Measuring capital stock in the New Zealand economy

Fourth edition

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1 Purpose and summary

1.1 Purpose

This report explains the concepts and methodology for developing the two measures of capital stock and the corresponding consumption of fixed capital.

1.2 Summary

Capital stock is one of the main inputs into production. Capital goods range from tangible assets such as buildings, roads, and machinery, to intangible items such as software and exploration rights. Measures of capital stock provide a snapshot of capital assets available for use in production at a point in time, as well as a forward-looking measure of the economy's potential performance.

In recent years, the fixed capital stocks of countries have occupied an important place in economic policy debates, and the analysis of economic growth. Measures of a country's stock of capital provides the basis for measuring national wealth, and understanding factors that underpin growth, such as advances in productivity, technical progress, and efficiency.

In 2000, Statistics NZ began the release of official capital stock series for New Zealand. Two measures of the stock of fixed assets are available, along with a corresponding measure of consumption of fixed capital. This represented an important step in compiling balance sheets and providing an official measure of capital stock for use in productivity studies.

The first measure of capital stock – net capital stock in current prices – encompasses the fixed assets to be included in balance sheets, and is also available as a chain-volume series. The second measure – productive capital stock – allows the measurement of the real value of capital services used in production. While the two measures are different, they are linked and are derived from the same underlying capital formation data.

1.3 Technical information about the data

Percentage changes

Percentage movements are, in a number of cases, calculated using data of greater precision than published. This could result in slight variations.

Rounding procedures

On occasion, figures are rounded to the nearest thousand or some other convenient unit. This may result in a total disagreeing slightly with the total of the individual items as shown in tables. Where figures are rounded the unit is in general expressed in words below the table headings, but where space does not allow this the unit may be shown as (000) for thousands.

All business counts in this report have been randomly rounded to base 3 to protect the confidentiality of respondents. For this reason not all figures will sum to stated totals.

Source

All data is compiled by Statistics NZ, except where otherwise stated. Both administrative and survey data has been used in this report.

2 Introduction to measuring capital stock

2.1 Contents of this paper

This introduction explains the history of capital stock measurement in New Zealand as well as the key concepts used throughout this paper to discuss capital stock. The introduction also includes an overview of capital stock and consumption of fixed capital measurement in New Zealand. Bolded key terms in this section are defined in appendix 9, Glossary of technical terms.

Chapter 3, Conceptual framework, expands on the concepts introduced in the introduction, providing detailed definitions and an explanation of gross fixed capital formation (GFKF), consumption of fixed capital (CFK), gross capital stock (GKS), net capital stock (NKS), and productive capital stock (PKS) for use.

Chapter 4, Classification and coverage of fixed assets, identifies and defines the seven asset classes used in measuring capital stock and consumption of fixed capital in New Zealand.

Chapter 5, Perpetual inventory method (PIM), describes what the PIM is and how it produces capital stock and consumption of fixed capital measures for New Zealand. The PIM parameters (including average asset lives, retirement functions, and efficiency decline), along with their assumptions, are surveyed. Age-efficiency and age-price profiles are described and their relevance to capital stock and consumption of fixed capital measures are explained.

Chapter 6, Data sources, details the array of sources used for the two key inputs into the New Zealand PIM (gross fixed capital formation in current prices and price deflators).

2.2 History

In 2000, Statistics NZ released the first official capital stock series for New Zealand. Prior to this release, most economic analysts made use of the unofficial capital stock series produced by the Research Project on Economic Planning (RPEP) at Victoria University (see appendix 3 for more information).

The development of the official capital stock series has its origins in the 1991 Review of Macroeconomic Statistics (Department of Statistics, 1991), which recommended that Statistics NZ develop productivity measures. Following a feasibility study (Lepper & Simons, 1993) completed in 1993 (by Integrated Economic Services Ltd. on contract to Statistics NZ), and subsequent work in-house developing experimental series for the electricity industry, the development was reviewed by the Advisory Committee on Macroeconomic Statistics in 1994. The committee concluded that Statistics NZ should focus on providing users with the basic labour and capital input series and leave the development of productivity measures to others, allowing them to produce the derived measures using whatever methods they wished.

However, a sequence of events led to a change of view regarding the publication of productivity measures by Statistics NZ, most notably:

- the work done by the Department of Labour, The Treasury, and the Reserve Bank of New Zealand who established a joint work programme in 1997 to advance productivity research

- the publication by the OECD in 2001 of two manuals that outlined accepted best-practice methods to compile capital stock and productivity measures.

Statistics NZ's work on the development of capital stock series began in 1998. The publication of the series in 2000 was the culmination of this work.

In 2004, Statistics NZ received funding under the Growth and Innovation Framework to develop official productivity measures, and these were first released in 2006. A key requirement for the productivity series was the capital stock measures outlined in this publication.

The official capital stock series closely follow the best practice guidelines promoted by the Organisation for Economic Co-operation and Development (OECD, 2001a), which Statistics NZ had early access to, and also the similar methods adopted by the Australian Bureau of Statistics (ABS) to compile its capital stock measures (ABS, 2000). During the development phase of the project, the ABS released revised capital stock series for Australia, based on an upgraded PIM model. This model was made available to Statistics NZ, and a number of the PIM parameters were borrowed directly from the Australian PIM.

Close ties with the ABS methods remove many methodological differences that might otherwise limit or hinder bilateral comparisons.

The annual series, available from 1987 and analysed by industry, sector and asset type, include:

- net capital stock in current prices (replacement cost)
- net capital stock (chain-volume series in 2009/10 prices)
- consumption of fixed capital in current prices (replacement cost).

Productive capital stock measures (chain-volume series in 2009/10 prices) are also compiled and used in the compilation of productivity statistics.

2.3 International standards updates and other developments

The capital stock series are a core part of the New Zealand System of National Accounts (NZSNA). We currently compile these series by following the standards laid out in the international framework for national accounts, the System of National Accounts. A revised version of the international framework was published in late 2009, the System of National Accounts 2008 (2008 SNA). We have done some work to implement the revised standards into the 2014 accounts.

The most substantive change to the international standards is that the asset boundary has been expanded to include new types of assets. The new asset types include the capitalisation of research and development activities, which better reflects that we are dealing with durable and intangible items that are not consumed but continue to provide a flow of capital services. Also, the asset boundary has been extended to include expenditures on military weapons systems as gross fixed capital formation.

We have also updated the base year for constant price series and expression year used in the chain-volume series. We have updated the chain-volume series to be expressed in 2009/10 prices. Previously they were expressed in 1995/96 prices.

2.4 Key concepts in capital stock measurement

All the key terms that are used in this section have been bolded. Definitions for these terms can also be found in appendix 9, Glossary of technical terms.

Capital stock refers to the stocks of fixed assets owned and used by producers in the production process. The development of capital stock measures for the New Zealand economy has arisen out of the needs of two different facets of economic analysis.

- Firstly, the need to measure national wealth. Calculating **net capital stock** statistics for use in balance sheets is the first step in this process. Net capital stock measures the current value of fixed assets still in use.
- Secondly, the need to understand and explain economic growth. This requires statistics of **productive capital stock**, a measure of capital stock for productivity statistics, from which the real value of **capital services** used in production can be derived.

While these two concepts of capital stock are different, they are linked and are derived from the same underlying capital formation data.

Capital stock statistics in New Zealand are produced using a modified **perpetual inventory method (PIM).** Briefly, this generates an estimate of the capital stock by accumulating past purchases of assets over their estimated service lives. A traditional approach uses the PIM to:

- estimate the gross capital stock
- apply a depreciation function to calculate **consumption of fixed capital**
- obtain the net capital stock by subtracting accumulated consumption of fixed capital from the gross capital stock.

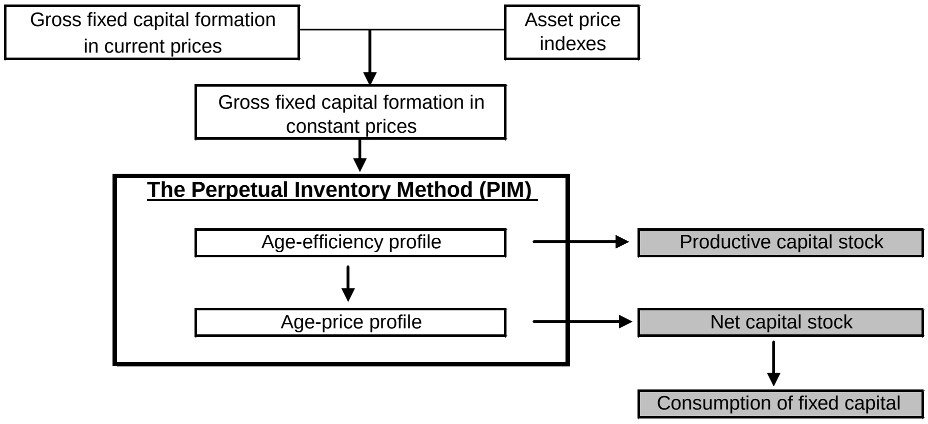
To obtain productive capital stock, gross capital stock would need to be adjusted for efficiency deterioration of the assets.

Statistics NZ, however, uses an alternative, integrated method of applying the PIM which operates by:

- calculating **age-efficiency profiles** for each type of asset (used to calculate productive capital stock), and then
- using the age-efficiency profiles and a discount rate to determine the **age-price profiles** (used to calculate net capital stock and consumption of fixed capital).

The important advantage of this method is that it produces net capital stock, productive capital stock, and consumption of fixed capital measures that are mutually consistent because they are based on identical assumptions and data. A simplified version of the New Zealand PIM can be seen in figure 2.1.

Figure 2.1 The Statistics NZ perpetual inventory method simplified



Gross fixed capital formation is a key input series to the PIM. Gross fixed capital formation is the total value of acquisitions less disposals of new or existing fixed assets during the accounting period.

The stocks of assets are usually referred to as being valued at current prices or in volume terms.

- Current prices: the prices at which each asset has been re-valued in order to bring its value to the prices of the current year. Valuation at current prices is sometimes referred to as current 'replacement' cost (the amount that a company would have to pay, presently, to replace the asset).
- Volume measures: Within the NZSNA, volume measures are presented as annual Laspeyres chain-linked measures (further discussed in section 5.3). Volume measures are expressed in the prices of a given year.

Replacement cost reflects the cost of producing the asset at a given location, quality, and point in time. This differs from market value which depends on many other factors, such as the demand for final product, in addition to the cost of production.

Gross fixed capital formation, net capital stock, and consumption of fixed capital are all published in current prices but at various stages of the PIM process they are converted into **constant prices** (the price of an asset expressed in the prices of a selected base year).

The values of new assets entering the PIM model through gross fixed capital formation need to be valued consistently with the assets previously accumulated. Using asset price indexes, a given gross fixed capital formation series is converted from current to constant prices. The PIM model then takes these detailed constant price gross fixed capital formation series, applies age-efficiency and age-price profiles, and aggregates them to produce both productive and net measures of capital stock expressed in constant prices. The PIM model outputs can then be reflated to current prices using the relevant asset price indexes.

For capital stock estimates, chain-linking is done by asset class for each industry. Individual industry totals are then summed to an aggregate industry total.

In the standard PIM, a third measure of capital stock, the gross capital stock, would be produced, as this is needed to derive the other capital stock measures. However, this intermediate series is not required in the PIM model used by Statistics NZ and is not produced.

The capital stock distinctions are:

1. The **gross capital stock (GKS)** is the value of assets held by producers with each asset valued at ‘as new’ prices over its service life. GKS represents accumulated investment, less the accumulated value of the assets no longer operating (ie retired). Therefore, it depends only on those assets in existence, regardless of age or condition. GKS is of limited value as an economic variable in its own right and is generally produced only as an intermediate step to deriving net capital stock. It is discussed here in order to clarify the distinctions between the different capital stock measures found in the literature.

2. The **net capital stock (NKS)** is the depreciated value of fixed assets valued at current replacement cost. It is derived as accumulated investment less accumulated consumption of fixed capital. Conceptually, net capital stock is a forward-looking measure. It can be thought of as the value of the flow of services that assets in existence can produce over the remainder of their service lives. As these services are provided sequentially, the values of the services provided at different points in time in the future have to be discounted to derive their current market value. The net capital stock is therefore the present value of expected future capital services. In perfectly competitive markets, economic theory would suggest that this is how the market value of traded fixed assets is determined.

3. The **productive capital stock (PKS)** is a measure of the volume of the capital services produced by fixed assets, making allowance for the decline in efficiency as the assets age. Productive capital stock represents accumulated investment less the accumulated value of the assets retired and the loss of efficiency of those assets still operating (that is, gross capital stock adjusted for a decline in efficiency of assets still in operation).

4. Finally, **consumption** of **fixed capital (CFK)** which is equal to the decline in the value of the net stock of assets used in production, as a result of physical deterioration and normal obsolescence. That is the decrease between the beginning and the end of the current period in the present value of the remaining expected capital services.

These concepts will be further explained in the next chapter.

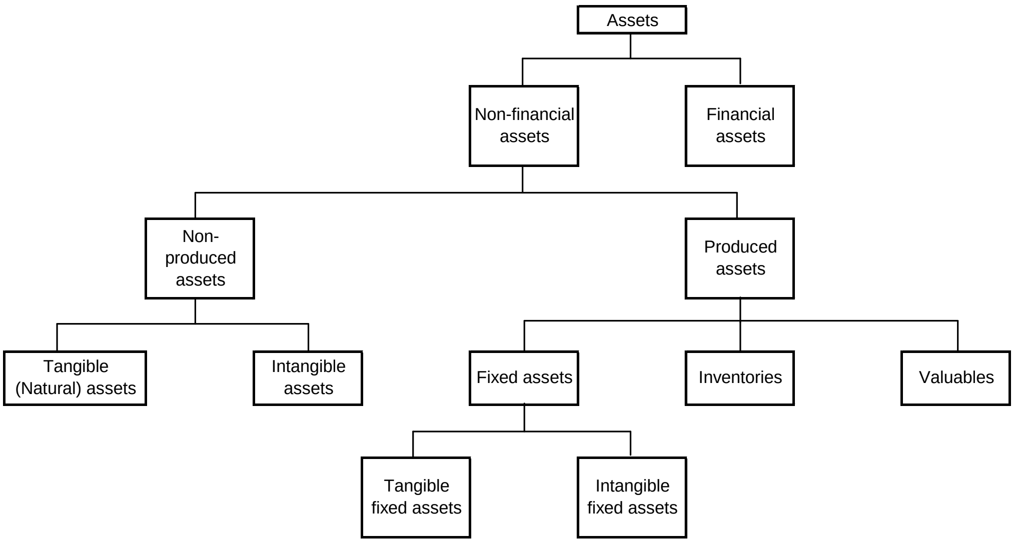
3 Conceptual framework

3.1 Classification of assets

Assets, as defined in the 1993 System of National Accounts (SNA), are entities that must be owned by some unit, or units, and from which economic benefits are derived by their owner(s) by holding or using them over a period of time.

The classification of assets within the SNA is summarised in figure 3.1.

Figure 3.1 Classification of assets within the System of National Accounts



Assets are broken down into financial assets and non-financial assets.

- Financial assets are those in which there is a counterpart liability on the part of another unit. They mostly consist of financial claims but also include monetary gold, special drawing rights allocated by the International Monetary Fund (IMF), and shares in corporations.
- Non-financial assets on the other hand, hold no counterpart liability and consist of produced and non-produced assets:

Produced assets are those that have come into existence as outputs from processes that fall within the production boundary of the SNA.

Produced assets are further broken down into valuables, inventories, and fixed assets. Fixed assets and inventories are held only by producers for the purposes of production.

- Valuables are goods of considerable value that are not used primarily for purposes of production or consumption, but are held as stores of value over time.
- Inventories consist of stocks of outputs still held by units that produced them prior to their being further processed, sold or delivered to other units and stocks of products acquired from other units which are intended to be used primarily for purposes of production or consumption.

Fixed assets are assets that are used repeatedly, or continuously, in processes of production for more than one year (this separates them from assets such as coal which can only be used once).

Fixed assets are broken down further into tangible or intangible fixed assets:

- tangible fixed assets consist of dwellings, other buildings and structures, machinery, and equipment and cultivated assets.
- intangible fixed assets on the other hand consist of exploration, computer software, and artistic originals which are intended to be used for more than one year.

Non-produced assets are those needed for production but have not themselves been produced.

Non-produced assets are further broken down into tangible or intangible non-produced assets.

- Tangible (natural) non-produced assets include land, subsoil assets, water resources and certain uncultivated biological resources.
- Intangible non-produced assets entitle the owners to engage in certain specific activities or to produce certain specific good or services and exclude other institutional units from doing so except with the permission on the owner (for example patented entities and purchased goodwill).

3.2 Gross fixed capital formation

Gross fixed capital formation (GFKF) is defined as the total value of a producer's acquisitions, less disposals, of fixed assets during the accounting period, plus certain additions to the value of non-produced assets as a result of productive activity of institutional units (such as land improvements).

GFKF includes:

1. Acquisitions, less disposals, of new or existing tangible fixed assets.
2. Acquisitions, less disposals, of new or existing intangible fixed assets.
3. Major improvements to tangible non-produced assets, including land.
4. Costs associated with the transfers of ownership of non-produced assets.

The first two types of GFKF refer to new and existing fixed assets.

Enterprises can acquire either ‘new’ or already ‘existing’ fixed assets. Acquisition of new assets refers to assets which are new to the New Zealand economy (for example, a second-hand asset bought from overseas is defined as a new asset) and covers not only complete assets but also any renovations, reconstruction, or enlargements that significantly increase the productive capacity or extend the service life of an existing asset.

The distinction between ordinary maintenance and repairs and improvements to existing fixed assets is not always precise. For example ordinary maintenance and repairs constitute intermediate consumption but improvements to existing fixed assets that constitute GFKF must go well beyond the requirements of ordinary maintenance and repairs. These improvements must bring about significant changes in the characteristics of the existing fixed assets (such as extending the assets' expected service life or increasing its productivity). The acquisition of existing assets on the other hand refers to assets which have already been acquired by at least one user or produced on own-account and whose value has therefore already been included in the GFKF of at least one user at an earlier point in time.

