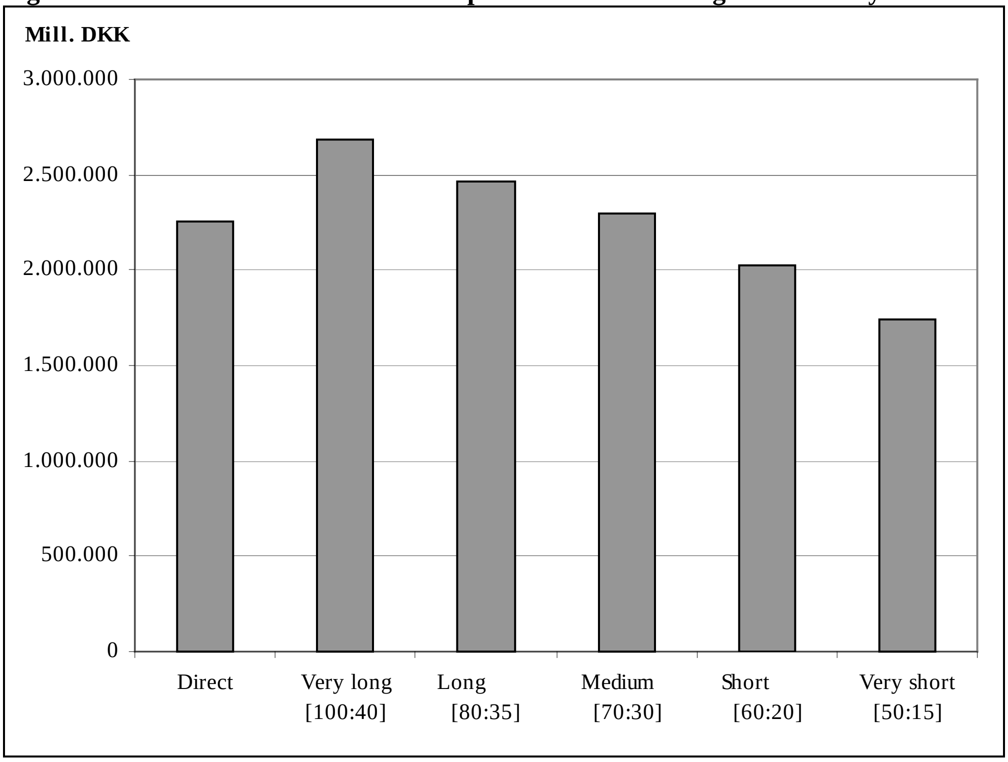
An important point, however, is that in the absence of a register enabling a direct estimate to be made, the PIM calculation dubbed the "high" case in figure 1 would presumably be considered as the best possible estimate of the stock of dwellings. As is clear from the figure this would imply an overstatement of the gross capital stock of dwellings by 9 per cent, or in absolute terms of 209 billion crowns at 1995-prices or 19 per cent of GDP.

9. Sensitivity analysis

In order to see how much the PIM estimate depends on the assumption about average service lives we have calculated the closing stock in 1998 at 1995-prices by means of PIM with five different scenarios regarding service lives. As a by-product this sensitivity analysis yields an indirect estimate of the average service lives of dwellings, namely the service lives that would render the PIM estimates compatible with the direct stock estimate.

It goes without saying that this indirect estimate of service lives is dependent upon the long investment series as well as the form of the survival function being broadly correct. These are important assumptions, but given the absence of direct information about the service lives of dwellings it is interesting to derive an indirect estimate.

Figure 2: PIM Estimates of the Gross Capital Stock of Dwellings – Sensitivity to Service Lives



Note: All high initial 1930 stock.

The results of the sensitivity analysis are shown in figure 2. The service lives applied in the five scenarios are shown in brackets. The first number refers to the average service life of new dwellings and additions, the second to the average service life of alterations. The chart shows that an average service life of 70 years for new dwellings and additions and 30 years for alterations would render the PIM estimate almost compatible with the direct stock estimate.

