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Suggestions for simplified Fixed Capital Stock calculations at Statistics Sweden

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Introduction

The Perpetual Inventory Method (PIM) used at Statistics Sweden to calculate the Fixed Capital Stock (FCS) is rather inflexible which necessitates ad hoc solutions to certain problems. Part of the problem lies in the old FORTRAN program used but a modified PIM accumulation formula would help making both programming and use easy and flexible.

With the implementation of SNA93 more emphasis is put on the wealth aspects of the FCS. This means that not only the rate of stock changes is of great importance but also the level of the stock. The PIM now in use at Statistics Sweden is often commented upon as being acceptable in estimation of stock changes but poor in level estimates. If this is true SNA93 challenges the PI-method and implies a revision. A more detailed description of the methods is given in Tengblad and Westerlund (1976) and Tengblad (1993).

The suggested formula in this paper only calculates the net stock so a problem of estimating the gross stock occurs. This paper deals with a simple way to resolve the problem without any greater loss of meaning in the gross stock concept.

Gross and net stock

The gross stock can be thought of in relation to the volume of output. The changes in stock reflects the changes in potential production of output. On the other hand, the actual output in relation to potential output is the degree of capacity utilisation. This means that the gross capital stock can be used to construct an index of productive capacity and once there exists a bench mark value of capacity utilisation the corresponding time series also can be constructed.

The net stock is related to the wealth value of the stock, i.e. the discounted value of the income stream due to the use of the stock in production. This is the valuation made on the market with equally distributed information and perfect foresight, i.e. the neo-classical ideal market and the market concept underlying SNA.

The present calculations

In the present calculations of gross and net FCS with PIM long time series of past Gross Fixed Capital Formation (GFCF) are used to calculate the stock value for one single year. A typical length of a time series needed for office buildings is 100 years. The accumulation formula used is given below:

$$K_{t+1} = \sum_{\tau=t-\lambda\text{ (max.)}}^{t} (I_\tau / P_\tau) * \varphi_{t-\tau} \qquad (1)$$

where K_{t+1} is the replacement cost of the stock of a specific asset type in an activity in the beginning of year t+ 1, I_t the GFCF in current prices year t, P_t is the price index relating year t to the base year and the proportion of assets of vintage still existing in year t. denotes a survival curve with a distribution of service lives around an average value and with a maximum value (max.) and t- denotes the number of service years for each vintage of assets. Summing over all asset types and all activities will give the total stock value. This implies an assumption of the efficiency being unchanged over the entire service life.

The net stock value is achieved by subtracting consumption of flied capital (CoFC) from equation (1) which leads to the following expression of the net stock, N_{t+1} at year t+1:

$$N_{t+1} = \sum_{\tau=t-\lambda\,(max.)}^{t} (I_\tau/P_\tau) * \varphi_{t-\tau} * (1-(t-\tau)/\lambda_{t-\tau}) \qquad (2)$$

where the term $(t-\tau)/\lambda_{t-\tau}$ accounts for CoFC. The term $t-\tau$ is the age of the asset and $\lambda_{t-\tau}$ is the expected average service life of an asset with age $t-\tau$. An example might help in understanding. Let the service life lie between 0 and 10 years distributed around an average of 5 years. A new asset has an age of zero and an expected service life of 5 which means no CoFC. An asset of five years age have an expected service life longer than five years say 7 years which gives an accumulated CoFC of 5/7 of the replacement costs for that particular asset. We should remind us of the fact that only about 50 percent of all assets bought 5 years ago are in use which gives a higher share for the total CoFC. An asset of 8 years age might have an expected service life of 9 years so 8/9 of the replacement costs is used up and so on.

Problems

There are two major problems which can not easily be dealt with in the present framework. The first is unforeseen obsolescence and changes in sector or activity classification. Unforeseen obsolescence can be viewed upon as the first pan of the classification problem. So, the both problems turn out to be of the same type. The solution depends on what information is at hand. If only the corresponding net stock value is known the solution is different than if the corresponding past GFCF values axe known.