The first two types of GFKF also refer to disposals. This covers the sale or transfer of existing assets to another owner. These disposals may remove assets from the capital stock as their new owners may scrap them or they may not be used as fixed assets by their new owners (for example, vehicles sold by businesses to households for their personal use).

The value of new and existing fixed assets acquired includes any associated transport and installation charges along with any costs incurred in the transfer of ownership. This could include fees paid to surveyors, engineers, architects, lawyers, or real estate agents and/or any taxes payable.

The third type of GFKF refers to major improvements to tangible non-produced assets (for example, land). These improvements must increase the productive capacity; extend the service life, or both. This GFKF does not lead to the creation of new assets that can be separately identified and valued from the underlying non-produced asset. For example, land contouring is within the scope of GFKF but inseparable from the land itself.

The final type of GFKF refers to the associated costs of ownership transfer incurred by units acquiring non-produced assets. The types of ownership transfer costs included here are the same as those listed above for produced assets.

The value at which the asset enters the balance sheet of its new owner therefore includes the costs of ownership transfer. Consistent with this method of valuation, disposals of existing fixed assets are valued at the prices payable by the units acquiring the assets minus any associated costs of ownership transfer incurred by the latter.

Transfer costs can consist of:

- estate agent fees, customs fees, or other taxes (for example, sales tax and stamp duty)
- the cost of transporting the assets to their site and installing them (including the wages of own employees if they install the goods)
- fees paid to lawyers, architects, surveyors, designers, engineers
- legal fees not associated with financing.

Transfer costs are collected for the following asset classes:

- residential buildings
- non-residential buildings
- other construction
- land improvements.

Transfer costs are measured through real estate agents' and conveyance fees. These are derived using the number of sales (by type of asset) as reported by Quotable Value New Zealand, multiplied by the average sale price and rate of fees.

3.3 Consumption of fixed capital

Consumption of fixed capital (CFK) is a cost of production. It is defined as the decline, during the course of the accounting period, in the current value of the stock of fixed assets owned and used by a producer as a result of physical deterioration, normal obsolescence or normal accidental damage. CFK excludes the value of fixed assets destroyed by acts of war or exceptional events such as major natural disasters which occur very infrequently. Any real holding gains or losses on assets due to changes in their relative prices over the accounting period are also excluded.

Fixed assets will normally have been purchased over a time period, when both relative assets prices and the general price level were different from prices in the current period. In order to be consistent with the other entries in the same production account, CFK must be valued with reference to the same set of current prices that are used to value output and intermediate consumption. CFK should therefore be calculated using the actual or estimated prices of fixed assets prevailing at that time and not at the times the assets were originally acquired.

To avoid confusion, the term 'consumption of fixed capital' is used in the national accounts to distinguish it from 'depreciation' as typically measured in business accounts. Measuring CFK at current costs is equivalent to estimating the costs of maintaining intact the stock of fixed assets used in production. Even when the fixed assets used up are not actually replaced, the amount of CFK charged as a cost of production should be sufficient to enable the assets to be replaced, if desired.

Consumption of fixed capital and future rentals

The value of a fixed asset at a certain point of time is determined by the present value of the future rentals (that is, the sum of the discounted values of the stream of future rentals) that can be expected over its remaining service life. CFK is therefore measured by the decrease, between the beginning and the end of the current accounting period, in the present value of the remaining sequence of rentals. This decrease is influenced by:

- the efficiency decline of the asset during the current period
- the shortening of the asset's service life
- the rate of efficiency decline of the asset over its remaining service life.

The calculation of CFK is a forward-looking measure that is determined by future, and not historic, events. CFK is often thought of as being the same as depreciation as usually calculated in business accounts, however, it is quite different. Unlike business accounting depreciation, CFK is not a method of allocating the costs of past expenditures on fixed assets over subsequent accounting periods. The value of a fixed asset at a given moment in time depends only on the remaining benefits to be derived from its use and CFK must therefore be based on values calculated in this way. Depreciation as recorded in business accounts may not provide the right kind of information for the calculation of CFK. Since depreciation allowances for tax purposes may be manipulated arbitrarily to influence rates of investment, SNA 1993 recommends that independent estimates of CFK should be compiled in conjunction with estimates of capital stock.

Calculating consumption of fixed capital

CFK is the difference between the real economic value of an asset at the beginning of the period and the end of the period. There are two different ways to calculate CFK.

The first is to directly estimate CFK by applying a depreciation function (an age-price profile) to the gross value of the asset. Several different depreciation functions are available and each implies a different age-efficiency profile.

The second is to indirectly estimate CFK by using age-efficiency profiles to obtain age-price profiles for different types of assets. CFK is then calculated as the difference between successive real asset values.

This second way of calculating CFK ensures consistency between age-efficiency profiles and CFK and is the method Statistics NZ uses. When CFK is derived indirectly using age-efficiency profiles no assumptions about the form of the depreciation function are needed. Instead assumptions about the form of the age-efficiency profiles and the discount rate are required. These will be discussed further in chapters 5.3 to 5.5.

The coverage of consumption of fixed capital

CFK is calculated for all fixed assets owned by producers, the fixed assets themselves having been earlier produced as outputs from the processes of production. CFK does not therefore cover the depletion or degradation of non-produced assets such as land, mineral or other deposits, coal, oil, or natural gas. CFK is, however, calculated for fixed assets which are constructed to improve land (such as drainage systems, dykes, or breakwaters) and for assets which are constructed on or through land (such as roads, railway tracks, tunnels, dams).

Some structures, such as roads or railway tracks, may appear to have infinite lives if properly maintained. However, the value of assets may decline either because they deteriorate physically or because of a decrease in the demand for their services as a result of technical progress and the appearance of new substitutes for them. In practice, many structures, including roads and railway tracks, are scrapped or demolished because they have become obsolete. Even though the estimated service lives may be very long for some structures, such as roads, bridges, and dams, they cannot be assumed to be infinite. Therefore, CFK is calculated for all types of structures, including those infrastructure assets owned and maintained by government units.

Losses of fixed assets due to normal accidental damage are also included in CFK. Normal accidental damage is damage caused to assets used in production resulting from their exposure to the risk of fires, storms, and accidents due to human errors. When these kinds of accidents occur with predictable regularity they are taken into account in calculating the average service lives of the goods in question. At the level of the economy as a whole, the actual normal accidental damage within a given accounting period is expected to be equal, or close, to the average. However, for an individual unit, or group of units, any difference between the average and the actual normal accidental damage within a given period is regarded as an abnormal loss and not as a cost of production. In a full set of national accounts, abnormal losses are recorded in the ‘other changes in volume of assets’ account, along with losses through war or major natural disasters which occur very infrequently.

Similarly, although CFK includes reductions in the value of fixed assets resulting from normal, expected rates of obsolescence, it should not include losses brought about by unexpected technological developments that may significantly shorten the service lives of a group of existing fixed assets. Such losses are treated in the same way as losses resulting from abnormal accidental damage. In practice, however, it is difficult to measure such losses.

3.4 Flow measures in the national accounts

Both GFKF and consumption of fixed capital are flow measures representing specific economic activity. Both measures feed into gross domestic product (GDP), which is also a flow measure, an indicator of an economy’s performance.

There are three approaches to measuring GDP. The expenditure approach relates to all final purchases of goods and services by New Zealand residents. GFKF is one of the final expenditure items. This type of capital accumulation can be undertaken by any kind of producer. Items can be produced domestically or imported from overseas. In order to capture New Zealand total GFKF, items that have been exported are deducted when compiling GDP.

CFK is an important variable in the national accounting framework. As previously outlined, CFK is a cost of production arising from the use of fixed assets. To derive net domestic product, CFK is usually subtracted from the aggregate GDP estimate. CFK is also required for compiling the accounts of non-market producers, such as government departments.

GFKF and CFK are flows which reflect change during a certain period of time, for example a quarter or year. Both measures are contributing to the change in wealth of the New Zealand economy, which is reflected in the balance sheets.

3.5 Capital stock as a measure of wealth

Balance sheets

Balance sheets record the value of assets (both financial and non-financial) and liabilities at a particular moment of time. The national accounting system provides for balance sheets to be compiled at the beginning and end of the accounting period. It therefore provides for a complete recording of the balance sheet positions and the changes in the various items in the balance sheet within the accounting period.

A balance sheet may be drawn up for institutional units, institutional sectors and the total economy. For an institutional unit or sector the balance sheet provides an indicator of economic status – that is the financial and non-financial resources at its disposal that are summarised in the balancing item net worth. For the economy as a whole the balance sheet shows what is often referred to as national wealth – the sum of non-financial assets and net claims on the rest of the world. Balance sheets are not currently produced as part of the NZSNA.

Balance sheet values are connected with the flows recorded in the national accounts. They complete the sequence of accounts, showing the ultimate result of the entries in:

- the production account
- the distribution and use of income accounts
- the accumulation accounts that records the changes in the value of assets, liabilities and net worth during the accounting period.

A basic accounting identity links the opening balance sheet and the closing balance sheet for any given asset. With reference to the full sequence of national accounts shown in figure 3.2, the identity is:

The value of the stock of assets at the start of the accounting period (Account 1, Opening balance sheet).

plus

The transactions in non-financial assets within the accounting period (Account 2, Capital account). This includes the total value of the assets acquired less the total value of those disposed of (GFKF) and CFK (valued at replacement cost)

plus

The transactions in financial assets within the accounting period (Account 3, Financial account).

plus

The value of other positive or negative changes in the volume of the assets held, for example, as a result of the discovery of a subsoil asset or the destruction of an asset (Account 4, Other changes in volume of assets account).

plus

The value of the positive or negative nominal holding gains accruing during the period resulting from a change in the price of the assets (Account 5, Revaluation account).

equals

The value of the stock of assets at the end of the accounting period (Account 6, Closing balance sheet).

Figure 3.2 A simplified accounting framework linking the opening and closing balance sheet positions

Opening Balance Sheet

Financial assets	Liabilities
Fixed assets	Net worth
Inventories	
Valuables	
Non-produced assets	
Total assets	Total liabilities

Capital Account

Gross fixed capital formation	Saving
Change in inventories	Capital transfers, net
Net purchases of valuables	
Net purchases of non-produced assets	
less **Consumption of fixed capital**	
Net lending	
Capital accumulation	Financing of capital accumulation

Financial Account

Net acquistions of financial assets	Net lending
	Net incurrence of liabilities
Changes in financial assets	Changes in liabilities/net worth

Other Changes in Volume of Assets Account

Changes in financial assets	Changes in liabilities
Changes in fixed assets	Changes in net worth
Changes in inventories	
Changes in valuables	
Changes in non-produced assets	
Other changes in assets	Other changes in liabilities/net worth

Revaluation Account

Revaluations of financial assets	Revaluations of liabilities
Revaluations of fixed assets	Changes in net worth
Revaluations of inventories	
Revaluations of valuables	
Revaluations of non-produced assets	
Revaluations of assets	Revaluations of liabilities/net worth

Closing Balance Sheet

Financial assets	Liabilities
Fixed assets	Net worth
Inventories	
Valuables	
Non-produced assets	
Total assets	Total liabilities

Net capital stock

As noted above, balance sheets record the value of assets at a particular moment of time. For balance sheets, the appropriate measure of the stock of fixed assets is the net capital stock (NKS) which is a current price wealth measure. The NKS is the sum of the written-down values of all the fixed assets still in use, valued at current replacement cost.

Conceptually, NKS is a forward-looking measure. It can be thought of as the value of the flow of services that assets in existence can produce over the remainder of their service lives. As these services are provided sequentially, the values of the services provided at different points in time in the future have to be discounted to derive their current market value. The NKS is therefore the present value of expected future capital services. In perfectly functioning markets, economic theory would suggest that this is how the market value of traded fixed assets is determined.

In practice, the NKS is the sum of the written-down values of the fixed assets still in use. The written-down value of a fixed asset is equal to the actual or estimated current purchaser's price of a new asset of the same type, less the cumulative value of the consumption of fixed capital accrued up to that point in time. Specific price indexes for fixed assets are used to revalue to current prices those fixed assets still in use but purchased in earlier periods. Derived age-price profiles are used to estimate net capital stock.

3.6 Capital stock for measures of productivity

Productivity measurement has long been of interest to economists. Along with increases in factors of production and changes in terms of trade, productivity improvement is a major determinant of economic growth and national welfare. Slow productivity growth limits the rate at which real incomes can advance, and also increases the likelihood of conflicting demands concerning the distribution of income. Measures of productivity growth and productivity levels are therefore important economic indicators (Schreyer & Pilat, 2001).

Productivity is a measure of how efficiently production inputs (labour and capital, for example) are being used in the economy to produce outputs. It is commonly defined as a ratio of a volume measure of output to a volume measure of input use.

Statistics NZ first released productivity measures in March 2006. The capital services series included in these measures are derived from the productive capital stock series described here.

More information about the productivity measures can be found on Statistics NZ's website.

Capital stock and capital services

For any given type of asset, there is a flow of productive services (called capital services) from the cumulative stock of past investments. This flow of capital services is an appropriate measure of capital input which is used in productivity measures.

Conceptually, capital services reflect a quantity (or physical concept) not to be confused with the value (or price concept) of capital. Because flows of the quantity of capital services are not usually directly observable, they are approximated by assuming that service flows are in proportion to the stock of assets after each vintage has been converted into standard 'efficiency' units. This is the 'productive stock' of a given type of asset. Capital stock measures therefore provide a practical means of estimating flows of capital services. (Organisation for Economic Co-operation and Development, 2001b).

The following example (Triplett, 1992) illustrates the nature of capital services.

Suppose a trucking company has purchased a number of trucks in each of five successive years. Except from the year in which they were purchased, the trucks are identical (no quality change has taken place) and therefore differ only in age.

A new truck can be said to produce one unit of capital services. D_1 represents the proportionate deterioration between a new and a one-year-old truck and D_2 represents the proportionate deterioration between a one and two-year-old truck. Each truck's age can then be expressed as some fraction of a new truck (the proportion that has not been reduced by deterioration) and therefore all ages of truck can be expressed as 'new truck equivalents'. So, for example, a truck that is two years old is equivalent to one new truck multiplied by a factor $(1-D_1)(1-D_2)$. When a retirement occurs, the retired truck is reduced to zero ‘new truck equivalents’.

Expressing used trucks in terms of ‘new truck equivalents’ implies that all of the trucks are perfect substitutes. Accordingly, it is appropriate to add up all of these new truck equivalents to obtain a measure of the quantity of trucks. Thus, the quantity of new truck equivalents owned by the trucking company after five years of operation can be expressed as:

$$
\begin{aligned}
T = \ & t_5 (1- D_1) (1- D_2) (1- D_3) (1- D_4) (1- D_5) \\
& + t_4 (1- D_1) (1- D_2) (1- D_3) (1- D_4) \\
& + t_3 (1- D_1) (1- D_2) (1- D_3) \\
& + t_2 (1- D_1) (1- D_2) \\
& + t_1 (1- D_1)
\end{aligned}
$$

where:

T = the aggregate measure of ‘new truck equivalents’ trucks
$t_1,\ldots, t_5$ = the quantities of one-year-old, to five-year-old trucks
$D_1,\ldots,D_5$ = the deterioration profile for trucks as they age, from first year to fifth

The second term in the expression, for example, represents the quantity of four-year-old trucks (t_4), proportionately reduced by four years’ deterioration.

The flow of capital services provided by the truck fleet can therefore be said to be proportional to the constructed stock of new truck equivalents. This is mainly so because the measures of deterioration ($D_1,\ldots, D_5$) are derived from the service contributions from trucks of various ages. A more elaborate and explicit procedure for estimating trucking services involves measuring each truck's contribution in units such as tonne-kilometres of capacity. This procedure could be used if the trucks in the fleet were not of identical specification (eg if the fleet were a mix of one-tonne, two-tonne vehicles).

Productive capital stock

Productive capital stock (PKS) consists of all capital goods still in existence, with the value of each one reduced by the proportionate deterioration that has occurred since it was new. In the example shown above the PKS of the trucks is ‘T’ (the aggregate measure of ‘new truck equivalents’ trucks).

Deterioration represents the loss in potential capital services resulting from declines in efficiency through ageing and asset retirements (scrapping of assets). A light bulb that lasts for 10 years with no loss of brightness or increases in energy consumption is an example of an asset with zero loss in efficiency. Most capital goods, however, lose productiveness as they age, and so exhibit some form of efficiency loss. When deterioration is just offset by new investment, the current-period productiveness of the capital stock remains intact in the following period, in the sense that it yields an unchanged volume of capital services.

In theory, PKS is a volume measure of those assets still operating expressed in standard efficiency units. In practice, this volume measure is valued in constant dollars. Note that PKS is a stock measure. For productivity purposes, we require a measure of the volume of capital services and the assumption is made that capital service flows are a fixed proportion of the level of productive stocks.

3.7 Illustration of the different types of capital stock

The relationship between the three types of capital stock measures is illustrated in the following example.

A business purchases one unit of machinery. Assume:

- the machine has a useful service life of 10 years
- it is expected to produce $1,000 of capital services in its first year of use and each following year these will decline by $100, that is, the machine will decline in efficiency by 10 percent of the initial output each year
- there is no opportunity cost in deferring future income, that is, real interest rates are zero so present value is equal to the future value.

The capital services provided by this machine are shown in table 3.1.

Table 3.1 Capital services provided by a unit of machinery

Start of year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Capital services ($)	1000	900	800	700	600	500	400	300	200	100

Initial acquisition cost (assuming a perfectly competitive market)

= the sum of future capital services

= 1,000+900+800+700+600+500+400+300+200+100

= $5,500

At the beginning of year 1

GKS = asset in existence and valued as new.

= $5,500

NKS = the present value of future capital services.

= 1,000+900+800+700+600+500+400+300+200+100

= $5,500

PKS = asset in existence and 100 percent efficiency.