Given the earlier remark about the initial 1930 capital stock being probably somewhat underestimated in the PIM calculations, it can be said that there is no indication in the investment data from 1930 onwards that the average service life for new dwellings and additions is higher than 70 years. If anything, it may be argued to be slightly lower.

In the Danish case the PIM estimates are highly sensitive to the assumed service life of new dwellings and additions but much less so to even big variations in the average service life for alterations. This is due to the fact that the investment in alterations is much smaller than in new dwellings and additions except for the last two decades where the picture is drastically changed. However, for such recent investment the stock estimates are not very sensitive to variations in the average service life as there are very few discards at this early stage.

Table 6, which is based on information in OECD (1993), cf. also Meinen, Verbiest and de Wolf (1998), shows the average service lives used in the PIM estimates of the stock of residential capital in a number of OECD countries. It is seen that there are big differences in the service lives assumed by the various countries. This may reflect real differences among countries which may be related to cultural and demographic factors. However, to the extent that the different service lives assumed in the various countries are not real, but merely the consequence of assumptions, they do affect the reliability of capital stock data in general and of international comparisons of capital and wealth in particular. The sensitivity analysis shown in figure 2 illustrates that PIM estimates of the stock of dwellings are critically dependent on a relatively narrow margin of error concerning the average service life, a margin much narrower than the 45 – 100 years variation for new 1-4 unit structures shown in table 6.

Table 6: Average Service Lives of Dwellings (years)

	USA	**Japan**	**Australia**	**Belgium**	**Finland**	**Germany**	**Iceland**	**Norway**	**Sweden**	**UK**
1-4 unit structures										
- new	80	45	60-90	80	55	70	85	90	75	100
- add. and alterat.	40	-	40	-	-	-	85	90	-	10
5+ unit structures										
- new	65	50	60	80	55	70	85	90	75	100
- add. and alterat.	32	-	40	-	-	-	85	90		40

Source: OECD (1993), Mainen, Verbiest and de Wolff (1998). For more detailed information for the USA, see Katz and Herman (1997).

On this basis Mainen, Verbiest and de Wolff conclude: "On dwellings no observed data are available. Looking at the OECD-tables an average of 75 years seems to be an acceptable estimate"

The results of our analysis based on Danish register data and historical investment data would appear to confirm that conclusion. Our sensitivity analysis suggests an average service life for new dwellings and additions in the order of 70 years. A priori, we had expected an average service life for new dwellings and additions of about 80 years. This finding together with the results from other countries will be taken into consideration in the forthcoming benchmarking of the Danish capital stock estimates.

The conclusion about the average service life of new dwellings in Denmark reached in this paper is apparently at variance with the average service life estimated by Boligministeriet (1990) and Andersen (1992). Andersen estimates a median service life of 100 years. The median is used in her analysis instead of the mean because she assumes that a small number of dwellings have an infinite service life. For practical purposes the median reported in her article can be compared with the average service lives reported by others.

There are at least two reasons to believe that the average service life of 100 years is too high, at least if the service life is to be understood as pertaining to residential investment in new dwellings as understood in the national accounts.