Knowing the net stock value only, necessitates an estimation of the gross stock value. This has to be done for every year the reclassified stock is in use and that might be several years. This has to be done for all reclassifications which means that a system of reclassifications corrections will emerge and grow.

In the other case where the past GFCF figures are known this information can be used to construct the gross and net stock to be added and/or withdrawn from a specific sector or activity. This will also lead to a separate system of corrections which has to be in use as long as the remaining service life of the reclassified GFCF.

The problem might even be more complicated if the two sectors or activities involved in the transaction have different service life for the same asset due to more or less intensive use. This leads us to the second problem, i.e. changes of service lives due to technical progress. To introduce a new service life for all GFCF made a specific year and onwards and in the same time retain the older service life for previous GFCF can easily be handled by splitting the calculations into two and then summing them in the end to get yearly sums for each asset. Problems occurs when the service life is changed for all assets of the same type or when a gradual (yearly) change in service life is introduced. I think these problems can be dealt with but the number of calculations will increase as well as the complexity of the stock estimations system.

To avoid building huge systems to correct the output from the PIM I would propose using an other formulation of the PIM accumulation formula.

An alternative PI-method

With the integration of Balance Sheets in SNA more emphasis is put on the wealth value of the capital stock, i.e. the net stock concept. This implicates that a good estimate of the net stock now is of greater interest. So, a switch from an accumulation formula starting with the gross stock and adjusting it to a net stock, to start with a formula of the net stock is not to strive against the intentions of SNA93.

The alternative method is no new finding but a rather well known relation between CoFC, GFCF and net FCS at the beginning and end of an accounting period. Added is a correction term. But to make it really useful we have to replace the linear CoFC pattern with a geometric one. This means that CoFC is a given share, δ of the net stock rather than a given share of the gross stock.

This leads us to the following expression:

$$N_{t+1} = N_t + GFCF_t - \delta_t N_t - \varepsilon_t N_t \qquad (3)$$

Where $\varepsilon_t N_t$ is the correction term. But in this case the correction is only made the first year it occurs. For each reclassification only one correction is needed. This is because a geometric CoFC rate is used, i.e. the same rate for all assets of the same type independent of age. So, once the correction is made the correct stock and CoFC will be calculated.

Equation (3) can be reformulated as:

$$N_{t+1} = (1- \delta_t - \varepsilon_t)N_t + GFCF_t \qquad (4)$$

The switch from equation (2) to equation (4) can be made in at least three different ways. The most attractive, I think, would be to use the FCS, N_t calculated with equation (2) as the starting point for the future. This will leave the previous time series unchanged. The CoFC rate, δ is constructed by using the following relation:

$$\delta = 2 / \lambda^* \qquad (5)$$

where λ^* is the mean service life of the asset. This relation is called double declining balance. Another way is to use a bench mark value of the net stock estimated in a different way than with the PI-method. The third, and I think least attractive way is to use equation (4) and cumulate a net stock in the same manner as with equation (2).

The proposed method of stock calculations has some obvious advantages. As already stated: it is easy to make corrections, e.g. introducing new bench marks to improve the level estimates. Changes in service life can be introduced in a simple way. Long time series of past investments are only necessary to estimate a starting point (bench mark), which means that values of GFCF will only be used once and not repeatedly over the entire service lives of the assets. This leads to a drastic reduction in the amount of input data.

The great disadvantage is that we have to omit the gross stock[1] unless it 's possible to reconstruct it. How this can be done is discussed below.