= 5,500 x (1000/1000)

= $5,500

The gross, net, and productive capital stocks are all equal to the amount that the owner is prepared to pay to purchase the machine.

At the beginning of year 2

GKS = asset in existence and valued as new.

= $5,500

NKS = the present value of future capital services

= 900+800+700+600+500+400+300+200+100

= $4,500

PKS = asset in existence and efficiency 90 percent of when new.

= 5,500 x (900/1000)

= $4,950

At the beginning of year 3

GKS = asset in existence and valued as new.

= $5,500

NKS = the present value of future capital services.

= 800+700+600+500+400+300+200+100

= $3,600

PKS = asset in existence and efficiency 80 percent of when new.

= 5,500 x (800/1000)

= $4,400

Table 3.2 shows the gross, net, and productive capital stock for the asset until it retires at the end of its full service life.

Table 3.2 Capital stock measures for a unit of machinery

Start of year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Gross capital stock (GKS)	5500	5500	5500	5500	5500	5500	5500	5500	5500	5500	0
Net capital stock (NKS)	5500	4500	3600	2800	2100	1500	1000	600	300	100	0
Productive capital stock (PKS)	5500	4950	4400	3850	3300	2750	2200	1650	1100	550	0

The assumption that the volume of the capital services provided declines in efficiency by $100 each year, or 10 percent of the initial cost, is a simple age-efficiency profile, a key parameter in the PIM. Similarly, the estimated present value of future capital services in each year is a simple age-price profile. These concepts are described in more detail in chapter 5.2.

4 Classification and coverage of fixed assets

4.1 Scope of capital stock measures

Chapter 3 discussed the four main types of gross fixed capital formation (GFKF), which are:

- acquisitions, less disposals, of new or existing tangible fixed assets
- acquisitions, less disposals, of new or existing intangible fixed assets
- major improvements to tangible non-produced assets, including land
- costs associated with the transfers of ownership of non-produced assets.

The coverage of GFKF effectively determines the scope of the consumption of fixed capital (CFK), as the same assets that have been produced are progressively used up (or written down) in the production process. However, the asset coverage of the capital stock measures produced by Statistics NZ is not quite as broad, and is restricted to produced tangible and intangible fixed assets. This is shown in figure 4.1.

Table 4.1 The scope of capital stock measures

<table>
<tr><th rowspan="4"></th><th colspan="4">Type of asset</th></tr>
<tr><th colspan="2">Non-produced assets</th><th colspan="2">Produced assets[1]</th></tr>
<tr><th>Tangible assets</th><th>Intangible assets</th><th colspan="2">Fixed assets</th></tr>
<tr><th></th><th></th><th>Tangible fixed assets</th><th>Intangible fixed assets</th></tr>
<tr><td>Gross fixed capital formation (GFKF)</td><td>Land improvements and transfer costs</td><td>Transfer costs (added to underlying asset)</td><td></td><td></td></tr>
<tr><td>Consumption of fixed capital (CFK)</td><td>Land improvements and transfer costs</td><td>Transfer costs (added to underlying asset)</td><td></td><td></td></tr>
<tr><td>Net capital stock (NKS)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Productive capital stock (PKS)</td><td></td><td></td><td></td><td></td></tr>
</table>

1. Inventories and valuables are excluded from this table.

The shaded squares in the table represent the scope of the assets (the columns) included in the various capital measures (the rows). As can be seen, GFKF and CFK cover the produced and non-produced assets as defined in the above paragraph whereas the capital stock measures do not include the non-produced assets. Inventories and valuables, two further categories of produced assets, are excluded from the scope of both GFKF and the capital stock series.

GFKF on major improvements to non-produced natural assets (such as land improvements), once made, become part of the value of the natural asset itself and are not separated from it as a separate item of capital stock. While this practice is understandable for improvements such as land clearance, initial fertiliser applications, contouring or reclamation, the rationale is not so clear-cut for developments such as breakwaters, and dykes. In these cases, the land improvement expenditures are more in the nature of infrastructural investment rather than improvements in the quality of land itself and the rationale that the improvement only has value in conjunction with the land itself is arguable. For example, while flood protection stop-banks may add value to an area of land, they also may have wider benefits for the whole community, such as safety and security of property. In these cases, the expenditure could arguably be classified as other construction and not as land improvements. Regardless of the asset classification, identification of a separate infrastructural asset is, in most cases, possible and could be included in the capital stock series. The separation of land improvements into infrastructural structures and land quality improvements is recommended in the revised international standards (SNA 2008).

However, at present, although the expenditure on improvements to non-produced assets such as land is treated as gross fixed capital formation and this is subsequently depreciated, it does not lead to a separate tangible asset and is therefore beyond the scope of the capital stock measures currently produced. The scope of the NKS and PKS series is confined to fixed assets[1].

The fourth type of GFKF outlined in chapter 3.1 refers to the costs associated with the transfer of ownership of non-produced assets and, with regards the scope of the capital stock measures, the same arguments applying to land improvements hold. The transfer costs, which, in practice, are confined to land transfer costs, are incorporated in the value of the land itself. So again the costs are treated as gross fixed capital formation, the capitalised expenditure is depreciated, but this does not lead to a separate fixed asset and is therefore beyond the scope of capital stock measures.

4.2 The classification of fixed assets by type

A classification standard

In 2014, a statistical classification for non-financial assets was approved for our use. This classification reflects the System of National Accounts 2008 (2008 SNA) guidelines.

The 2008 SNA expanded the fixed asset boundary. The main changes were:

- the inclusion of research and development
- the inclusion of expenditure on military weapons systems

Included in GFKF and in the capital stock series are expenditures by the military on fixed assets of a kind that that could be acquired by civilian users for purposes of production and which the military use in the same way. Examples include personnel dwellings, storage facilities, standard trucks and other

1. While the written-down value of land improvements can be derived in the PIM, to publish this as an NKS series in the absence of the full value of the stock of land would be quite misleading from a net wealth perspective. Similarly, a land improvements PKS series would be a very poor partial indicator of the capital services flowing from the stock of land.

vehicles, airfields, docks, roads, hospitals, and other buildings or structures. These are classified to the appropriate asset type. In line with the 2008 SNA, expenditures on military equipment and vehicles with weapons capability (specialised military equipment) are also classified as gross fixed capital formation.

The 1993 SNA had also altered the fixed asset boundary. The main changes in the 1993 SNA were:

- the inclusion of produced intangible assets
- the inclusion of military expenditures that resulted in an asset that could be used for civilian purposes
- the exclusion of artworks and valuables that are not used in production but are held primarily as stores of value.

The principal types of produced intangible assets included were those that embody knowledge or creativity, namely expenditure on mineral exploration, computer software, and artistic or literary originals. While this coverage of intangible assets has been adopted in principle, in practice Statistics NZ has only included exploration and computer software in its capital stock estimates. At present, it has not proved possible to measure the stock (or GFKF) of artistic and literary originals and other forms of intangible fixed assets because of a lack of suitable data.

Items such as precious metals, artworks, antiques, and other valuables that were included in miscellaneous fixed assets in the 1980 classification are no longer classified as fixed assets. Since these assets are owned primarily for their store of value they are now classified as a separate group of produced assets, titled valuables.

Both the 1968 and 1993 versions of SNA classify certain cultivated assets, such as livestock for breeding or for dairy or wool production, as fixed assets. The SNA 1993 extended this further to include all cultivated assets that are used repeatedly or continuously over periods of more than one year to produce other goods, such as orchards and vineyards. The NZSNA has accepted the 1993 definition of cultivated assets in principle. However, in practice, no separate asset type for cultivated assets is included either in GFKF or in the capital stock series. All cultivated livestock remains classified as inventories and expenditures on establishing orchards and vineyards are included in the category Land improvements. As illustrated in table 4.1, while expenditure on land improvements is a separate category of GFKF, the expenditure becomes part of the value of the land itself, and is excluded from the capital stock series.

The asset classification

Table 4.2 sets out the classification of fixed assets that is used for gross fixed capital formation and in the PIM. With the exception of land improvements, this classification also applies to the published capital stock series.

The classification identifies seven main asset classes. These are then broken down into different asset types which are the minimum level at which the GFKF, CFK and capital stock series are calculated in the PIM. Although for a number of the asset types in the PIM expenditure and deflation calculations are performed at an even finer level.

Table 4.2 The classification of assets by type

Asset class	Asset type
1. Residential buildings	Residential buildings
	Residential building transfer costs
2. Non-residential buildings	Non-residential buildings
	Non-residential building transfer costs
3. Other construction	Power generation construction
	Central government roading
	Local government roading
	Railway construction
	All other construction
	Other construction transfer costs
4. Land improvements	Land improvements
	Land improvement transfer costs
5. Transport equipment	Buses
	Road vehicles other than buses
	Ships
	Aircraft
	Rail equipment
6. Plant, machinery and equipment	Heavy plant and machinery
	General purpose plant and machinery
	Electrical plant and machinery
	Electronic plant and machinery
	Computers
	Furniture and fittings
7. Intangible fixed assets	Oil & gas exploration
	Other exploration
	Computer software
	Research and development
8. Weapons systems	Weapons systems – air
	Weapons systems – ships
	Weapons systems – vehicles

1. Residential buildings

Residential buildings are all buildings built for accommodation purposes (other than hotels and motels). They include houses, flats and multi-units, garages and carports, hostels and boarding houses, as well as the costs of site clearance and preparation. Uncompleted buildings and structures are included to the extent that the ultimate user is deemed to have taken ownership, either because the construction is for own use or as evidenced by the existence of a contract of sale/purchase. Buildings and structures acquired for military purposes are included to the extent that they resemble civilian buildings acquired for purposes of production and are used in the same way. Transfer costs associated with the change of ownership of existing buildings is included.

2. Non-residential buildings

Non-residential buildings includes hotels and motels, hospitals and nursing homes, recreational buildings, shops and restaurants, offices and administrative buildings, factories, powerhouses, and farm buildings. As with residential buildings, the costs of site clearance and preparation and transfer costs are also included.

3. Other construction

Other construction broadly encompasses structures other than buildings and includes all infrastructural assets such as roads, bridges, tunnels, subways, railways, airport runways, waterways, harbours, dams, pipelines, communication cables, and power lines. Transfer costs associated with the change of ownership are also included with these asset types.

Although the service lives of many of these infrastructural assets may be very long, CFK is estimated for them, in keeping with 1993 SNA guidelines. As the SNA notes, service lives are not determined purely by physical durability, and many buildings and infrastructure assets are eventually scrapped because they have become obsolete.

In implementing this, it is useful to subdivide other construction into certain categories according to their asset lives so that CFK could be more accurately measured. This resulted in the following five asset types of other construction:

Power generation construction

Power generation construction includes hydro-electric structures including sluices and control mechanisms, penstocks, and pipelines but excludes prime movers, generators and other housed equipment (removable or not). It also includes electric power lines, supporting structures and associated equipment (not housed in buildings) such as pole transformers.

Central government roading

Includes state highways, bridges, tunnels and embankments.

Local government roading

Includes streets, roads, bridges, tunnels, kerbing and channelling.

Railway construction

Includes railways lines, signals, yards, platforms, ramps, humps, and viaducts.

All other construction

Includes airports, fixed navigation and approach systems, waterways, harbours and wharves, car-parking areas not housed in buildings, traffic lights, and telecommunications networks.

4. Land improvements

Land improvements include expenditure which increases the availability or productivity of land itself. Both the expenses associated with the initial development of land (clearing, draining, and contouring) and any subsequent redevelopment which brings about improvements in fertility and carrying capacity, such as initial fertiliser application and sowing are, in principle, included. Expenditure on new farm fencing is also included here. As noted above, capitalised expenditures associated with developing orchards and vineyards are included in this asset class, and not as a separate cultivated assets category, largely due to data availability issues.

Land improvements also cover expenditures on land reclamation, irrigation works, erosion and flood control developments such as constructing stop-banks, and tree planting. Note that the planting of trees for afforestation is not included as trees grown for felling are classified as inventories.

As discussed in chapter 3.1, land improvements are a separate asset type in GFKF but not in the capital stock measures as once these improvements are in place they become part of the value of the land – a non-produced asset – and not fixed capital stock.

There are no transfer costs for land improvements, the costs associated with the transfer of land however are included with this asset type.

5. Transport equipment

Transport equipment encompasses equipment for moving people and goods such as motor vehicles, ships, aircraft and rail locomotives and rolling stock. Equipment that has been designed to move on farmland or in forests is excluded and covered in plant, machinery and equipment. Similarly, vessels whose navigability is subsidiary to their main function such as floating cranes, oil rigs, and towable platforms are not included. However, fishing vessels are included.

Since the range of assets included varies considerably in size and asset life, transport equipment has been subdivided into five asset types.

Buses

Includes all road passenger vehicles other than cars and station wagons.

Road vehicles other than buses

Includes road passenger vehicles other than buses, such as cars, station wagons, and motorcycles. Also included are trailers, utility vehicles, goods vehicles other than mobile construction equipment, and farm tractors. Consideration was given to further subdividing road vehicles into passenger and goods vehicles but this was not possible because of data limitations.

Ships

Includes passenger and cargo ships, fishing vessels, tugs, lifeboats, and search and rescue craft.

Aircraft

Includes all passenger and goods-carrying aircraft, helicopters, rescue craft, top dressers and sprayers. Aircraft primarily used in surveying, photography, and meteorology are also included in this category.

Rail equipment

Includes all passenger and freight rolling stock, railway engines, and other railway stock such as track testing and repairing vehicles, workshop vehicles, and jiggers.

6. Plant, machinery, and equipment

Plant, machinery and equipment covers a large variety of equipment not covered by the other tangible asset types. Because of this variety and its varying nature in terms of asset life and usage, this asset class has been further subdivided into six asset types.

Heavy plant and machinery

Includes: large logging, civil engineering, mining and quarrying equipment such as bulldozers, diggers, tunnelling, and boring machines; handling equipment such as cranes, hoists and conveyor systems; large steam generators; and construction machinery such as excavators, graders, dumpers, and loaders.

General purpose plant and machinery

Includes machinery which is common to many, if not all, industries. It includes such items as pumps and compressors; stacking, elevating and multipurpose machines of which the main purpose is goods handling; industrial trucks/forklifts which are not used for road transport; and packing machines.

Electrical plant and machinery

Includes all electrical equipment such as generators, turbines, distributing systems, transformers, converters, rectifying equipment, electric motors, major switch-gear equipment, power control systems, and air conditioning equipment.

Electronic plant and machinery

Includes: medical and surgical equipment, broadcasters, transmitters, receivers, and other telecommunication equipment, optical and photographic equipment, and photocopiers.

Computers

Includes all computing equipment including personal computers, networking systems, scanners, printers, receivers, and word processors.

Furniture and fittings

Includes all shop and office furniture and fittings, furniture and durable goods used in hotels and restaurants such as for bedding and dining, and hospital furniture.

7. Intangibles

As discussed previously, the 1993 SNA broadened the scope of fixed assets to include intangible fixed assets. While the extended range of intangible fixed assets has been agreed to in principle, in practice Statistics NZ has only included ‘oil & gas and other exploration’ and ‘computer software’ in its capital stock estimates.

Oil & gas and other exploration

Oil & gas and other exploration is capitalised, since the knowledge obtained through exploration activities is considered to be productive over a number of years for future exploration and development whether the exploration is successful or not. Included are pre-licence costs, licence and acquisition costs, appraisal costs and the costs of actual test drilling and boring, as well as the costs of aerial and other surveys, and transportation costs, incurred to make it possible to carry out the tests. 'Oil & gas and other exploration' is further split into 'Oil and gas exploration' and 'Other exploration'.

Computer software

Computer software includes computer programs, program descriptions and supporting materials for both systems and applications software. Included are purchased software and software developed on own account, if the expenditure is large. Major expenditure on the purchase, development or extension of computer databases that are expected to be used for more than one year, whether marketed or not, are also included in principle. However, given the present data sources it is not possible to distinguish between software and databases developed on contract or on own account, so it is not known to what extent databases are included. The costs of collecting and capturing the information stored in databases are excluded.

Research and development

We derive total research and development (R&D) investment from the R&D expenditure values we currently publish (see our report series Research and development in New Zealand). These values include the costs of all inputs of labour, materials, and capital goods used in the R&D process. We make adjustments to expenditure to better reflect capital inputs, remove double counting of software development assets, account for R&D imports and exports, and correct historical under-coverage of private sector R&D.

8. Weapons systems – air, ships, and vehicles

In the SNA, military equipment is defined as ships, aircraft, tanks, armoured vehicles, and other military equipment with weapons capability used for military purposes. Expenditures on military equipment are treated as fixed capital formation. Most single-use weapons military equipment deliver, such as bombs, ammunition, missiles, torpedoes etc, are recorded as inventories.

4.3 The classification of assets by kind of economic activity and by sector of ownership

The capital stock, GFKF, and CFK series are also grouped by kind of economic activity and by sector of ownership.

The standard ANZIND industry groupings used elsewhere in the national accounts have been used. These are based on the Australia New Zealand Standard Industrial Classification (2006). The classification is detailed in appendix 7.

An additional grouping based on sector of ownership is also produced. This groups the enterprises that own the assets into one of three sectors: private, central government, and local government. The ownership classification is aligned with the New Zealand Institutional Sector Classification (1996). The classification is detailed in appendix 6.

5 Perpetual inventory method

5.1 Estimating capital stock using a perpetual inventory method (PIM)

Estimates of capital stock (gross, net, or productive) can be obtained using a number of methods. The more popular of these include direct surveys and the PIM.

Statistics NZ investigated the possibility of using direct surveys. While direct surveys have many benefits they were discounted because they are costly to conduct in terms of resources and time, mainly because they involve repeating large sample surveys each year. Some countries do, however, use direct surveys as a supplementary source to improve the quality of capital stock estimates derived from the PIM.

Statistics NZ chose to use a modified PIM to derive estimates of capital stock and consumption of fixed capital. The differences between the traditional PIM and the modified PIM are explained below.