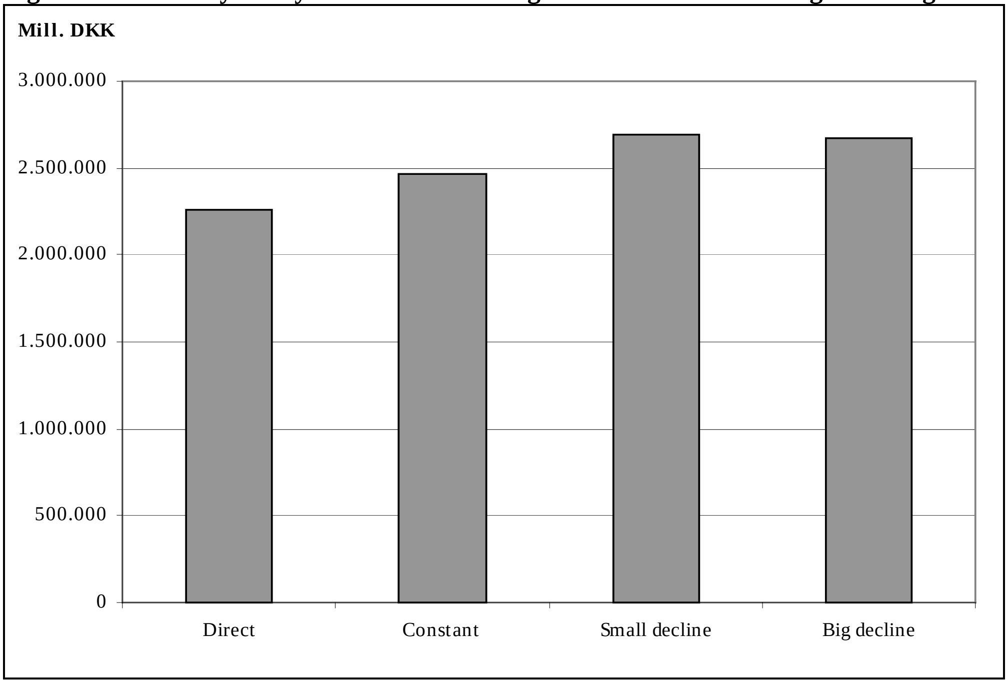
Firstly, these authors estimate the service life of dwellings by looking at demolition statistics showing the actual age of the (small number of) dwellings that were discarded in the course of the 1980s. The solid data for the 1980s based on the BDR is supplemented by material from the population and housing censuses of the previous decades which can indirectly shed light on the number of discarded dwellings but not on the average age of the dwellings demolished or abandoned. Looking at the actual age of dwellings demolished is in principle a sound methodology for estimating the service life of the *load-bearing construction* of a dwelling but not of the dwelling as a whole. If the period studied is long enough, the age pattern of houses demolished should give a reasonably representative picture of the longevity of the bearing constructions. However, as already mentioned, the 1980s and (1990s) were characterised by a policy of renovating and upgrading old residential buildings rather than building new ones. Consequently, the average age of houses demolished in the 1980s may not be representative of the longevity of the vintages of dwellings they come from. This may potentially lead to an upward bias. Moreover, the material used from censuses is much less solid than the BDR information and does not give a clear-cut picture of the age of dwellings that have been demolished.

Secondly, the service life of the *load-bearing construction* of a dwelling cannot be identified with the average service life of the dwelling as a whole. Indeed, the load-bearing construction (foundation, pillars, walls etc.) is typically that part of a dwelling which has the longest economic life. Important parts of the dwelling such as the roof, the heating or air-conditioning installations, the kitchen, bathrooms etc. mostly have to be replaced in whole or in part one or more times in the course of the life of the load-bearing construction. The replacements are themselves predominantly treated as investment (alterations) in the national accounts. The average service life of a *dwelling as a whole* must therefore be considerably lower than that of the bearing construction.

For the above reasons there is hardly any doubt that the 100 years service life estimated by Boligministeriet (1990) and Andersen (1992) are too high for national accounting purposes.

Another sensitivity analysis has been carried out regarding the impact of a potential decline in service lives on the capital stock estimates. Some people have advanced the idea that the longevity of dwellings has declined over time as a consequence of the "industrialisation" of construction work. The idea is that the move from traditional individual construction to prefabricated houses in particular has caused the average service life of new dwellings to decline. Figure 3 shows the impact on the PIM calculations of the gross capital stock of dwellings of assuming a fall in longevity. The chart shows three scenarios plus the direct stock estimate. In all three the average service life of alterations is assumed to be 35 years. In the first scenario the average service life of new dwellings and additions is held constant at 80 years. In the second the service life is assumed to be 100 years until 1935, then gradually declining to 90 years in 1950, and further gradually declining to 80 years in 1966 from which time it is then assumed to be constant. In the third scenario the corresponding lifetimes for the same time intervals are 100, 75 and 60 years.