Gross stock

The gross FCS is used for different analytical purposes. Omitting this statistics is not recommended, but how can it be estimated consistently with no changed in concept and in accordance with equation (4)? The difference between gross and net stock is the accumulated CoFC of the assets in the stock. This is clear from equations (1) and (2) above. The accumulated CoFC is the sum of the yearly

[1] Under certain assumptions of the efficiency decline when assets grow older the gross and net stock coincides (c.f. Hansson (1989)). But I doubt that we in this case can argue that we are dealing with two genuinely different stock concepts. The gross stock in this paper is assumed having no in place loss of efficiency so the possibility of using equation (4) both for gross and net stock calculations is excluded.

CoFC figures over the past service life for all assets in use. The relation between gross and net stock consists of information of past GFCF, CoFC and survival shares. The way to use information of the past without having detailed information for every year is to use averages. So, averages will play a crucial role in reconstructing the gross stock.

The average survival share depends on the pattern of past GFCF. When GFCF is of equal value in constant prices each year the average survival share, by definition, will be 50 percent. This will rarely be the case due to the pattern of GFCF acting as weights. With an increasing trend in GFCF the average share lies above 50 percent. This part of the problem will be omitted if a simplified version of equation (1) is used. If the distribution of service lives around the average service life is ignored the equation will be stated as follows:

$$K_{t+1} = \sum_{\tau = t-\lambda^*}^{t} (I_\tau / P_\tau) \qquad (6)$$

with the cumulating interval changed to the average service life which is approximately half of the original length. The rationale for this simplification is that summing 100 percent half of the period will approximately give the same value as summing 50 percent of the value (on average) for the whole period.

Once having calculated the gross stock bench mark with historic data the next step is to calculate the consecutive changes of the stock. What equation (6) implies is that the value of the oldest GFCF, $I_{t-\lambda^*-1}$ should be exchanged for the value I_t. But we do not want to carry all the GFCF series with us for the consecutive calculations so the historic information has to be condensed in one single value which can be used in combination with the present value of GFCF to calculate the gross stock. One kind of useful information is the average growth of GFCF from λ^* years back to the present. The average growth, g can be estimated in different ways depending on the degree of precision needed. With this information we can use equation (7) to calculate consecutive stock values.

$$K_{t+1} = K_t + (I_t / P_t) * (1-(1 / (1+g)^{\lambda^*})) \qquad (7)$$

Using the average growth will underestimate the stock change when the growth of GFCF goes down and vice versa when the GFCF growth increases.[2] Equation (7) will give us a gross stock series and the last step will be to relate the independent gross and net stock series formulated in equations (4) and (7) with each other. First of all it is possible to accept the independent series because they will be used for different analytical purposes. Secondly, we can use information from the relation between equations (1) and (2) to relate the gross stock level to equation (4) for a single year (bench mark) together with the independent information of stock change from equation (7). A third way is to use the net stock counterpart of equation (7) to construct a yearly ratio between gross and net stock.

Summary and conclusions

With the integration of balance sheets in National Accounts more emphasis will be put on the net stock concept. The accuracy of stock level estimates will also be of greater importance. Together with the inflexibility of the PIM in use this necessitates a revision in method. But a change to a method only calculating the net FCS raises a problem for those who uses the gross stock, e.g. in productivity analysis. To reconstruct the gross stock without loosing the gained flexibility by the method switch leads us to a simplified version of the original method using averages. Before we decide upon which method to use a simulation of the results with the simplified method has to take place. A simulation might also give information of how to modify equation (7) to increase quality.

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[2] The under- or overestimation is in relation to equation (1). There is in fact a possibility that equation (7) better copes with reality. The difference in estimation can be seen as a change in service life. In recession the growth of GFCF might be lower than the average growth in the past. In such a case the gross stock change ratio between equation (7) and equation (1) will be lower. This can be seen as a temporary shortening of the service life which also would have the effect of lowering the growth. The opposite happens when there is an investment boom. The GFCF growth increases and so does the gross stock ratio but this would also be the fact if we temporarily increased the service life. The rationale for this is that in a recession scrapping is larger due to increased price competition and in a boom the prices of investment goods raises and thereby making it economically interesting to use existing machinery a little bit longer.

References:

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