In general terms, the PIM is used to derive an estimate of the capital stock by accumulating past purchases and disposals of assets over their useful lives. To derive this estimate, information is needed on:

- GFKF by asset type
- fixed asset price indexes
- asset lives (service lives)
- asset retirement patterns (survival functions)
- either an age-price profile (traditional PIM) or age-efficiency profile (modified PIM)
- initial stock values for very long-life assets (possibly).

The modified method involves estimating how many of the fixed assets installed as a result of gross fixed capital formation undertaken in previous years have survived to the current period, combined with estimates of both the rates at which assets are retired (scrapped) and the rates the efficiency of fixed assets decline over their service lives. The fixed assets purchased at different prices in the past are then revalued at the prices of the current period.

As the PIM is a model, it suffers from any misspecification of parameters, changing parameters over time and/or weaknesses in input data. However, the advantages of using the PIM outweigh the disadvantages.

Advantages

1. Data availability. Most of the basic data needed for the PIM is either available or can be estimated from existing data. Time series of GFKF are available within Statistics NZ, as well as from other published studies such as the Research Project on Economic Planning (see appendix 3 for more details). Asset price indexes at the required level of detail are produced by Statistics NZ, although for the pre-1980 period proxy indexes are often required. Average asset life data is available through a depreciation survey that was conducted by Statistics NZ for Inland Revenue (see appendix 2 for more details).

2. Cost-benefit. Direct surveys of capital stock have to be frequently repeated and extensive data on asset values and vintages collected. Once a PIM is in place it can be updated for subsequent years by simply inputting GFKF and price index

data, both of which are readily available. Therefore significantly fewer administration and financial resources are required for the PIM than for the direct survey method.

3. Consistency between constant and current estimates. The capital stock and CFK estimates produced by the PIM are consistently valued at current and constant prices.

4. Flexibility. The PIM is very flexible, it can provide estimates for a single year or for a sequence of years. Variables can easily be included or excluded from the model. It is also possible to check the sensitivity of estimates produced by the model to changes in the basic data and to changes in depreciation or retirement patterns.

Disadvantages

The PIM also has several disadvantages. These include:

1. Quality of backdated data. The PIM needs a starting point. This starting point can either begin with a survey-based opening stock or the model can be run backwards for the number of years of the longest lasting asset type. Statistics NZ chose to adopt the second option, requiring lengthy backdated data for a number of long-life assets. Accordingly, some of the GFKF and price deflator series required backdating to the late 19th century. In the absence of detailed information it was often necessary to backcast using broad economic indicators. For example, residential building GFKF was extrapolated using the population movement for the period from 1858 to 1900. The influence of older assets, however, diminishes over time and the quality of the estimates is not believed to be seriously affected post-1972.

2. Assumptions about asset retirement. There is very little recent data on retirement patterns of the various types of assets. Some of the retirement patterns used in the PIM are based on empirical data that was collected in the early 20th century. Therefore these patterns may not accurately represent the current real world situation. Overseas evidence suggests PIMs may typically overstate the GKS because of a failure to account for changing cyclical or accelerating rates of retirements. Therefore some countries have used accelerating rates of retirements for some asset types in their PIM. Statistics NZ does not currently use accelerating rates of retirement. However, specific adjustments are made for known cases of early scrapping or retirement due to business closures.

3. Problems associated with accumulation. As the PIM model is an accumulation model, any misestimation in one period (in relation to GFKF or price deflators) will affect all subsequent estimates for the life of that asset.

5.2 The Statistics NZ PIM

Traditional and modified methods

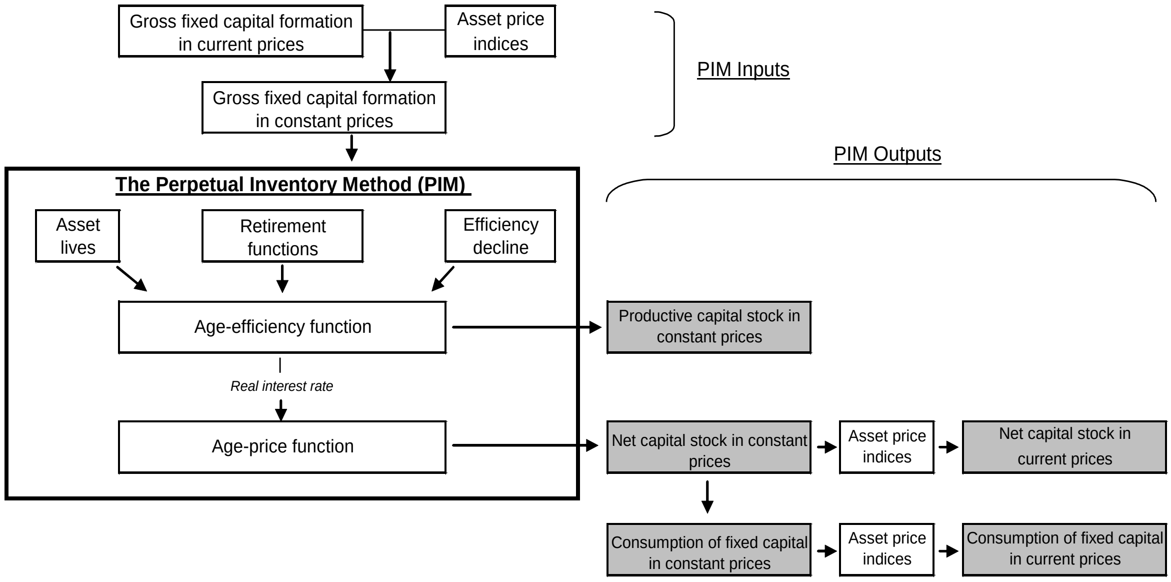
A traditional approach uses the PIM to:

- estimate the gross capital stock
- apply a depreciation function to calculate consumption of fixed capital
- obtain the net capital stock by subtracting accumulated consumption of fixed capital from the gross capital stock.

This approach produces net capital stock measures with no specific allowance made for assets declining in efficiency as they age, ie this decline is implicit in the depreciation function. For productivity studies, gross capital stock needs to be adjusted to allow for efficiency deterioration of the assets. However, depending on the age-efficiency profile chosen, even where the same gross capital stock series are used as the starting point, this may lead to the net capital stock and productive capital stock measures being inconsistent.

Using an alternative PIM approach, pioneered by the United States Bureau of Labor Statistics (BLS) and also applied by the Australian Bureau of Statistics (ABS), Statistics NZ has adopted a model to eliminate this inconsistency. This model can be seen in figure 5.1. The key difference to the traditional PIM is that age-efficiency profiles are first estimated for each type of asset and these are then used to derive consistent age-price profiles. The age-efficiency and age-price profiles are then used to directly estimate the respective PKS and NKS series, with CFK derived indirectly by differencing the NKS series. All series are consistent.

Figure 5.1 The Statistics NZ perpetual inventory method



Average asset life assumptions

Average asset lives are one of the most important parameters used in the PIM. Together with retirement functions, they determine the length of the input series (GFKF in constant prices and asset price indices). They also have a direct relationship with the outputs of the PIM. The longer the asset life, the slower the assets depreciate and the smaller the amount of CFK and the larger the estimate of NKS.

New Zealand average asset lives are mainly based on information obtained from a depreciation survey which Statistics NZ conducted on behalf of Inland Revenue in 1992. This survey collected information on the estimated lives for a range of assets within the plant, machinery and equipment, and transport equipment asset classes. The survey data was used by Inland Revenue to assess economic lives and to set depreciation rates allowed for taxation purposes (appendix 2 provides more information on the IRD depreciation survey).

In most cases there were enough observations in the survey data to provide robust data. For assets that were either under-covered or not covered in the survey, alternative sources were used to estimate the average lives. Appendix 4 provides more information on how New Zealand asset lives compare with asset lives used by other OECD countries.

The different average asset lives used for the seven PIM asset classes are discussed below. Some asset classes have a single all-industry average asset life while others have different average lives for different industries.

1. Residential buildings

In the PIM, all residential buildings are given an average life of 70 years. This is based on an average of asset lives used by the Australian Bureau of Statistics (ABS) (1985) and New Zealand's IR 265 depreciation tables (Inland Revenue, 2007).

One new recommendation of the 2008 SNA relates to the treatment of ownership transfer costs. The 2008 SNA recommends that costs of ownership transfers should be written off over the period the asset is expected to be held, rather than over the entire life of the asset (as was recommended in the 1993 SNA). Taking this into consideration, we now use an average asset life of seven years for transfer costs on residential buildings (previously 70 years), based on some research conducted by Quotable Value Limited.

2. Non-residential buildings

To determine the average life for non-residential buildings, relevant New Zealand company reports, asset lives used by the ABS and New Zealand tax lives were examined. New Zealand company reports by industry varied greatly with a range of lives typically being from 25 to 50 years, with some up to 100 years. New Zealand tax lives were similar to the lives used by the ABS (1985) and it was therefore decided to use these lives, by industry, in the PIM. This resulted in average lives of between 45 and 65 years (depending on the industry).

As with the revised treatment to residential buildings transfer costs, the average asset lives of non-residential buildings transfer costs has also been revised. The revision recognises that, in general, assets change owners during their life and so, the costs of ownership transfer should have average lives that are based on the period of time they are expected to be held by one owner, rather than over the entire life of the asset. We now use average asset lives of 25–30 years for ownership transfer costs for non-residential buildings.

3. Other construction

The average life for other construction is also determined by examining average lives from relevant New Zealand company reports, asset lives used by the ABS (1985) and New Zealand tax lives. This resulted in average lives of:

- 60 years for power generation construction
- 55 years for railway construction
- 110 years for central government roading
- 58 years for local government roading
- 25–110 years (depending on the industry) for all other construction.

The asset type 'central government roading' is estimated to have a much longer asset life than the other 'other construction' asset types, based on data from the Crown Financial Accounts. However, 'local government roading' does not appear to have such a long asset life. Local authority annual reports confirmed that local government roads are subject to more wear and tear (mainly because of their location and construction method). Local government roading is therefore assumed to have a similar asset life to other 'other construction' asset types and is given an asset life of 58 years.

4. Land improvements

There is very little information on the average asset lives for the asset class 'land improvements'. The New Zealand IR 265 depreciation tables (Inland Revenue, 2007) definition of 'land improvements' is different from that used in GFKF which significantly limited the use of any comparison with New Zealand tax lives. Relevant company reports record a range of lives between six and 30 years. There are very few countries that have land improvements as an asset in their PIM models. However, India does have land improvements and uses a service life of 30 years. The little data that is available was analysed and it was decided that an average life of 30 years was the best fit for the

Statistics NZ PIM, except for the local government sector where an average asset life of 58 years is used.

5. Transport equipment

The Inland Revenue survey provided some information on the asset lives of transport equipment. Although this information is limited it gave an indication of the variation of asset lives used in different industries. This is supplemented with information from the New Zealand IR 265 depreciation tables (Inland Revenue, 2007). Using this information, simple average asset lives were then estimated at the industry level for the five asset types under transport equipment, as shown in table 5.1.

Table 5.1 Transport equipment average asset lives, in years[1]

Industry	Rail equipment	Buses	Road vehicles	Ships	Aircraft
Agriculture			7	20	10
Forestry and logging			7		
Fishing			7	21	
Mining			7	20	
Food, beverages, and tobacco manufacturing			7		
Textile and apparel manufacturing			7		
Wood and paper products manufacturing			8		
Printing, publishing, and recorded media			8		
Petroleum, chemical, plastic, and rubber manufacturing			8		
Non-metallic mineral products manufacturing			7		
Metal product manufacturing			7		
Machinery and equipment manufacturing			7		
Furniture and other manufacturing			8		
Electricity, gas, and water supply			7		
Construction			7		
Wholesale trade			9	25	
Retail trade			9		
Accommodation, restaurant, and bars			9		
Transport and storage	25	18	8	25	20
Communication			7		
Finance and insurance		18	7		
Property and business services			5	25	20
Central government administration and defence			20	25	20
Local government administration		18	7		

Education			7		
Health and community services			7		
Cultural and recreational services			7	25	20
Personal and other community services			7	25	20

1. The blank cells show that there is usually no capital formation for this type of asset in the corresponding industry.

6. Plant, machinery, and equipment

Information on the asset lives of plant, machinery, and equipment is largely based on Inland Revenue's depreciation survey. This provided asset lives for 22 sub-types of plant, machinery and equipment analysed by 25 industry groups. The asset sub-type averages were aggregated to six asset types using GFKF for 1996 as weights. Where the depreciation survey industry data was inadequate, average lives were estimated from survey data for related industries (within, for example, manufacturing), or by using tax lives and information from annual company reports. The results are shown in table 5.2.

Table 5.2 Plant, machinery, and equipment average asset lives, in years

Industry	Heavy	General purpose	Electronic	Electrical	Computers	Furniture/ fittings
Agriculture	17	16	16	11	4	9
Forestry and logging	17	14	16	10	4	9
Fishing	17	12	16	11	4	9
Mining	16	13	16	11	4	9
Food, beverages, and tobacco manufacturing	19	14	16	8	4	9
Textile and apparel manufacturing	20	15	16	11	4	9
Wood and paper products manufacturing	20	16	16	11	4	9
Printing, publishing, and recorded media	20	17	16	11	4	9
Petroleum, chemical, plastic, and rubber manufacturing	19	14	16	11	4	9
Non-metallic mineral products manufacturing	20	13	16	11	4	9
Metal product manufacturing	19	14	16	11	4	9
Machinery and equipment manufacturing	19	13	16	11	4	9
Furniture and other manufacturing	20	13	16	11	4	9

Electricity, gas, and water supply	25	13	16	11	4	9
Construction	17	14	16	8	4	9
Wholesale trade	14	11	16	11	4	10
Retail trade	14	11	16	11	4	10
Accommodation, restaurant, and bars	14	11	16	11	4	10
Transport and storage	18	11	16	11	4	9
Communication	14	11	16	12	4	9
Finance and insurance	14	10	16	9	4	12
Property and business services	14	11	16	11	4	9
Central government administration and defence	14	11	16	8	4	9
Local government administration	14	11	16	8	4	9
Education	14	11	16	8	4	9
Health and community services	14	11	16	8	4	9
Cultural and recreational services	14	11	16	8	4	9
Personal and other community services	14	11	16	8	4	9

7. Intangibles

Oil & gas and other exploration

In line with the 1993 SNA recommendation, 'oil & gas and other exploration' is depreciated using relevant mine asset lives. In New Zealand this data comes from the New Zealand energy data file publication from the Ministry of Economic Development. Asset lives for oil & gas and other exploration are derived by examining the average lives from this publication alongside annual company reports and mine life information from Australia. Using this information oil & gas exploration is given an average life of 17 years while other exploration is given an average life of 20 years.

Computer software

Computer software is assumed, for practical purposes, to have a similar life to computers. This is underpinned by the assumption that whenever a new computer is purchased it comes with new and improved software. Computer software therefore has an average asset life of four years (in all industries).

Research and development

There is generally little variation in international practice regarding the assumed useful life of R&D assets. The OECD R&D capitalisation task force proposes an average life length of 10 years for all R&D assets, which is what we have decided to use in the Statistics NZ PIM. The ABS has collected information on patent values as they age and concluded that the average life is 11 years. The Netherlands has conducted a similar study to conclude that the average life is 12 years.

8. Weapons systems

We are using the average asset lives of air, ships, and road vehicles in the transport equipment asset class for the defence industry.

Summary

Below is a summary of all the asset classes and asset types and their corresponding average asset life.

Table 5.3 Summary of average asset lives, in years

Asset class and type		Average asset life (years)
1. Residential buildings		70
	Residential buildings transfer costs	7
2. Non-residential buildings		45–65
	Non-residential buildings transfer costs	25–30
3. Other construction		
	Local government roading	58
	Central government roading	110
	Power generation construction	60
	Railway construction	55
	All other construction	25–110
4. Land improvements		30–58
5. Transport equipment		
	Buses	18
	Road vehicles (excluding buses)	5–20
	Ships	18–25
	Aircraft	10–32
	Rail equipment	25
6. Plant, machinery, and equipment		
	Heavy machinery	14–25
	General purpose machinery	10–17
	Electronic equipment machinery	8–12
	Electrical equipment machinery	16–33
	Computers	4
	Furniture and fittings	9–12
7. Intangibles		
	Oil & gas exploration	20
	Other exploration	20
	Computer software	4
	Research and development	10

8. Weapons systems		
	Air	32
	Ships	18
	Vehicles	20

Asset retirement functions

There are two aspects to asset retirements:

1. the average life of the asset
2. the distribution of retirements about that average. Chapter 5.2 discussed the average lives of assets. This section will discuss the distribution of retirements about these means.

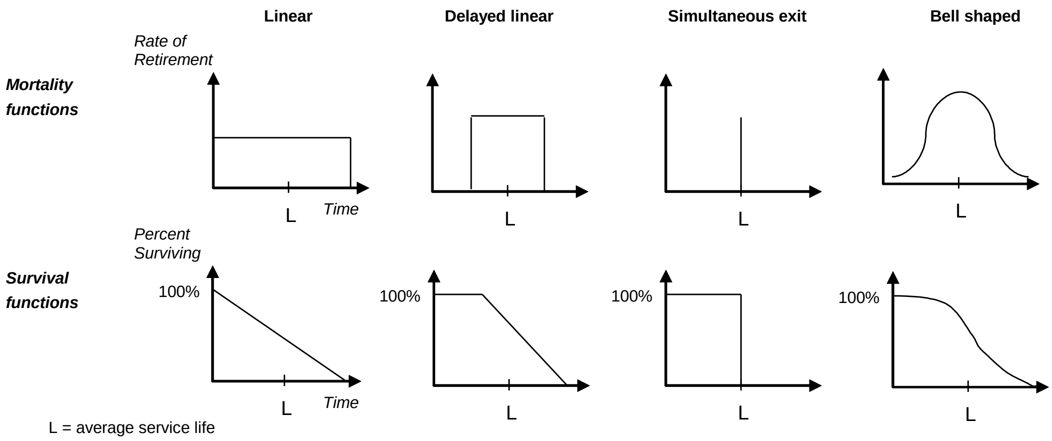
There are four main types of retirement patterns put forward. These are discussed below with figure 5.2 showing the mortality and survival functions for the different retirement patterns. The mortality function shows the rate of retirement (vertical axis) over the lifetime of the longest-lived member of a group of similar assets installed at the same time (horizontal axis). The survival function shows what proportion of the original members of the group of original assets (vertical axis) are still in service at each point in time during the lifetime of the longest-lived asset (horizontal axis).

