ANNEX B

Implementation of capital estimates using an artificial dataset

This Annex uses the formulae worked out in chapter 19 and presents them in a typical sequence of implementation. An artificial but not unrealistic dataset is used to demonstrate implementation. The purpose of this annex is to document the sequence of implementation, to demonstrate how to aggregate across sectors and industries and to examine the effects of using an *ex-ante* versus an *ex-post* approach when measuring user costs. The documented dataset with all the calculations is available in spreadsheet form on [URL here]. The data set has the following features:

- The dataset distinguishes between institutional sectors and industries. The institutional units are 'corporations' or market producers and 'government' or 'non-market producers', the industries are 'manufacturing', 'services' and 'public administration'.
- Manufacturing industry is exclusively composed of corporations. For services, a distinction has been made between market producers and non-market producers. Public administration is exclusively made up of non-market producers.
- Three types of assets are considered, 'machinery', 'software' and 'land'. They were chosen to represent three typical types of assets. 'Machinery' is the prototypical equipment with a long-run price change that is somewhat less than overall inflation, and medium-range service life; 'software' stands for short-lived high-tech equipment with a short service life, and rapid declines in relative prices; 'land' represents a non-produced asset whose quantity is fixed in our example but whose prices undergo large cyclical movements as has been observed in reality.
- Geometric age-price and age-efficiency profiles are used throughout.
- All producers face the same purchase price for assets.
- Two main methods will be compared in the computation of user costs: *ex-post* and *ex-ante* measures of costs of capital. For the *ex-post* case, a distinction is made between the standard and the simplified case, as shown in the table below.

The main steps in the calculation procedure were:

1. Apply price indices of GFCF to machinery and software investment to obtain GFCF series in chained dollars of the reference year 2000.
2. Estimate an initial stock for each asset. In our simple example, the initial stock was calculated for the year 1979 as initial stock = GFCF in 1979/(long-run growth of constant-price GFCF + rate of depreciation). Obviously, for actual implementation, the initial

Industry	Type of producer	Method		
		Ex-post rate of return		*Ex-ante* rate of return
		Standard method with *ex-post* asset price changes	Simplified method with real asset price changes set to equal zero	*Ex-ante* (average or smoothed) real asset price changes
Manufacturing	Market producers	Endogenous rate of return		4% exogenous real rate of return
Services	Market producers			
	Non-market producers	With ex-post rate as average of ex-post rate from market producers		2% exogenous real rate of return
Public administration	Non-market producers			

stock should be computed for a period that lies further in the past so that errors in the estimates of the initial stock have only a small effect on more recent levels of capital stocks. Computation of an initial stock marks a major difference to models with non-geometric patterns where no initial stock is needed but GFCF time series of the entire service life of an asset. The stock of land is expressed in physical units here, and information about it has to come from registers or land surveys. The stock of land has been taken as fixed in the present example, implying that there is only one type of land.

3. Given the net stock at the beginning of the first period, W1979B, end-period net stocks for all consecutive periods are set up by applying the stock-flow relationship $WtE = WtB + It - \delta(It/2+WtB)$. All stocks are valued at average prices (chained dollars) of the year 2000.
4. On the basis of net stock and rates of depreciation, the value of depreciation at average prices of the year 2000 is computed by applying the rate of depreciation to the net stock at the beginning of the period plus half the current period's investment: $Dt/P0t = \delta[It/2 + WtB]$. Subsequently, depreciation is re-valued to current prices by multiplying through by the price index for capital goods, P0t.
5. Only a small transformation is needed to compute the year-average net stock for every period as well as the productive stock Kt which, in the set-up in this Manual, equals the wealth stock plus investment in the latest period: $Kt=It/2+WtB$.
6. Given time series of gross operating surplus Gt along with depreciation re-valued to current prices, Dt, net operating surplus Nt is measured as Gt-Dt. For non-market producers, the net operating surplus is zero in the first instance. However, if costs of capital are imputed in the way shown in the example, the net operating surplus will be non-zero.
7. Indices of real asset prices are established by deflating nominal asset price indices by the consumer price index.
8. For every type of asset, industry and sector, the value of capital services is computed in three variants as outlined above. Results are marked up with different colours in the accompanying spreadsheet.
9. A chain Laspeyres volume index of capital services is computed as a weighted average of each asset's volume change of the productive stock with user cost shares as weights. Similar, a Paasche-type index is computed and the geometric average of both indices yields a Fisher index of capital services for each industry-sector combination.
10. Aggregation towards a measure of capital services for market producers and for non-market producers proceeds in a similar way. The volume index for capital services for the market sector is a weighted average of the volume index for market producers in the

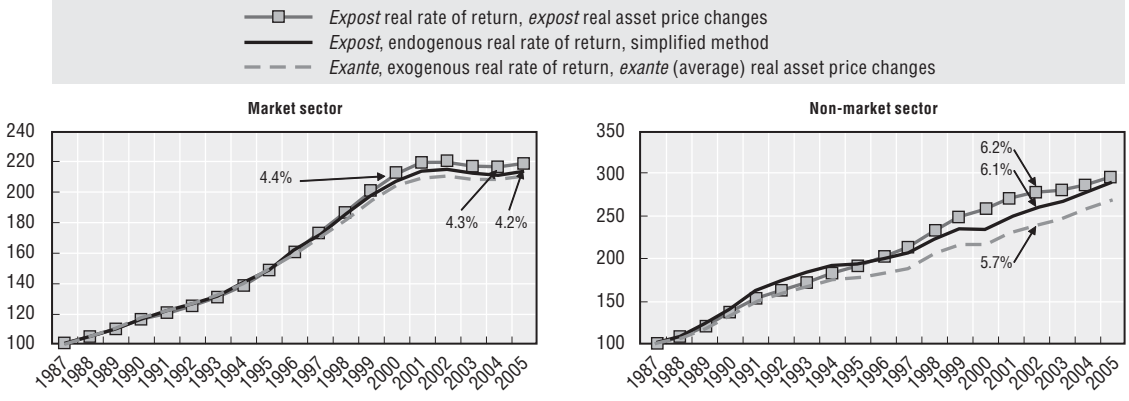
manufacturing and in the service industries. The user cost shares of each producer serve as weights in the aggregation. The same procedure is applied to non-market producers.

11. The ultimate aggregation is across market and non-market producers to yield a measure for the total economy.

The following conclusions can be drawn from examination of the results. The first and general impression is that, in terms of the volume series of capital services, one of the main outputs of the calculations, results are quite robust. The differences between the three methods of computing user costs are fairly small for the market sector. For the non-market sector, differences are larger but still less than one percentage point in average annual growth rates over the entire period (see Figure).

Figure B.1. **Comparison of three methods for the calculation of user costs**

Volume index of capital services, 1987 = 100



7. A second conclusion is that the artificial dataset confirmed an observation made in many empirical studies, namely that the *ex-post*, endogenous method for the computation of user costs produces a larger number of negative prices of capital services than the other methods. This is inconvenient from a practical perspective.

8. A third conclusion is that the comparison between the gross operating surplus for market producers as 'taken' from the national accounts and the gross operating surplus as implied by the ex-ante method yields a picture as would be expected: differences change sign and oscillate around a long-run value close to zero. This is in line with the idea that the difference between *ex-ante* and *ex-post* values is a 'surprise' term.