Figure 3: Sensitivity Analysis of Differentiating Service Lives According to Vintages



Note: All high initial 1930 stock

Figure 3 shows that at present the PIM estimates of the *gross* stock of dwellings are not very sensitive to the speed of an assumed decline in longevity after 1935. The results in scenario 2 and 3 are very close. This is due to the fact that very few dwellings erected after 1935 are discarded before 1999 under the Winfrey S3 retirement pattern with these average service lives.

However, in future, when the newer dwellings from the big vintages in the 1960s and 1970s approach their average service life and begin to be discarded in large numbers if the Winfrey S3 curve is assumed, the assumption about a decline, or absence thereof, in the average service life will become critical if one applies PIM in order to calculate the gross stock of dwellings. Furthermore, a gradual decline in the service life of dwellings may have a very sizeable impact on consumption of fixed capital and the *net* capital stock, since the reduction in service life has an immediate impact on the consumption of fixed capital calculated for the newer vintages. The calculation of consumption of fixed capital and the net stock are, however, outside the scope of the paper.

10. Conclusion

The comparison of direct estimates of the gross stock of residential capital with estimates derived from long time series of investment data using PIM gives several interesting insights.

First, the need to have extremely long time-series of residential investment if PIM is to account properly for the older dwellings. Of course, in countries experiencing very fast economic growth and population growth this aspect will be less important than in economies with more modest population growth and (overall) economic growth. The need to estimate investment data for the distant past introduces significant uncertainty in PIM estimates for assets with as long a lifetime as dwellings.

Second, the sensitivity analysis of the results of PIM demonstrates the need for reasonably accurate estimates of the average service life of dwellings, if PIM is to yield reliable results.

Third, as a by-product of the comparison and the sensitivity analysis it is possible to derive an indirect estimate of the average service life of dwellings, namely as the service life that renders the PIM compatible with a direct estimate of the capital stock. The paper suggests an average service life which is close to the average of the service life assumptions reported to the OECD by a number of countries.

Fourth, the service lives for dwellings currently applied by countries in deriving capital stock estimates vary from 45 – 100 years. It is by no means clear that all of this variation is due to real differences between the countries. To the extent it is not, the variation poses a problem for international comparisons of capital and wealth. Given the very great weight of dwellings in the capital stock, there is a good case for investing research funds in studies of the retirement pattern of dwellings.