It should be noted that little empirical evidence exists on actual retirement patterns. Those described below are possible patterns that may exist and are accepted / rejected more on the grounds of plausibility than solid evidence. The exception is the bell-shaped pattern which does have some – albeit limited - empirical support based on overseas studies.

- **Linear retirement**. Linear retirement assumes that asset retirements start directly after the assets are installed. This retirement pattern assumes that assets are retired at the same rate each year from the time of installation until twice the average asset life. There is currently no evidence of this pattern of retirement being used by any country. OECD (2001) states this pattern fails the test of plausibility.
- **Delayed linear retirement**. In delayed linear retirement, retirement begins before the asset reaches its average life with some assets surviving for some time after the average life. In other words, retirements start later and finish sooner than in the simple linear case. For example the Research Project on Economic Planning (RPEP) uses a +/-20 percent delayed linear function in its PIM. This means that assets begin to retire when they reach the age of the average life less 20 percent and will be totally retired by the age of the average life plus 20 percent. OECD (2001) suggests that this pattern is a more realistic one but is less plausible than the bell-shaped pattern.
- **Simultaneous exit retirement**. The simultaneous exit retirement assumes that all assets are retired simultaneously when they reach the average asset life. This is the simplest assumption and easiest to deal with in a PIM but is unrealistic as in reality some assets will be retired before they reach their expected life and others will last longer. This is also the view of OECD (2001).
- **Bell shaped retirement**. Bell shaped retirement assumes that retirements begin gradually after installation, then build up to a peak around the average asset life and gradually fall away after the average. This distribution around the average follows a bell shaped curve. This is the most accepted method, being perceived as the most plausible representation of the real world situation. A number of different bell-shaped functions have been proposed.

The assumption that assets have bell-shaped retirement functions is supported by research conducted in the 1920s and early 1930s by Robley Winfrey. Winfrey collected information on the dates of installation and retirement of 176 groups of industrial assets and calculated 18 'type' curves that give good approximations to their observed retirement patterns. The 18 Winfrey curves give a range of options for distribution around the average asset life (left-modal, symmetrical or right-modal) and peakedness (0 to 7) (Winfrey, 1935). This is one of the few known empirical studies conducted on asset retirement functions. OECD (2001) concluded that a Winfrey retirement function, or any function with similar properties to a Winfrey function, is the most plausible retirement function to use in a PIM. They also note that Statistics Netherlands and the French INSEE have shown that certain bell-shaped functions satisfactorily replicate observed discard patterns. Appendix 5 contains further information detailing Winfrey retirement functions.

Figure 5.2 Mortality and survival functions



In terms of New Zealand research there is very little data available on asset retirement patterns. The Inland Revenue depreciation survey carried out by Statistics NZ provided some useful information concerning the survival patterns of plant, machinery and transport equipment. The survey collected data on the purchase dates and expected service lives for 250 different plant, machinery and transport equipment asset types. This data is aggregated into broad asset classes and retirement functions derived, based on their expected lives. The Winfrey function that had the best fit with the derived function was then picked as the retirement function for the asset classes 'plant, machinery and equipment' and 'transport equipment'. It was found that the L4 Winfrey curve best matched the asset classes 'plant, machinery, and equipment' and 'transport equipment'.

The depreciation survey did not collect data for building and construction assets and a similar analysis with Winfrey functions was not possible. It was noted that Winfrey studied retirement functions of railway buildings, and concluded that they begin retiring immediately after installation but with the bulk of the retirement taking place before the average life is completed. Winfrey modelled this as having right bias with low peakedness (an R2 Winfrey Curve). Using this model, and in the absence of other information, 'residential buildings' and 'non-residential buildings' are assumed to retire according to Winfrey's R2 function.

Winfrey also studied the retirement pattern of 'brick construction on pavements'. From his list of assets this is the closest match to the 'other construction' and 'land improvements' asset classes. Winfrey's conclusion for brick construction on pavements was that their retirement function could be modelled with left bias and high peakedness (an L4 Winfrey Curve). Again, in the absence of other information, it has been assumed that 'other construction' and 'land improvements' asset classes retire according to Winfrey's L4 function.

Finally, it has been assumed that intangibles also have a Winfrey retirement function of L4. Chapter 5.2 above explains that as computers and computer software are usually joint purchases, they are given the same asset life. For simplicity, computer software is assumed to retire along-side computers, and the same Winfrey L4 retirement function is used. In the absence of any other information, this retirement function is used for all assets within the asset class 'intangibles' and therefore it also encompasses the asset type 'oil & gas and other exploration'.

It should be noted that it is not possible to construct survival functions at the same level of asset detail used in the PIM (that is, by asset type, sector and industry) because of limitations in source data. Therefore, survival functions were constructed for each of the seven asset classes separately and these were applied to the relevant asset types. Table 5.4 shows the retirement functions used for each asset class.

Table 5.4 Asset class and Winfrey retirement function used

Asset class	Winfrey function used
Residential buildings	Winfrey R2
Non-residential buildings	Winfrey R2
Other construction	Winfrey L4
Land improvements	Winfrey L4
Plant, machinery, and equipment	Winfrey L4
Transport equipment	Winfrey L4
Intangibles	Winfrey L4

Age-efficiency and age-price profiles

The third key requirement in the PIM is information on the decline in the efficiency of assets.

An age-efficiency profile of an asset describes the change in the efficiency of an asset as it ages. Efficiency in this context refers to the asset's ability to produce a quantity of capital services. Age-efficiency profiles are created by taking a pre-determined rate of efficiency decline and a retirement function. These are then fed into the PIM which estimates an age-efficiency factor for each asset in each year until the asset retires.

Closely linked to the age-efficiency profile of an asset is an age-price profile. This describes the change in the price of an asset as it ages. In the Statistics NZ PIM, the age-price profile is calculated by taking the age-efficiency profile and adjusting it by a predetermined discount rate to derive the age-price profile every year until the asset retires. Incorporating both age-efficiency and age-price profiles (where the age-price profiles are derived using the same parameters as the age-efficiency profiles) into the PIM ensures consistency between net capital stock and productive capital stock estimates.

An age-efficiency profile is used to calculate PKS estimates. PKS is calculated by multiplying the GFKF of each year for the assets still surviving by the efficiency reduction factor given by the age-efficiency profile. An age-price profile on the other hand is used to produce NKS estimates. It does this by multiplying the GFKF of each year for the assets still surviving by their price as given by the age-price profile. For each age-efficiency profile and a given discount rate, there is a unique age-price profile. This results in consistency between the two capital stock measures.

The following example (Harrison, 1999) illustrates how consistency is achieved between age-efficiency and age-price profiles. The example in table 5.5 shows the derivation of an age-price profile for a single asset, given the following assumptions:

- the age-efficiency profile has been estimated (this will be further discussed in the next section)
- the asset has a life of five years

- the efficiency declines from an initial value of 100 by 20 each year
- a discount rate of 4 percent is used.

Table 5.5 Example of calculating an age-price profile

	Age-efficiency profile (%)	Year 1	Year 2	Year 3	Year 4	Year 5
Year 1	100	100.0				
Year 2	80	76.9	80.0			
Year 3	60	55.5	57.7	60.0		
Year 4	40	35.6	37.0	38.5	40.0	
Year 5	20	17.1	17.8	18.5	19.2	20.0
Total		285.0	192.5	117.0	59.2	20.0
Age-price profile (%)		100	67.5	41.0	20.8	7.0

The second column in table 5.5 shows the (given) age-efficiency profile, starting at 100 percent efficiency in year one and declining by 20 percent of the initial value each year after. These entries are put in the top diagonal line of the shaded triangle. Each entry in this diagonal line shows the revenue expected from the asset in the year in question. The numbers below the diagonal show the future years' earnings suitably discounted. For example in the column 'year 1', 76.9 is the second year's earnings of 80 discounted once (with a discount rate of 4 percent); 55.5 is the value of the third year's earnings of 60 discounted twice and so on. When each column is complete, the column totals are calculated. If these are scaled to give 100 in year one, then the age-price profile (as shown in the bottom shaded row) can be seen to be 100, 67.5, 41.0, 20.8, and 7.0.

It is also possible to start with an age-price profile and derive an age-efficiency profile. Using the same assumptions above (except that we now start with a given age-price profile that shows the price declines from an initial value of 100 to 20), this is shown in table 5.6.

Table 5.6 Example of calculating an age-efficiency profile

	Age-efficiency profile (%)	Year 1	Year 2	Year 3	Year 4	Year 5
Year 1	100.00	23.07				
Year 2	96.67	21.46	22.31			
Year 3	93.34	19.91	20.71	21.54		
Year 4	90.00	18.46	19.20	19.97	20.77	
Year 5	86.69	17.10	17.78	18.49	19.23	20.00
Age-price profile (%)		100	80	60	40	20

Starting with the bottom row of table 5.6, it is possible to work backwards from the right-hand end. If the price at the beginning of year five (its final year) is 20, we know that its earnings in that year will be only 20. This provides the starting point for the value of the year five earnings to be shown in the lowest row of the shaded triangle. Each entry in this row shows the year five earnings discounted (by 4 percent) which is the value of those earnings for the year shown. For example, in year four, the year five earnings of 20, which are one year, in the future will be valued at 19.23, ie 20 discounted once (by 4 percent). Similarly, the earnings are valued at 18.49 in year three, which are 20 discounted twice.

For year four we also know from the age-price profile that the asset price is 40 and that year five's earnings (20) are discounted to 19.23. The earnings in year four can therefore be calculated as the difference between these, 20.77. This figure can then be discounted (to 19.97) to complete the row for 'year 3' and so on.

When the triangle is complete, the age-efficiency profile can be calculated as the ratio of each entry in the top diagonal line relative to that for year one. For example, year one starts with a profile of 100 percent (which is the ratio of 23.07 to 23.07) while year two (96.67 percent) can be worked out from the ratio of 22.31 to 23.07. Year three (93.34 percent) can be worked out as the ratio of 21.54 to 23.07 etc. Therefore, the age-efficiency profile corresponding to the age-price profile, which declines from 100 by 20 for four years, is 100, 96.67, 93.34, 90.00, and 86.69.

For every age-efficiency profile there is a unique age-price profile. The age-price profile will always decline at least as fast as the age-efficiency profile and in most cases (that is, when the discount rate is greater than zero) the age-price profile will decline faster (such as in the above two examples).

5.3 Productive capital stock

Composite age-efficiency profiles

There is very little empirical data available about how the efficiency of assets declines over their lives and therefore the shape of age-efficiency profiles. The choice of age-efficiency profiles is therefore a matter of judgement. There are a number of different models available, as follows.

- Constant age-efficiency (one-hoss shay). In a constant age-efficiency profile there is no loss in efficiency and the asset has constant efficiency throughout its working life. In reality there are probably very few assets that maintain constant efficiency throughout their working lives. Light bulbs are sometimes used as an example but they are too short-lived to be classified as capital goods.

- Geometric age-efficiency. A geometric age-efficiency profile falls at a constant rate each year. Geometric decline implies that the rentals generated by an asset fall by the largest absolute amount in the first year of service and by decreasing absolute amounts each year after.
- Linear age-efficiency. In a linear age-efficiency profile, efficiency falls at a constant amount each year. A linear decline in efficiency can be seen as a compromise between the geometric profile and the hyperbolic profile (described below).
- Hyperbolic age-efficiency. In a hyperbolic age-efficiency profile, efficiency declines slowly in the earlier period and at an increasing rate towards the end of the asset's life. There is some evidence that this may be a common efficiency profile for many kinds of assets including both structures and plant and machinery.

Statistics NZ has chosen to use a hyperbolic age-efficiency profile to describe the rate of decline in efficiency. This is the same as used by the Australian Bureau of Statistics (ABS) and the United States of America Bureau of Labor Statistics (BLS). Hyperbolic age-efficiency profiles have assets declining by small amounts before the rate of decline increases as the asset ages.

The functional form for hyperbolic age-efficiency deterioration is as follows (ABS, 2000):

$$\mathrm{E_t} = \frac{\mathrm{M} - \mathrm{A_t}}{\mathrm{M} - \mathrm{bA_t}}$$

where:

E_t = the efficiency of the asset at time t, compared to its efficiency when new

M = the asset life as per the Winfrey distribution

A_t = the age of the asset at time t assuming that assets are purchased at the end of the year

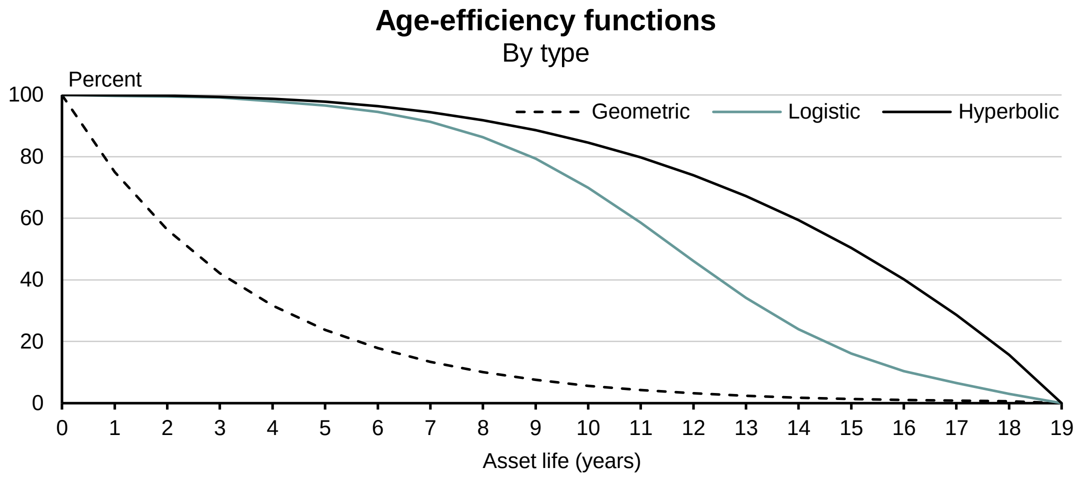
b = the efficiency reduction parameter

The term 'composite age-efficiency profile' is used for this PIM parameter. It is applied to a cohort of assets and so incorporates both an efficiency deterioration factor and an asset retirement pattern.

In New Zealand the efficiency reduction parameter is set to 0.75 for residential buildings, non-residential buildings, land improvements, and other construction. It is set to 0.5 for transport equipment and plant, machinery, and equipment with the exception of computers. Computers along with intangibles have an efficiency reduction parameter of 1. The value of 0.75 results in the efficiency decline occurring later in the asset's life, compared to the 0.5 value where the efficiency decline is distributed more evenly throughout the assets life. Computers and intangibles are set to 1 implying there is no efficiency decline.

When the hyperbolic age-efficiency profile for each of the possible lives of an asset are weighted together (as per the Winfrey distribution), the resulting composite age-efficiency profile resembles a logistic function with a point of inflection towards the end of its maximum life (ABS, 2000). This means that the efficiency of a group of assets deteriorates at a slower rate at the beginning of its life and accelerates around the average asset life before slowing down towards the end of the maximum life. This can be seen in figure 5.3 alongside the age-efficiency profiles produced by geometric and logistic age-efficiency profiles.

Figure 5.3



Source: Statistics New Zealand

Table 5.7 illustrates how the composite age-efficiency profile is calculated for the purchase on a number of the same (imaginary) assets, from the age-efficiency profile and the Winfrey retirement function. The following assumptions are applied.

- The assets have an average life of four years.
- The assets use an L4 Winfrey retirement function.
- The asset has a reduction parameter of 0.75.
- Gross fixed capital formation on the assets is assumed to have taken place at the end of the first year.

Table 5.7 Calculating a composite age-efficiency profile

Average asset life	**4**							
Maximum asset life, per Winfrey L4 function	**8** (determined by the Winfrey function)							
Efficiency reduction parameter	**0.75**							
End of year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Winfrey L4 retirement function, average life 4, R_i	0	1.84	26	46.28	18.87	6.05	0.94	0.03
Age-efficiency function (shows what is left after loss of efficiency). Note:It is assumed that assets are put in place at the end of the year, so at the end of year 1 the age-efficiency function is always 1.	$E_t = \frac{M - A_t}{M - bA_t}$ Where: E_t = efficiency of the asset at time t M = asset life as per Winfrey distribution A_t = age of the asset at time t b = efficiency reduction parameter							
Calculating the age-efficiency profile for year end:	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Assets lasting for 1 year	1.000							
Assets lasting for 2 years E_1 =1 E_2 =2-1/(2-(0.75*1))=0.800	1.000	0.800						
Assets lasting for 3 years E_1 =1 E_2 =3-1/(3-(0.75*1))=0.889 E_3 =3-2/(3-(0.75*2))=0.667	1.000	0.889	0.667					
Assets lasting for 4 years	1.000	0.923	0.800	0.571				
Assets lasting for 5 years	1.000	0.941	0.857	0.727	0.500			
Assets lasting for 6 years	1.000	0.952	0.889	0.800	0.667	0.444		
Assets lasting for 7 years	1.000	0.960	0.909	0.842	0.750	0.615	0.400	
Assets lasting for 8 years	1.000	0.966	0.923	0.870	0.800	0.706	0.571	0.364
Composite age-efficiency function, derived by weighting the age-efficiency function by the Winfrey retirerment function Composite age-efficiency profile, for year 2 = (0.800*1.84+0.889*26.00+0.923*46.28+0.941*18.87+ 0.952*6.02+0.960*0.94+0.966*0.03)/100 = 0.918	Composite age-efficiency function, for year *j* = $\sum_{i=j}^{m}(E_{ij} * R_i)$ Where: *m* = maximum life E_{ij} = age-efficiency function of assets lasting for *i* years, in year *j* R_i = retirement factor for year *i*							
	1.000	**0.918**	**0.768**	**0.458**	**0.142**	**0.033**	**0.004**	**0.000**

Further explanation of a number of the entries in table 5.7 follows.