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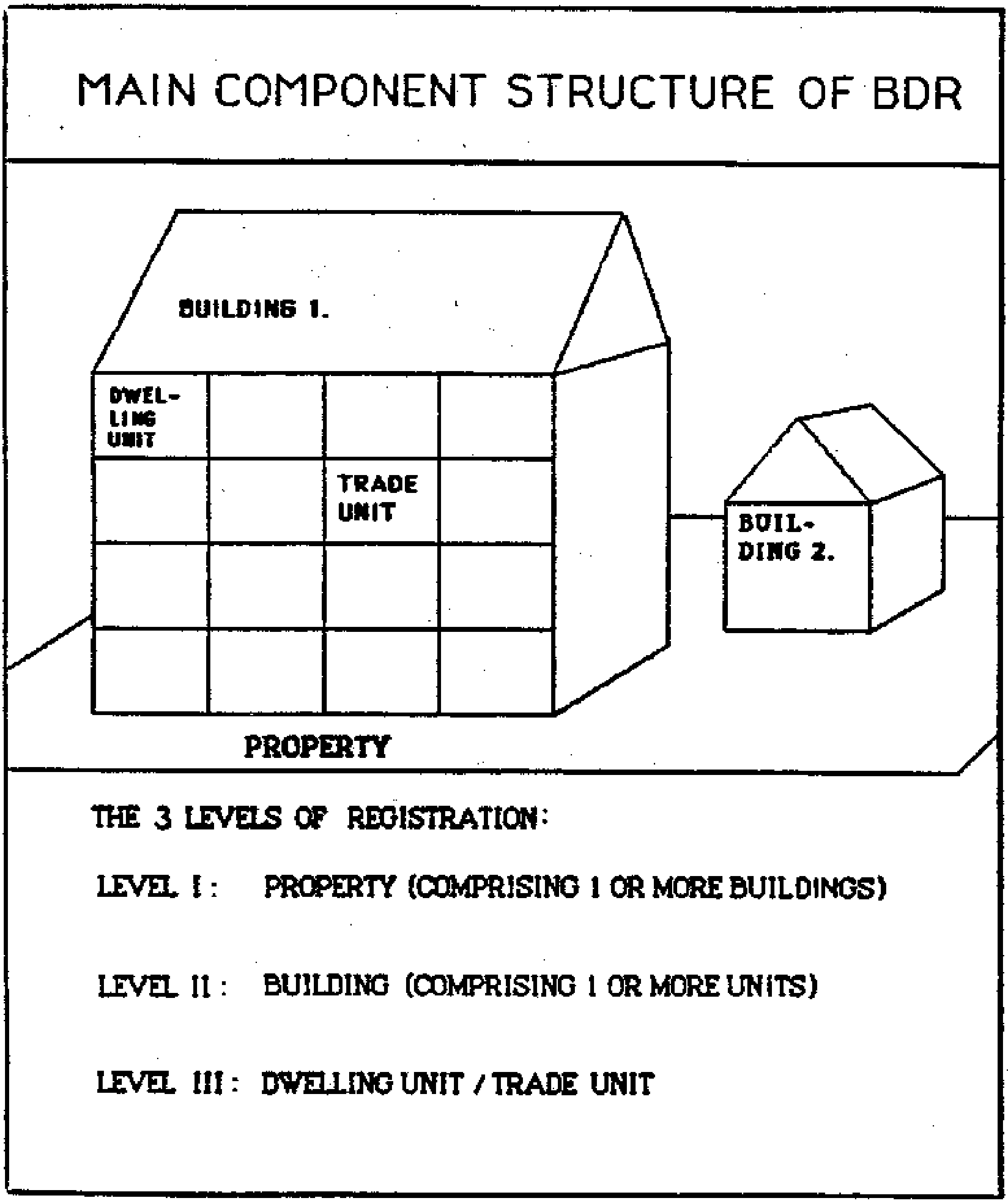
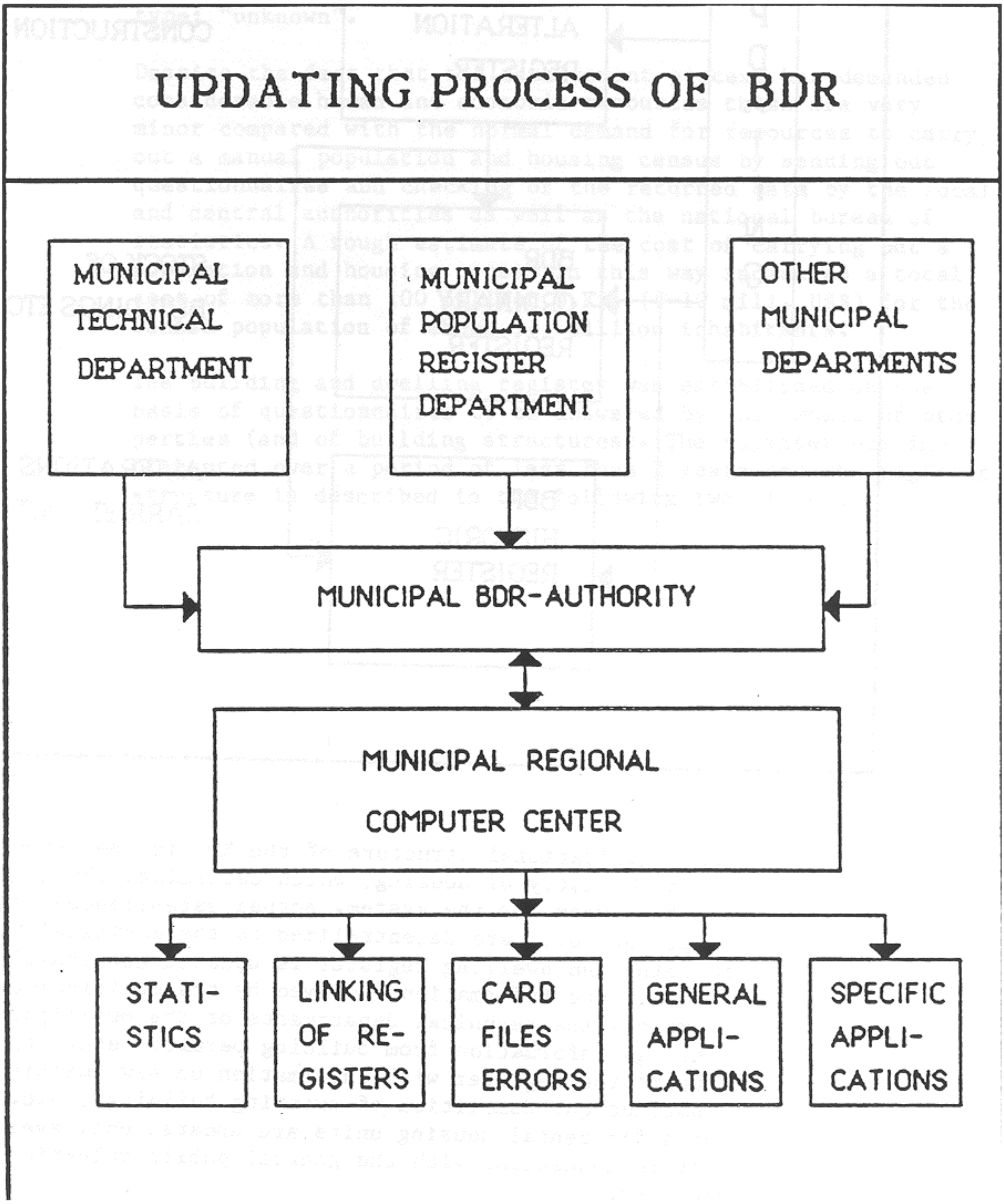
Annex1: The BDR Schematically