- The Winfrey retirement function row shows the percentage of assets that retire in each year.
- The age-efficiency profile for each cohort is different. So, for example, the cohort of assets that will last for three years operate in year two at an efficiency rate of 0.889 whereas the cohort that lasts for four years operate, as one might expect, at a higher efficiency rate in year two of 0.923.
- The composite efficiency parameter for, say, year two, is then derived by weighting the efficiency rate of each cohort still surviving in year two by the percent that that cohort makes up of the initial acquisition.

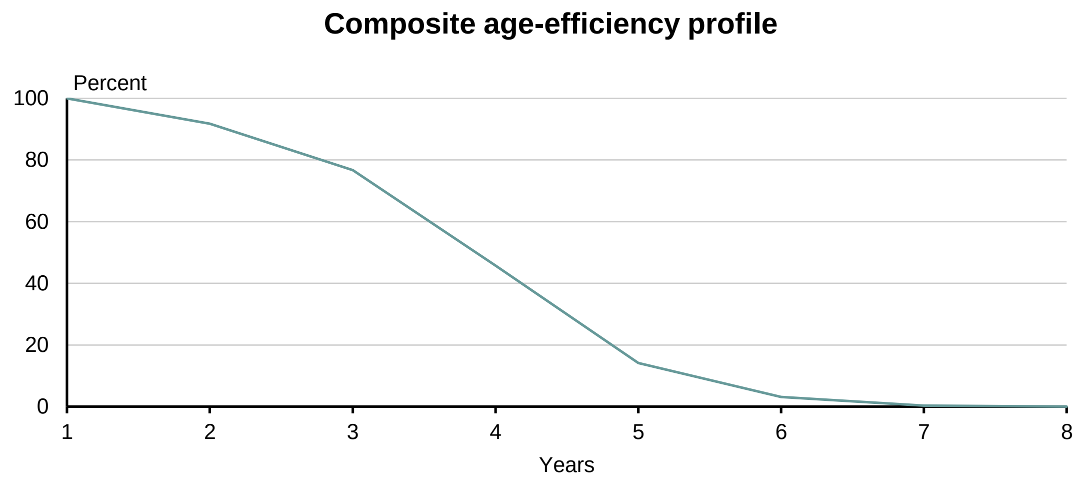
Table 5.8 summarises the composite age-efficiency profile that was calculated in table 5.7.

Table 5.8 Composite age-efficiency profile

Age (years)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Age-efficiency profile (percent)	100	91.75	76.79	45.80	14.20	3.20	0.39	0.01

When graphed (as in figure 5.4) this composite age-efficiency profile shows that the curve obtains the shape of a logistic function as shown below. This shows that this group of imaginary assets initially slowly deteriorates in efficiency, then after about three years the deterioration and retirement begins to accelerate and continues at a higher rate until the asset has been in operation for about five years, at which point it slows down until the maximum life of eight years is attained.

Figure 5.4



Source: Statistics New Zealand

Deriving productive capital stock

Once the composite age-efficiency profile is derived (such as in table 5.8) PKS can be estimated by applying this profile to constant price GFKF of each year. For example, if the GFKF of a group of imaginary assets used in the above example is 1000 (in constant prices) in year one then its PKS for the next seven years (after which it will be completely retired from the stock) can be estimated using the above age-efficiency profile. This is shown in table 5.9.

Table 5.9 Estimating productive capital stock

Year	Gross fixed capital formation (constant prices) (A)	Age-efficiency profile (%) (B)	Productive capital stock (constant prices) (AxB)
1	1000	100.00	1000.00
2		91.75	917.50
3		76.79	767.90
4		45.80	458.00
5		14.20	142.00
6		3.20	32.00
7		0.39	3.90
8		0.01	0.10

In the PIM, this calculation is done in relation to the GFKF of each asset type by industry and by sector in each year.

A PKS total for each separate asset type for a specific year is then calculated by adding the efficiency-adjusted GFKF from previous years still surviving. Because all Statistics NZ constant price series are chain-linked, chaining is done by asset class for each industry (expressed in 2009/10 prices).

5.4 Net capital stock

Composite age-price profiles

In order to derive net capital stock measures – and, subsequently, consumption of fixed capital – it is necessary to first develop age-price profiles for each of the assets in the PIM. As noted above, an age-price profile describes the change in the price of an asset as it ages. In the Statistics NZ PIM, the age-price profile is calculated by taking the composite age-efficiency profile and adjusting it by a predetermined discount rate to derive the composite age-price profiles[2] for each asset until the asset retires. Clearly, a key factor is the choice of discount rate.

The age-efficiency profile will determine the rentals generated by an asset over its life-time and these rentals are then discounted in order to calculate the price of the asset at any point in time. What discount rate to choose? In the New Zealand PIM, the decision was made to base the discount rate on real, long-term market interest rates. As the current design of the PIM does not allow multiple rates to be used and as all calculations are performed in constant or inflation-adjusted prices, a single, real discount rate was chosen.

To determine what rate to use, a long-term series of real interest rates was constructed. This was based on the nominal interest rates on long-term government stock deflated by the annual price changes given by the consumers price index (CPI). The series that this created was quite volatile over time, and in many periods was negative (especially during the 1970s, when inflation as measured by the CPI was higher than nominal interest rates at the time).

It was decided that the mean of the 20-year period from 1980 to 2000 would give a good representative long-term real interest rate. This period was chosen for two main reasons.

- First, the majority of New Zealand's economic regulatory reforms, structural changes, and changes in sector of ownership of enterprises and fixed assets have taken place within this 20-year period.
- Second, prior to 1980 there were a number of economic policies that affected the interest rate. These economic policies included: regulated interest rates, various price subsidies, and fixed exchange rates.

Therefore real interest rates from before 1980 are unlikely to be relevant to the current economic environment. The 20-year period from 1980 to 2000 gave a mean long-term real interest rate of 4 percent and this single discount rate is used for all years.

By combining the composite age-efficiency profiles with the discount rate of 4 percent, it is possible to construct associated composite age-price profiles for each of the PIM assets. Table 5.10 presents the composite age-price profile derived from the age-efficiency profile in table 5.8 using a real discount rate of 4 percent. This is illustrated in figure 5.5.

2. The term composite age-price profile is used as the profile incorporates both the age-price function and the retirement function.

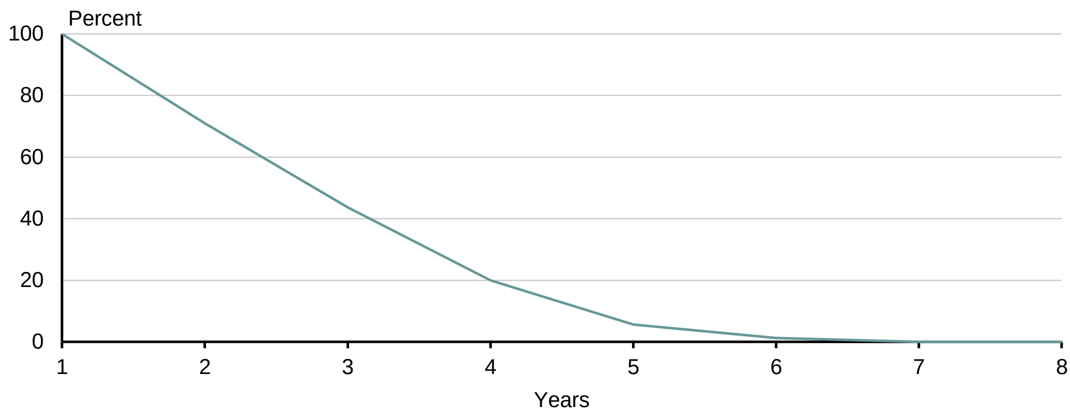
Table 5.10 Composite age-price profile

Age (years)	1	2	3	4	5	6	7	8
Age-price profile (%)	100.0	71.0	43.6	20.0	5.6	1.2	0.01	0.0

Figure 5.5 shows that this composite age-price profile has a more geometric shape. This indicates that the economic value of the assets depreciates more rapidly in the early years despite the assets' efficiency-deterioration rate being slower in those years. This illustrates that in the early years, the effect of ageing is greater on the value of assets than on efficiency deterioration. However, as assets move towards the maximum life there is consistency between loss of efficiency and loss of economic value as both decline in a similar pattern.

Figure 5.5

Composite age-price profile



Source: Statistics New Zealand

Deriving net capital stock

Once the composite age-price profile is derived (such as in table 5.10) NKS can be estimated by applying this profile to constant price GFKF for each year. For example, if the GFKF of a group of imaginary assets used in the above example is 1000 (in constant prices) in year one then its NKS for the next seven years (after which it will be completely retired from stock) can be estimated using the age-price profile.

Table 5.11 Estimating net capital stock

Year	Gross fixed capital formation (constant prices) (A)	Age-price profile (%) (B)	Net capital stock (constant prices) (AxB)
1	1,000	100.00	1,000.00
2		71.00	710.00
3		43.60	430.60
4		20.00	200.00
5		5.60	56.00
6		1.20	12.00
7		0.01	0.10
8		0.00	0.00

In the PIM this calculation is done in relation to the constant price GFKF of each asset type by industry and by sector in each year.

A NKS total for each separate asset type for a specific year is then calculated by adding the age-price adjusted GFKF from previous years still surviving. These separate assets are then added together to reach an aggregate total. This aggregate total is then reflated to current prices using the appropriate asset price indexes. NKS is published by asset, by industry, and by sector.

5.5 Consumption of fixed capital

In the Statistics NZ PIM there are three steps involved in deriving a depreciation profile:

1. Derive the composite age-efficiency profile for a group of assets put in place at a particular time.

2. Obtain the composite age-price profile using the composite age-efficiency profile and a discount rate.

3. Derive the depreciation profile by differencing the values of the composite age-price profiles for assets of consecutive ages.

The resulting set of depreciation rates is then multiplied by constant price GFKF for each year to estimate CFK in constant prices. For example, if the previous age-price profile is used and if GFKF is 1000 (in constant prices) in year one, then its annual CFK for the next seven years (after which it will be completely retired from stock) can be shown in table 5.12.

Table 5.12 Estimating consumption of fixed capital

Year	Gross fixed capital formation (constant prices) (A)	Age-price profile (%) (B)	Depreciation profile (%) (C)	Annual consumption of fixed capital (constant prices) (AxC)
1	1,000	100.00	0.00	0.00
2		71.00	29.00	290.00
3		43.60	27.40	274.00
4		20.00	23.60	236.00
5		5.60	14.40	144.00
6		1.20	4.40	44.00
7		0.01	1.19	11.90
8		0.00	0.01	0.10

To derive CFK estimates in current prices, the constant price series are reflated using appropriate asset price indexes.

An equivalent approach to calculating CFK is also available. As mentioned previously CFK is defined as the decline in the value of the net stock of assets used in production, as a result of physical deterioration and normal obsolescence. CFK can therefore be estimated as the difference between GFKF and the change in NKS. We have the following identity:

$NKS_t = NKS_{t-1} + GFKF_t – CFK_t$

So,

$CFK_t = NKS_{t-1} – NKS_t + GFKF_t$

In the above example, as GFKF in years other than year one is zero, CFK is simply the change in the value of the NKS in consecutive years. If, for example, in year two there was a further acquisition of assets of 800 (measured in constant prices), then (and with reference to table 5.11):

$NKS_1 = 1,000$

$NKS_2 = 710 + 800 = 1510$

So,

$CFK_2 = 1,000 – 1510 + 800 = 290$

which is the equivalent to applying the depreciation function to the initial GFKF, as shown in table 5.12.

Note that deriving CFK from either approach does not require any assumptions about the form of the depreciation function. Instead, assumptions are needed about the form of the age-efficiency profile and the discount rate (which creates the age-price profile).

5.6 Summary of the Statistics NZ PIM

The PIM used by Statistics NZ can be summarised through the following steps.

1. Deflate gross fixed capital formation

GFKF in current prices is first deflated using asset price indices. GFKF will then be expressed in constant prices (or volume terms) at the most detailed level practicable (current practice is 26 asset types by over 100 industries).

2. Determine the PIM parameters

The PIM parameters include average asset lives, retirement functions and age-efficiency profiles. Average asset lives are mainly derived from the Inland Revenue's depreciation survey and tax depreciation rates. Retirement functions in the PIM come from Winfrey retirement functions where an R2 retirement function is used for residential and non-residential buildings and an L4 retirement function for all other asset types. Finally the PIM uses a hyperbolic age-efficiency profile (with an efficiency reduction parameter for 0.75 for residential buildings, non-residential buildings, land improvements and other construction; 0.5 for transport equipment and plant, machinery and equipment with the exception of computers. Computers along with intangibles have an efficiency reduction parameter of 1).

3. Derive composite age-efficiency profiles

These PIM parameters are then used to derive composite age-efficiency profiles for each of the asset types. The values of the retirement function are used to weight together the hyperbolic age-efficiency values for all possible life spans to form a composite age-efficiency profile.

4. Derive productive capital stock

Once the composite age-efficiency profile is derived, PKS is estimated by applying this profile to the constant price GFKF of each year. Then, all efficiency-adjusted GFKF from previous years still surviving, are accumulated to derive the PKS of any one year. This gives PKS in constant prices (which is later converted to chain-volume series in 2009/10 prices).

5. Determine a discount rate

In order to derive a composite age-price profile a discount rate must be obtained. In New Zealand a single discount rate is used for all years in the PIM. The mean long-term real interest rate from 1980 to 2000 of 4 percent is used.

6. Derive composite age-price profiles

The composite age-efficiency profile for each asset type together with the annual real discount rate of 4 percent is used to derive associated composite age-price profiles.

7. Derive net capital stock

NKS for each asset type is estimated by applying the composite age-price profile to the constant price GFKF of each year. Then all age-price adjusted GFKF from previous years still surviving are accumulated to derive the NKS of any one year. This gives NKS in constant prices.

8. Derive the depreciation profiles

The depreciation profiles are then derived by taking the difference between the values of the composite age-price profile for assets of consecutive ages. In other words, the values of consecutive composite age-price profiles are differenced to obtain depreciation profiles.

9. Derive consumption of fixed capital

The resulting depreciation profiles are then multiplied by constant price GFKF for each year to calculate CFK. This gives CFK in constant prices.

10. Reflate net capital stock and consumption of fixed capital

Finally NKS and CFK are expressed in current prices. This involves reflating NKS or CFK in constant prices by the relevant price indices.

6 Data sources

Once the parameters of the PIM have been established, there remain two main variables as inputs, gross fixed capital formation (GFKF) in current prices, and asset price indexes. This section discusses the different data sources used for these two key inputs.

6.1 Gross fixed capital formation in current prices

As already noted, the PIM is an accumulation model: estimates of capital stock are made by accumulating past net acquisitions of assets over their estimated lives. This implies that the PIM requires either (a) an initial benchmark estimate of capital stock to which subsequent capital acquisitions can be added, or, if no benchmark is available (b) statistics on GFKF extending back for the full life of the longest-lived asset.

Benchmark values, at appropriately written-down replacement cost, were not available, so to compile the PKS and NKS measures long-term GFKF series had to be derived. The length of the series required for each asset type varied, depending on their average asset life, the relevant PIM functions chosen and its usage in different industries. In practice, average asset lives used in the PIM vary from four years to 110 years, depending on the type of the asset. The retirement functions require GFKF series for at least double the asset life. For example, an asset with a 50-year average life requires GFKF data for 100 years. For some long-lived assets such as roading construction, it was necessary to take the GFKF series back to 1858.

The PIM requires time series of GFKF at the finest possible level of asset type, analysed by industry and sector of ownership (that is, private, central and local government).

Different methods were used to compile the GFKF series for the following time periods:

- 1972 to the present
- 1950 to 1972
- Pre-1950.

The coverage and completeness of the data for the early periods was of varying quality, with numerous ‘proxy’ measures necessarily being used to fill gaps in series. However, the impact of most of these very early series on the published post-1971 NKS and PKS series is not significant.

The following section briefly outlines the GFKF data sources and the approach taken to compile the asset type series, while table 6.1 explains the data sources in more detail.

1972 to the present

GFKF for most asset-types is derived by reconciling two independent estimates: a supply-side, economy-wide total with a demand-side, industry-based total. Available data determines the extent to which this preferred ‘supply equals demand’ approach can be adopted.

Supply-side (economy wide) totals for 19 asset types were derived from various administrative databases and specific surveys. For example, supply totals were derived for:

- motor vehicles from vehicle registration data and price data
- plant, machinery, and equipment from import and local production data
- residential and non-residential buildings from Statistics NZ's Quarterly Building Activity Survey. These have been balanced against industry demand estimates after taking account of new and second hand asset sales to households, exports and changes in inventories. From 1986/87 onwards, Statistics NZ's Annual

Enterprise Survey (AES) is the source for the industry purchases while for earlier years a series of less frequent industry-based economic censuses were used. The exception is residential buildings for which household purchases are first deducted (based on the Quarterly Building Activity Survey data itself) with the residual allocated to business and government, based on their GFKF expenditures.

For the asset types 'other construction' and 'land improvements', only demand-side estimates are available, based on information from the Agriculture Production Survey, Agricultural Economic surveys, non-Statistics NZ farming surveys and surveys of other major purchasers of these types of GFKF.

For all years, detailed central and local government data by asset type and by industry has been available and private sector figures have therefore often been derived as a residual.

These sources were supplemented where necessary by more detailed industry and asset-type data from the various inter-industry studies produced during the period.

While the basic approach has remained the same for this period, the level of detail at which the estimates are prepared has varied as data sources have changed over time.

1950 to 1972

The starting point for this period is a total economy GFKF series at the all asset level.

From 1950 to 1962, GFKF from the National Income and Expenditure (NIE) accounts published by Statistics NZ (then called the Department of Statistics) is used. For 1962–1971 the series is as published in the New Zealand System of National Accounts (NZSNA). Both series exclude the 'new' assets that were added to the scope of capital expenditure under the revised SNA 1993 guidelines (such as software). The two series are spliced to produce a single series and aligned to the 1972 (SNA 1993 based) level. This series provides the all economy GFKF control total.

The asset by industry breakdowns of the total are derived from a number of sources.

- An industry GFKF series broken down at a two asset class level (building and construction, and plant & transport equipment), was available from the Research Project on Economic Planning (RPEP) datasets. These series are mainly based on Statistics NZ sources such as industry economic censuses, and government financial accounts data. These are considered robust. More information and detail regarding the Research Project on Economic Planning (RPEP) can be found in appendix 3.
- This data was further split into the six asset class level (residential buildings, non-residential buildings, other construction, land improvements, plant, machinery and equipment, and transport equipment) using data from a variety of sources: annual reports, various Parliamentary publications, Statistics NZ surveys and academic research.
- The asset classes 'non-residential buildings' and 'other construction' were then interpolated between periodic inter-industry benchmarks. However, for the other asset classes, insufficient inter-industry detail prevented this periodic benchmarking. As a result, some estimation was necessary.

These estimates were initially derived using the New Zealand Standard Industrial Classification (NZSIC) published industry groups. The industry by asset group estimates were reconciled first to the series produced by the RPEP and then to the all industry, all asset class totals of the published NZSNA/NIE. These were then converted to the published industry level, consistent with all other industry based national accounts series.

Pre-1950

Most asset class estimates are derived from supply-side data, using where possible the same data sources described above. However, alternative indicators had to be used when these data sources did not go back far enough in time. For example, residential building has been estimated by extrapolation, using building permits data back to 1922 and population data for earlier years. Other asset classes were estimated using demand data, particularly for 'land improvement' and 'other construction' where the major purchasers of this asset type were central and local government. GFKF data was estimated as far back as necessary to allow the PIM to derive capital stock estimates from 1971/72 onwards.

6.2 Asset price indexes

The PIM performs most of its calculations in constant prices. To derive the constant price series, the current price GFKF series are deflated using appropriate asset price indexes. Ideally, price deflators are required at the same asset and industry level as the GFKF series. This is a total of over 6,900 price deflators for the full time period of the GFKF series. Price indexes at this level are not available. For most asset types, specific price deflators have been used but with no industry or sector differentiation. This is not considered to be an issue as most businesses will face the same market prices – or at least, the same market price changes. More serious are those instances where specific asset prices were not available and 'proxies' have been used. For example 'other construction' price deflators have also been used for the asset type 'land improvements'.

6.3 Detailed data sources

In table 6.1, sources are from Statistics NZ, unless otherwise stated.

Table 6.1 Data sources

Period	Gross fixed capital formation sources		Price sources
	Total	**Allocation**	
Residential buildings			
1972 to present	Value of work put in place from the Quarterly Building Activity Survey.	Owner-occupied dwellings and residential property operators. Census of Population and Dwellings data is used to derive an allocation between owner-occupied and rental dwellings. For all other industries estimates at industry level are derived using data from the Annual Enterprise Survey, economic censuses, Crown Finance Information System, Local Authority Census and annual reports.	1981 to present Sub-indexes of the Capital Goods Price Index. 1979–1980 Producers Price Index for outputs of the building and construction industry. 1977–1979 General Price Index for inputs of the building and construction industry. 1972–1976 Wholesale Price Index for builders' materials.

Period	Gross fixed capital formation sources		Price sources
	Total	Allocation	
Residential buildings (continued)			
1950–1971	1966–1971 Value of work put in place from the Quarterly Building Activity Survey. 1950–1965 Estimates are calculated using building permits data.	Owner-occupied dwellings and residential property operators were estimated using Census of Population and Dwellings data. Estimates at industry level for other industries were made using a variety of sources, including inter-industry studies, then reconciled with non-residential buildings, land improvements and other construction to Philpott's series of 'structures' (Philpott, 1991).	1950–1971 Wholesale Price Index for builders' materials.
Pre-1950	1922–1949 Estimates are calculated using building permits data. Pre-1921 Combination of population movements and price index data given at right.	Owner-occupied dwellings and residential property operators were estimated back to 1930 using Census of Population and Dwellings data. Fixed proportions used prior to this point. For all other industries, estimates at industry level were derived using average proportions from capital formation by industry data from 1950–1972. Fixed proportions used prior to this point.	1911–1949 Wholesale Price Index for builders' materials. 1907–1910 Rent Price Index. 1902–1906 Implicit price index derived from values and volumes for registered mortgages. 1874–1901 Mean wage rates of artisans. Pre-1873 Average rate of change for the years 1873–1901.

Period	Gross fixed capital formation sources		Price sources
	Total	Allocation	
Non-residential buildings			
1972 to present	Value of work put in place from the Quarterly Building Activity Survey.	Estimates at industry level are derived using data from the Annual Enterprise Survey, economic censuses, Crown Finance Information System, Local Authority Census and annual reports.	1981 to present Sub-indexes of the Capital Goods Price Index. 1979–1980 Producers Price Index for outputs of the building and construction industry. 1977–1979 General Price Index for inputs of the building and construction industry. 1972–1976 Wholesale Price Index for builders' materials.

Period	Gross fixed capital formation sources		Price sources
	Total	Allocation	
Non-residential buildings (continued)			
1950–1971	1966–1971 Value of work put in place from the Quarterly Building Activity Survey. 1950 –1965 Estimates are calculated using building permits data.	Estimates at industry level are made using a variety of sources, including inter-industry studies, then reconciled with residential buildings, land improvements and other construction to Philpott's series of 'structures' (Philpott, 1991).	1950–1971 Wholesale Price Index for builders' materials.
Pre-1950	1922–1949 Estimates are calculated using building permits data. Pre-1921 Combination of population movements and price index data.	Fixed proportions are applied to all years prior to 1950 using the proportions from the 1950 year.	1911–1949 Wholesale Price Index for builders' materials. 1907–1910 Average wage in the Building Industry Price Index. 1874–1909 Mean wage rates of artisans. Pre-1873 Average rate of change for the years 1873–1901.

Period	Gross fixed capital formation sources		Price sources
	Total	**Allocation**	
Other construction			
Power generation construction			
1987 to present	No control total calculated.	Estimates at industry level are derived using data from the Annual Enterprise Survey, Crown Finance Information System, Local Authority Census and annual accounts or surveys of major operators, including government department reports.	1987 to present Sub-indexes of the Capital Goods Price Index.
1972–1986	No control total calculated.	Estimates at industry level were derived using data from annual accounts or surveys of major operators, including government department reports.	1981–1986 Sub-indexes of the Capital Goods Price Index. 1973–1980 Price indexes developed by the Research Project on Economic Planning (Philpott, 1991). 1972 Ministry of Works and Development Construction Index.
Pre-1972	No control total calculated.	New Zealand Electricity Department annual reports and Parliament report by New Zealand Electricity Department.	1964–1971 Ministry of Works and Development Construction Price Index. Pre-1963 The structures and roading price indexes used by Mulcare (1993).

Period	Gross fixed capital formation sources		Price sources
	Total	**Allocation**	
Other construction (continued)			
Central government roading			
All years	No control total calculated.	Capital expenditure on roads, bridges and footpaths derived from the Crown Financial Information System, and departmental reports.	1981 to present Sub-indexes of the Capital Goods Price Index. 1973–1980 Price indexes developed by the Research Project on Economic Planning (Philpott, 1991). 1964–1972 Ministry of Works and Development Construction Price Index. Pre-1963 The structures and roading price indexes used by Mulcare (1993).

Period	Gross fixed capital formation sources		Price sources
	Total	Allocation	
Other construction (continued)			
Local government roading			
1950 to present	No control total calculated.	Capital expenditure on roads, bridges and footpaths derived from the annual Local Authority Census.	1981 to present Sub-indexes of the Capital Goods Price Index. 1973–1980 Price indexes developed by the Research Project on Economic Planning (Philpott, 1991). 1964–1972 Ministry of Works and Development Construction Price Index. 1950–1963 The structures and roading price indexes used by Mulcare (1993).
Pre-1950	No control total calculated.	Extrapolated using movements in total local government other construction, using volume of non-residential building permits data together with price index data.	Pre–1949 The structures and roading price indexes used by Mulcare (1993).

Period	Gross fixed capital formation sources		Price sources
	Total	**Allocation**	
Other construction (continued)			
Railway construction			
1987 to present	No control total calculated.	Annual Enterprise Survey.	1987 to present Sub-indexes of the Capital Goods Price Index.
Pre-1986	No control total calculated.	NZ Railways Department annual reports.	1981–1986 Sub-indexes of the Capital Goods Price Index. 1973–1980 Price indexes developed by the Research Project on Economic Planning (Philpott, 1991). 1964–1972 Ministry of Works and Development Construction Price Index. Pre-1963 The structures and roading price indexes used by Mulcare (1993).

Period	Gross fixed capital formation sources: Total	Gross fixed capital formation sources: Allocation	Price sources
Other construction (continued)			
All other construction			
1972 to present	No control total calculated.	Estimates at industry level are derived using data from the Annual Enterprise Survey, Crown Finance Information System, Local Authority Census, economic censuses, the Agriculture Production Survey and surveys of major purchasers.	1981 to present Sub-indexes of the Capital Goods Price Index. 1973–1980 Price indexes developed by the Research Project on Economic Planning (Philpott, 1991). 1972 Ministry of Works and Development Construction Price Index.
Pre-1972	No control total calculated.	1950–1971 Estimates at industry level are made using a variety of sources, including inter-industry studies, and then reconciled with residential buildings, non-residential buildings and land improvements to Philpott's series of "structures" (Philpott, 1991). Pre-1950 Extrapolation using movements in non-residential building permits volumes data together with price indexes.	1964–1971 Ministry of Works and Development Construction Price Index. Pre-1963 The structures and roading price indexes used by Mulcare (1993).

Period	Gross fixed capital formation sources		Price sources
	Total	**Allocation**	
Land improvements			
1972 to present	No control total calculated.	Estimates at industry level are derived using data from the Agriculture Production Survey, Annual Enterprise Survey, economic censuses, trade data and dairy NZ.	1981 to present Sub-index of the Capital Goods Price Index. 1972–1980 Farming Capital Expenditure Price Index for land development.
Pre-1972	No control total calculated.	Estimates at industry level are made using a variety of sources, including inter-industry studies, and then reconciled with residential buildings, non-residential buildings and other construction to Philpott's series of "structures" (Philpott, 1991).	1968–1971 Average rate of change for the years 1972-1980. Pre-1967 Price indexes developed by the Research Project on Economic Planning (Philpott, 1991).
Transfer costs – residential and non-residential buildings, other construction and land improvements			
All years	Transfer costs consisting of real estate fee and conveyance fee are derived using the number of sales as reported by Quotable Value New Zealand multiplied by the average sale price. Totals for transfer costs are calculated for each associated asset type.	Allocated to industry by the same proportions as the associated asset type.	The same prices as the associated asset type are used with the exception of land improvements which is a composite of all the associated asset price indexes.

Period	Gross fixed capital formation sources		Price sources
	Total	Allocation	
Transport equipment			
Buses			
1972 to present	No control total calculated.	Estimates at industry level are derived using data from the Annual Enterprise Survey, Crown Finance Information System and Local Authority Census.	1981 to present Sub-index of the Capital Goods Price Index. 1972–1980 Implicit price index derived from new bus registration data from Land Transport Safety Authority.
Pre-1972	Domestic production of bus bodies volumes from the industrial production statistics multiplied by weighted unit level prices.	All allocated to the transport industry.	1971 Implicit price index derived from new bus registration data from Land Transport Safety Authority. Pre-1970 Implicit price index derived from domestic production of bus bodies from industrial production statistics.

Period	Gross fixed capital formation sources: Total	Gross fixed capital formation sources: Allocation	Price sources
Transport equipment (continued)			
Road vehicles other than buses			
1972 to present	No control total calculated.	Estimates at industry level are derived using data from the Annual Enterprise Survey, Crown Finance Information System and Local Authority Census.	1981 to present Sub-indexes of the Capital Goods Price Index. 1972–1980 Overseas Trade Index for road vehicles.
Pre-1972	New vehicle registrations multiplied by weighted unit level prices.	Fixed proportions are applied to all years prior to 1972 using the proportions from the 1972 year.	Overseas Trade Index for road vehicles.

Period	Gross fixed capital formation sources		Price sources
	Total	**Allocation**	
Transport equipment (continued)			
Rail equipment			
1972 to present	Imports and domestic production verified using the Annual Enterprise Survey, reports to Parliament by NZ railways department, NZ railways department annual reports and other annual reports.	All rolling stock is allocated to the rail transport industry.	1984 to present Sub-indexes of the Producers Price Index for local production supplemented with the price index for exported transport equipment from Japan (exchange rate adjusted). 1978–83 Producer Price Index inputs for transport and storage industry. 1972–1977 Wholesale Price Index for inputs to rail transport.
Pre-1972	Imports and domestic production verified using the reports to Parliament by NZ railways department.	All rolling stock is allocated to the rail transport industry.	1959–1971 Wholesale Price Index for inputs to rail transport. 1956–1958 Consumer Price Index for public transport. Pre-1955 Wholesale Price Index for manufactured metal.

Period	Gross fixed capital formation sources		Price sources
	Total	Allocation	
Transport equipment (continued)			
Ships			
1972 to present	Imports total based trade data and domestic production totals based on Annual Enterprise Survey, economic censuses and Economic Survey of Manufacturing.	Estimates at industry level are derived using data from the Annual Enterprise Survey, economic censuses, and surveys of major purchasers. Predominantly purchased by the Fishing and Water Transport industries.	Bank of Japan Ship Price Index, exchange rate adjusted, (The Bank of Japan, 2001) combined with the United States Bureau of Labor Statistics Ship Industry Output Producers Price Index (Bureau of Labor Statistics, 2001) and sub-indexes of the Capital Goods Price Index.
Pre-1972	Imports total based trade data and domestic production totals based on industrial production statistics.	Fixed proportions are applied to all years prior to 1972 using the proportions from the 1972 year.	1971 Bank of Japan Ship Price Index, exchange rate adjusted, (The Bank of Japan, 2001) combined with the United States Bureau of Labor Statistics Ship Industry Output Producers Price Index (Bureau of Labor Statistics, 2001) and sub-indexes of the Capital Goods Price Index. Pre-1970 Implicit price index derived from data on new ship registrations from transport statistics and trade data.

<table>
<tr><th rowspan="2">Period</th><th colspan="2">Gross fixed capital formation sources</th><th rowspan="2">Price sources</th></tr>
<tr><th>Total</th><th>Allocation</th></tr>
<tr><td colspan="4">Transport equipment (continued)</td></tr>
<tr><td colspan="4">Aircraft</td></tr>
<tr><td>1972 to present</td><td>Imports total based trade data and domestic production totals based on Annual Enterprise Survey, economic censuses and the Economic Survey of Manufacturing.</td><td>Estimates at industry level are derived using data from the Annual Enterprise Survey, economic censuses, and surveys of major purchasers.</td><td>1981 to present

Sub-indexes of the Capital Goods Price Index and an exchange-rate adjusted US Producers Price Index for fixed wing aircraft (Bureau of Labor Statistics, 2001).

1975–1980

Implicit price index derived from aircraft registration data from the Civil Aviation Authority (1999).

1972–1974

Overseas Trade Index for transport equipment.</td></tr>
<tr><td>Pre-1972</td><td>Imports total based trade data and domestic production totals based on industrial production statistics.</td><td>Fixed proportions are applied to all years prior to 1972 using the proportions from the 1972 year.</td><td>1971

Overseas Trade Index for transport equipment.

1964–1970

Implicit price index derived from imports of aircraft.

1953–1963

Wholesale Price Index for inputs for the transport industry, interpolated for missing years.

Pre-1952

An implicit price index derived from import values and volumes.</td></tr>
</table>

Period	Gross fixed capital formation sources: Total	Gross fixed capital formation sources: Allocation	Price sources
Plant, machinery, and equipment			
Heavy plant and machinery			
1972 to present	Imports total based trade data and domestic production totals based on the Annual Enterprise Survey, the Economic Survey of Manufacturing and economic censuses. Total sales are separated between capital and other goods using commodity data from supply-use analysis.	Estimates at industry level are derived using data from the Annual Enterprise Survey, Crown Finance Information System, Local Authority Census, economic censuses, the Agriculture Production Survey and surveys of major purchasers.	1981 to present Sub-indexes of the Capital Goods Price Index. 1978–1980 Farm Capital Expenditure Price Index for tractors and farm machinery. 1976–1977 Implicit price index derived from imports of general purpose machinery. 1972–1975 Farm Capital Expenditure Price Index for tractors and farm machinery.
Pre-1972	Derived from wholesale sales of machinery, supplemented for some components by imports from trade data.	1950–1971 Estimates at industry level are made using a variety of sources, including inter-industry studies, then reconciled to Philpott's series of 'equipment' (Philpott, 1991). Pre-1949 Fixed proportions are applied to all years prior to 1950 using the proportions from the 1950 year.	1939–1971 Implicit price index derived from imports of heavy machinery. Pre-1938 Wholesale Price Index for metals and their products.

Period	Gross fixed capital formation sources		Price sources
	Total	**Allocation**	
Plant, machinery, and equipment (continued)			
General purpose plant and machinery			
1972 to present	Imports total based trade data and domestic production totals based on the Annual Enterprise Survey, the Economic Survey of Manufacturing and economic censuses. Total sales are separated between capital and other goods using commodity data from supply-use analysis.	Estimates at industry level are derived using data from the Annual Enterprise Survey, Crown Finance Information System, Local Authority Census, economic censuses, the Agriculture Production Survey and surveys of major purchasers.	1981 to present Sub-indexes of the Capital Goods Price Index. 1978–1980 Farm Capital Expenditure Price Index for tractors and farm machinery. 1976–1977 Implicit price index derived from imports of general purpose machinery. 1972–1975 Farm Capital Expenditure Price Index for tractors and farm machinery.
Pre-1972	Derived from wholesale sales of machinery, supplemented for some items by imports from trade data.	1950–1971 Estimates at industry level are made using a variety of sources, including inter-industry studies, and then reconciled to Philpott's series of 'equipment' (Philpott, 1991). Pre-1949 Fixed proportions are applied to all years prior to 1950 using the proportions from the 1950 year.	1939–1971 Implicit price index derived from imports of general purpose machinery. Pre-1938 Wholesale Price Index for metals and their products.