UPDATING PROCESS OF BDR
MUNICIPAL TECHNICAL DEPARTMENT
MUNICIPAL POPULATION REGISTER DEPARTMENT
OTHER MUNICIPAL DEPARTMENTS
MUNICIPAL BDR-AUTHORITY
MUNICIPAL REGIONAL COMPUTER CENTER
STATI-STICS
LINKING OF RE-GISTERS
CARD FILES ERRORS
GENERAL APPLI-CATIONS
SPECIFIC APPLI-CATIONS

Annex2: Long investment series used for PIM calculations

Year	Invest. in new dwellings Current prices	Invest. in alterations Current prices	Total residential investment Current prices	Investment in new dwellings 1995-prices	Investment in alterations 1995-prices	Total residential investment 1995-prices	Deflator, new 1995=1,00	Deflator, alterations 1995=1,00
				1000 DKK				
1930	*255,943*	*42,608*	*298,551*	25,177,932	3,333,944	28,511,877	*0.021*	*0.027*
1931	*255,781*	*42,581*	*298,362*	25,974,510	3,439,423	29,413,934	*0.021*	*0.026*
1932	*191,755*	*31,922*	*223,677*	19,714,143	2,610,455	22,324,597	*0.020*	*0.026*
1933	*277,015*	*46,115*	*323,131*	27,898,607	3,694,203	31,592,810	*0.021*	*0.026*
1934	*348,173*	*57,961*	*406,135*	33,954,465	4,496,092	38,450,557	*0.022*	*0.027*
1935	*328,722*	*54,723*	*383,446*	31,442,641	4,163,488	35,606,129	*0.022*	*0.028*
1936	*285,768*	*47,573*	*333,341*	26,565,406	3,517,667	30,083,073	*0.023*	*0.028*
1937	*268,910*	*44,766*	*313,677*	23,150,397	3,065,467	26,215,864	*0.024*	*0.031*
1938	*255,619*	*42,554*	*298,173*	21,010,543	2,782,118	23,792,661	*0.026*	*0.032*
1939	*334,233*	*55,641*	*389,874*	26,480,157	3,506,379	29,986,536	*0.027*	*0.033*
1940				19,511,615	2,583,637	22,095,252		
1941				13,981,800	1,851,405	15,833,205		
1942				17,974,675	2,380,122	20,354,797		
1943				23,155,779	3,066,180	26,221,959		
1944				21,118,716	2,796,442	23,915,158		
1945				15,968,946	2,114,533	18,083,479		
1946	824,970	137,335	962,305	17,619,679	2,333,115	19,952,794	0.047	0.059
1947	696,995	116,031	813,026	13,753,169	1,821,130	15,574,300	0.051	0.064
1948	842,878	140,316	983,194	15,340,073	2,031,261	17,371,334	0.055	0.069
1949	866,809	144,300	1,011,109	15,348,674	2,032,400	17,381,074	0.056	0.071
1950	1,048,864	174,607	1,223,471	17,304,470	2,291,377	19,595,847	0.061	0.076
1951	1,136,323	189,167	1,325,490	15,498,531	2,052,243	17,550,774	0.073	0.092
1952	1,241,284	206,640	1,447,924	16,302,440	2,158,693	18,461,133	0.076	0.096
1953	1,418,390	236,124	1,654,514	19,301,200	2,555,775	21,856,974	0.073	0.092
1954	1,584,492	263,775	1,848,267	21,230,891	2,811,295	24,042,186	0.075	0.094
1955	1,331,581	221,672	1,553,253	17,364,115	2,299,275	19,663,390	0.077	0.096
1956	1,315,923	219,065	1,534,988	16,490,473	2,183,591	18,674,064	0.080	0.100
1957	1,614,527	268,775	1,883,302	19,605,182	2,596,027	22,201,209	0.082	0.104
1958	1,499,296	249,592	1,748,889	18,224,500	2,413,203	20,637,703	0.082	0.103
1959	1,944,465	323,701	2,268,166	23,373,986	3,095,074	26,469,060	0.083	0.105
1960	2,084,869	347,074	2,431,943	24,317,297	3,219,983	27,537,280	0.086	0.108
1961	2,644,647	440,262	3,084,909	28,749,917	3,806,930	32,556,847	0.092	0.116
1962	3,023,957	503,407	3,527,363	31,246,034	4,137,454	35,383,488	0.097	0.122
1963	2,991,562	498,014	3,489,576	29,774,171	3,942,556	33,716,727	0.100	0.126
1964	4,062,722	676,333	4,739,056	38,181,023	5,055,753	43,236,776	0.106	0.134
1965	4,728,054	787,093	5,515,147	40,616,978	5,378,310	45,995,288	0.116	0.146
1966	5,238,013	871,987	6,110,000	42,310,070	5,602,502	47,912,572	0.124	0.156
1967	6,029,210	1,121,790	7,151,000	45,882,717	6,859,012	52,741,729	0.131	0.164
1968	6,243,699	1,283,301	7,527,000	44,462,812	7,417,271	51,880,083	0.140	0.173
1969	8,354,939	1,594,061	9,949,000	55,554,308	8,714,880	64,269,188	0.150	0.183
1970	8,763,970	1,618,030	10,382,000	53,627,316	8,176,325	61,803,641	0.163	0.198
1971	9,091,154	1,740,846	10,832,000	51,919,807	8,280,629	60,200,436	0.175	0.210
1972	12,505,866	2,455,134	14,961,000	66,728,325	11,089,959	77,818,284	0.187	0.221
1973	14,884,072	2,868,928	17,753,000	68,083,445	11,215,364	79,298,809	0.219	0.256
1974	12,961,080	3,379,920	16,341,000	49,168,143	11,039,159	60,207,302	0.264	0.306
1975	11,822,596	3,934,404	15,757,000	40,471,988	11,689,332	52,161,320	0.292	0.337
1976	15,000,584	5,117,416	20,118,000	47,567,916	14,232,782	61,800,698	0.315	0.360
1977	13,820,214	6,041,786	19,862,000	39,819,080	15,399,185	55,218,265	0.347	0.392
1978	14,727,465	6,671,535	21,399,000	38,581,573	15,587,811	54,169,384	0.382	0.428
1979	15,373,207	7,466,793	22,840,000	36,629,776	16,037,690	52,667,466	0.420	0.466
1980	13,087,614	7,943,386	21,031,000	27,831,733	15,336,014	43,167,747	0.470	0.518
1981	10,126,559	7,224,441	17,351,000	19,106,917	12,478,486	31,585,403	0.530	0.579
1982	10,025,063	7,988,937	18,014,000	17,208,993	12,653,730	29,862,723	0.583	0.631
1983	12,097,435	9,585,565	21,683,000	19,098,244	14,081,061	33,179,305	0.633	0.681
1984	17,216,131	10,430,869	27,647,000	25,777,788	14,650,005	40,427,793	0.668	0.712
1985	17,708,627	10,809,373	28,518,000	25,258,197	14,585,395	39,843,592	0.701	0.741
1986	23,322,343	12,279,657	35,602,000	32,946,885	16,547,369	49,494,254	0.708	0.742
1987	21,313,312	15,603,688	36,917,000	28,793,967	20,268,975	49,062,942	0.740	0.770
1988	19,481,215	15,291,785	34,773,000	24,540,921	18,683,082	43,224,000	0.794	0.818
1989	18,568,158	14,983,842	33,552,000	22,089,729	17,520,271	39,610,000	0.841	0.855
1990	17,200,460	13,957,540	31,158,000	19,247,884	15,873,131	35,121,000	0.894	0.879
1991	14,131,514	14,312,526	28,444,000	15,515,158	16,041,856	31,557,000	0.911	0.892
1992	13,562,189	15,467,811	29,030,000	14,679,332	16,896,686	31,576,000	0.924	0.915
1993	11,632,729	20,101,271	31,734,000	12,201,673	21,356,307	33,558,000	0.953	0.941
1994	13,083,384	22,295,616	35,379,000	13,328,328	23,228,645	36,557,000	0.982	0.960
1995	15,876,301	23,787,699	39,664,000	15,876,301	23,787,699	39,664,000	1.000	1.000
1996	19,123,380	23,459,620	42,583,000	18,846,947	23,121,053	41,968,000	1.015	1.015
1997	21,139,771	25,933,229	47,073,000	20,480,248	25,124,752	45,605,000	1.032	1.032
1998	22,528,791	27,637,209	50,166,000	21,117,633	25,906,684	47,837,000	1.067	1.067

Note: Constant price figures 1939-1945 not from the national accounts but extrapolated backwards by means of quantity indicator. National accounts figures for 1930-1939 only used to carry back the 1939 level to 1930.