Period	Gross fixed capital formation sources		Price sources
	Total	Allocation	
Plant, machinery, and equipment (continued)			
Electronic plant and machinery			
1972 to present	Imports total based trade data and domestic production totals based on the Annual Enterprise Survey, the Economic Survey of Manufacturing and economic censuses. Total sales are separated between capital and other goods using commodity data from supply-use analysis.	Estimates at industry level are derived using data from the Annual Enterprise Survey, Crown Finance Information System, Local Authority Census, economic censuses, the Agriculture Production Survey and surveys of major purchasers.	1981 to present Sub-indexes of the Capital Goods Price Index. 1976–1980 Bank of Japan Export Price Index for electronic communication equipment adjusted for exchange rate movements (The Bank of Japan, 2001). This is combined with an implicit price index for imports derived from trade data. 1972–1975 Bank of Japan Export Price Index (The Bank of Japan, 2001) for telecommunication and sound equipment, adjusted for exchange rate movements. This is combined with an implicit price index for imports derived from trade data.

Pre-1972	Derived from wholesale sales of machinery, supplemented for some items by imports from trade data.	1950–1971 Estimates at industry level are made using a variety of sources, including inter-industry studies, and then reconciled to Philpott's series of 'equipment' (Philpott, 1991). Pre-1949 Fixed proportions are applied to all years prior to 1950 using the proportions from the 1950 year.	1971 Bank of Japan Export Price Index (The Bank of Japan, 2001) for telecommunication and sound equipment, adjusted for exchange rate movements. This is combined with an implicit price index for imports derived from trade data. 1953–1970 Bank of Japan Export Price Index for electronic communication equipment adjusted for exchange rate movements (The Bank of Japan, 2001). Pre-1952 Average rate of change for the years 1952–1960.

<table>
<tr><th rowspan="2">Period</th><th colspan="2">Gross fixed capital formation sources</th><th rowspan="2">Price sources</th></tr>
<tr><th>Total</th><th>Allocation</th></tr>
<tr><td colspan="4">Plant, machinery, and equipment (continued)</td></tr>
<tr><td colspan="4">Electrical plant and machinery</td></tr>
<tr><td>1972 to present</td><td>Imports total based trade data and domestic production totals based on the Annual Enterprise Survey, the Economic Survey of Manufacturing and economic censuses. Total sales are separated between capital and other goods using commodity data from supply-use analysis.</td><td>Estimates at industry level are derived using data from the Annual Enterprise Survey, Crown Finance Information System, Local Authority Census, economic censuses, the Agriculture Production Survey and surveys of major purchasers.</td><td>1981 to present

Sub-indexes of the Capital Goods Price Index.

1972–1980

Bank of Japan Export Price Index (The Bank of Japan, 2001) for transformer and motors adjusted for exchange rate movements.</td></tr>
<tr><td>Pre-1972</td><td>Derived from wholesale sales of machinery, supplemented for some items by imports from trade data.</td><td>1950–1971

Estimates at industry level are made using a variety of sources, including inter-industry studies, and then reconciled to Philpott's series of 'equipment' (Philpott, 1991).

Pre-1949

Fixed proportions are applied to all years prior to 1950 using the proportions from the 1950 year.</td><td>1971

Bank of Japan Export Price Index (The Bank of Japan, 2001) for transformer and motors adjusted for exchange rate movements.

Pre-1970

Implicit price deflator derived from imports of electric motors/meters.</td></tr>
</table>

Period	Gross fixed capital formation sources		Price sources
	Total	**Allocation**	
Plant, machinery, and equipment (continued)			
Computers			
1972 to present	Imports total based trade data and domestic production totals based on the Annual Enterprise Survey, the Economic Survey of Manufacturing and economic censuses. Total sales are separated between capital and other goods using commodity data from supply-use analysis.	Estimates at industry level are derived using data from the Annual Enterprise Survey, Crown Finance Information System, Local Authority Census, economic censuses, the Agriculture Production Survey and surveys of major purchasers.	2011 to present Overseas Trade Index for computers. 1988 to 2010 Computer Price Index from US Bureau of Economic Analysis (2001), adjusted for exchange rate movements. 1972–1987 Japan Export Index (The Bank of Japan, 2001) of electronics and calculating machines adjusted for exchange rate movements.
Pre-1972	Automatic data processing machines imports volumes multiplied by the price index.	Estimates at industry level were made using a variety of sources, including inter-industry studies, and then reconciled to Philpott's series of 'equipment' (Philpott, 1991).	Overseas Trade Index for electrical and electronic machinery.

Period	Gross fixed capital formation sources: Total	Gross fixed capital formation sources: Allocation	Price sources
Plant, machinery, and equipment (continued)			
Furniture and fittings			
1972 to present	Imports total based trade data and domestic production totals based on the Annual Enterprise Survey, the Economic Survey of Manufacturing and economic censuses. Total sales are separated between capital and other goods using commodity data from supply-use analysis.	Estimates at industry level are derived using data from the Annual Enterprise Survey, Crown Finance Information System, Local Authority Census, economic censuses, the Agriculture Production Survey and surveys of major purchasers.	1981 to present Sub-indexes of the Capital Goods Price Index. 1972–1980 Home Furnishings Consumer Price Index.
Pre-1972	Derived from wholesale sales of machinery, supplemented for some items by imports from trade data.	1950–1971 Estimates at industry level are made using a variety of sources, including inter-industry studies, and then reconciled to Philpott's series of 'equipment' (Philpott, 1991). Pre-1949 Fixed proportions are applied to all years prior to 1950 using the proportions from the 1950 year.	1957–1971 Home Furnishings Consumer Price Index. 1948–1956 Composite index of Wholesale Prices Indexes for timber, metals and textiles inputs into the furniture industry, and a wage rate index for the textiles, clothing and footwear industry.

Period	Gross fixed capital formation sources		Price sources
	Total	**Allocation**	
Intangible assets			
Oil & gas exploration and Other exploration			
1972 to present	No control total calculated.	Estimated as the sum of costs of exploration based on the Annual Enterprise Survey, financial accounts of exploration companies and number of metres drilled times a price per metre.	Sub-index of the producer price index for oil and gas exploration
Pre-1972	No control total calculated.	Estimated using drilling meters from Ministry of Economic Development (formerly the Ministry of Commerce) multiplied by the price index.	Drilling Price Index from US petroleum statistics (Independent Petroleum Association of America, 2001).

Period	Gross fixed capital formation sources: Total	Gross fixed capital formation sources: Allocation	Price sources
Computer software			
1972 to present	1994 to present Derived from the Information and Communication Technology Supply Survey, the Population Census, trade data, the Household Economic Survey and Business Demography data. 1983–1993 Derived from the Population Census, trade data, and Business Demography data. 1972–1982 Derived from the Population Census and Business Demography data.	1996 to present Crown Financial Information System, Annual Enterprise Survey, the Central Government Enterprise Survey, and the Local Authority Census, and Business Demography data are used for industry allocations. 1974–1996 A combination of Business Demography and government departments' accounts data, and fixed percentages against computer hardware are used for industry allocation. 1972–1993 A combination of Business Demography data and fixed percentages against computer hardware are used for industry allocation.	2002 to present A composite index of the Pre-packaged Software Price Index from the US Bureau of Labor Statistics (2001), adjusted for exchange rate movements. This is combined with a Labour Cost Index for computing professionals. 1995–2001 A composite index of the Pre-packaged Software Price Index from US Bureau of Labor Statistics (2001), adjusted for exchange rate movements. This is combined with a Price Index for computer services. 1987–1994 A composite index of the Pre-packaged Software Price Index from US Bureau of Economic Analysis (2001), adjusted for exchange rate movements. This is combined with a Labour Cost Index for business services. 1972–1986 Japan Export Index of electronics and calculating machines (The Bank of Japan, 2001), adjusted for exchange rate movements.
Pre-1972	No control total calculated.	Estimated as a fixed proportion of computer hardware for each industry based on 1972 proportions.	Japan Export Index of electronics and calculating machines (The Bank of Japan, 2001), adjusted for exchange rate movements.

Period	Gross fixed capital formation sources: Total	Gross fixed capital formation sources: Allocation	Price sources
Research and development			
1990–present	R&D expenditure is adjusted to measure gross fixed capital formation. These adjustments are described in section 4.2. Expenditure on R&D available from the Research and Development Survey – published annually between 1994 and 1996, every two years from 1996. For the years without a Research and Development Survey, three annual indicators are used for total expenditure at the broad sector level. These indicators are: The Business Operations Survey for business and non-profit sectors. Funding income of Crown Research Institutes recorded in the Central Government Enterprise Survey for government sector (excluding higher education) R&D expenditure Research funding income reported in the Tertiary Education Commission website for higher education R&D expenditure totals.	2002–present: All industry and sector breakdowns are derived from the latest R&D survey 1990–2000: Industry splits derived from the R&D surveys from 2002.	The R&D price deflators compiled from the Labour Cost Index and Producer Price Index using expenditure weights from the R&D survey.
Pre-1990	R&D expenditure values reported in Statistics NZ's *New Zealand Official Yearbook* are used to benchmark broad sector totals.		

Period	Gross fixed capital formation sources		Price sources
	Total	Allocation	
Weapons systems			
	Air, ships, and vehicles weapons systems and specialist military projects sourced from the New Zealand Defence Force.		1991 to present: Overseas trade index for military aircraft, warships and tanks, and military vehicles. Pre-1991: Existing deflators for transport equipment air, ships, and vehicles (spliced together with the overseas trade index from above).

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Appendix 1: Worked example of the Statistics NZ PIM

Statistics NZ does not use the traditional PIM approach. The following example illustrates the basic calculations performed in the modified PIM used by Statistics NZ. This example expands on the previous introduction in chapter 5.

Using the composite age efficiency profile and age price profiles derived in tables 5.8 and 5.10 respectively, we can perform a basic PIM run. For this example we shall assume that the GFKF data has already been deflated to give constant prices based in some year. For simplicity, we shall deal with only a five-year period, and assume there were no capital investments prior to this. The deflated GFKF input data is as follows:

Year	GFKF (constant prices)
1995	1,850
1996	2,560
1997	2,230
1998	2,780
1999	2,150

Deriving productive capital stock (PKS)

The first step is to compute the value of PKS in each year. Note that the age-efficiency profile needs to begin again for each cohort, and the tables illustrate how the same profile is moved forward for subsequent years.

For the 1995 cohort:

Year	GFKF (constant prices)	Age-efficiency profile (percent)	PKS
1995	1,850	100.00	1,850.00
1996		91.75	1,697.38
1997		76.79	1,420.62
1998		45.80	847.30
1999		14.20	262.70

For the 1996 cohort:

Year	GFKF (constant prices)	Age-efficiency profile (percent)	PKS
1996	2,560	100.00	2,560.00
1997		91.75	2,348.80
1998		76.79	1,965.82
1999		45.80	1,172.48

For the 1997 cohort:

Year	GFKF (constant prices)	Age-efficiency profile (percent)	PKS
1997	2,230	100.00	2,230.00
1998		91.75	2,046.03
1999		76.79	1,712.42

For the 1998 cohort:

Year	GFKF (constant prices)	Age-efficiency profile (percent)	PKS
1998	2,780	100.00	2,780.00
1999		91.75	2,550.65

For the 1999 cohort:

Year	GFKF (constant prices)	Age-efficiency profile (percent)	PKS
1999	2,150	100.00	2,150.00

To compute the PKS in any given year, it is simply a matter of summing across all cohort tables for the years of interest.

Year	1995 cohort	1996 cohort	1997 cohort	1998 cohort	1999 cohort	Total PKS
1995	1,850.00					1,850.00
1996	1,697.38	2,560.00				4,257.38
1997	1,420.62	2,348.80	2,230.00			5,999.42
1998	847.30	1,965.82	2,046.03	2,780.00		7,639.15
1999	262.70	1,172.48	1,712.42	2,550.65	2,150.00	7,848.25

Deriving net capital stock (NKS)

The process for computing NKS is exactly the same, except an age-price profile is used. Begin by compiling the cohort tables as before:

For the 1995 cohort:

Year	GFKF (constant prices)	Age-price profile (percent)	NKS
1995	1,850	100.00	1,850.00
1996		71.00	1,313.50
1997		43.60	806.60
1998		20.00	370.00
1999		5.60	103.60

For the 1996 cohort:

Year	GFKF (constant prices)	Age-price profile (percent)	NKS
1996	2,560	100.00	2,560.00
1997		71.00	1,817.60
1998		43.60	1,116.16
1999		20.00	512.00

For the 1997 cohort:

Year	GFKF (constant prices)	Age-price profile (percent)	NKS
1997	2,230	100.00	2,230.00
1998		71.00	1,583.30
1999		43.60	972.28

For the 1998 cohort:

Year	GFKF (constant prices)	Age-price profile (percent)	NKS
1998	2,780	100.00	2,780.00
1999		71.00	1,973.80

For the 1999 cohort:

Year	GFKF (constant prices)	Age-price profile (percent)	NKS
1999	2,150	100.00	2,150.00

And as with deriving PKS, to compute NKS summing across all cohort tables for relevant years is required.

Year	1995 cohort	1996 cohort	1997 cohort	1998 cohort	1999 cohort	Total NKS
1995	1,850.00					1,850.00
1996	1,313.50	2,560.00				3,873.50
1997	806.60	1,817.60	2,230.00			4,854.20
1998	370.00	1,116.16	1,583.30	2,780.00		5,849.46
1999	103.60	512.00	972.28	1,973.80	2,150.00	5,711.68

Deriving consumption of fixed capital (CFK)

CFK can be computed by first deriving a depreciation profile from the age-price profile. An example of this can be found in section 5 (table 5.12). Once the profile is obtained the same process as above is completed as outlined below.

Depreciation profile for the 1995 cohort:

Year	GFKF (constant prices)	Depreciation profile (percent)	CFK
1995	1,850	0.00	0.00
1996		29.00	536.50
1997		27.40	506.90
1998		23.60	436.60
1999		14.40	266.40

For the 1996 cohort:

Year	GFKF (constant prices)	Depreciation profile (percent)	CFK
1996	2,560	0.00	0.00
1997		29.00	742.40
1998		27.40	701.44
1999		23.60	604.16

For the 1997 cohort:

Year	GFKF (constant prices)	Depreciation profile (percent)	CFK
1997	2,230	0.00	0.00
1998		29.00	646.70
1999		27.40	611.02

For the 1998 cohort:

Year	GFKF (constant prices)	Depreciation profile (percent)	CFK
1998	2,780	0.00	0.00
1999		29.00	806.20

For the 1999 cohort:

Year	GFKF (constant prices)	Depreciation profile (percent)	CFK
1999	2,150	0.00	0.00

Total CFK for the selected years:

Year	1995 cohort	1996 cohort	1997 cohort	1998 cohort	1999 cohort	Total CFK
1995	0.00					0.00
1996	536.50	0.00				536.50
1997	506.90	742.40	0.00			1,249.30
1998	436.60	701.44	646.70	0.00		1,784.74
1999	266.40	604.16	611.02	806.20	0.00	2,287.78

And finally the results from deriving all three measures in this hypothetical example can be presented together in a consolidated capital stocks table as follows.

Year	PKS	NKS	CFK
1995	1,850.00	1,850.00	0.00
1996	4,257.38	3,873.50	536.50
1997	5,999.42	4,854.20	1,249.30
1998	7,639.15	5,849.46	1,784.74
1999	7,848.25	5,711.68	2,287.78

Appendix 2: Inland Revenue depreciation survey

Introduction

In May 1992, a depreciation survey was conducted by Statistics NZ on behalf of Inland Revenue. The survey was expected to provide some vital information for a comprehensive tax review, including a new depreciation regime to be introduced by Inland Revenue. In New Zealand, businesses must use approved Inland Revenue depreciation rates for specific assets within their industry group. The review would provide information on more accurate mean depreciation rates, useful lives and residual value. Subsequent to the survey, on 1st April 1993, the new depreciation regime was made effective by the 'Income Tax Amendment Act (No 16 of 1993)' and was further revised in April 1994.

Methodology

The population was defined as all New Zealand tax paying businesses and the survey sample was identified by using the Statistics NZ Business Directory (a register of all businesses in New Zealand). As the survey was focused on taxpayers the following institutions were excluded from the survey:

- private non-profit organisations
- central government
- local government (excluding trading subsidiaries).

A list of 250 asset types were defined and classified using the Standard Industrial Trade Classification. For each asset type a target group of businesses were chosen using the New Zealand Standard Industrial Classification (NZSIC). The sample was made up of 10,000 enterprises and was randomly selected within the target NZSIC group. A structured questionnaire was posted to the identified enterprises in the sample who were asked to report on a specified asset type.

Results

The survey provided summarised data for each of the 250 asset types. The survey results were just one information source that Inland Revenue used when revising the depreciation regime. Other sources such as information from registered valuers and from interviews with key businesses were also used. Inland Revenue chose to have largely standardised asset lives across industries, ie asset lives do not differ significantly from industry to industry. Inland Revenue has also revised the depreciation schedules (which include asset lives revisions) several times since the 1994 revision. These revisions usually resulted in an increase in the length of the tax life.

Statistics NZ used the results to:

- derive average asset lives at a more aggregated grouping of the asset types, more in line with other data on capital expenditure and capital price indexes
- sort the asset groups by the industry they are used in to examine whether lives differed across industries.
- These lives were then used alongside tax lives and average asset lives used by other OECD countries to determine the average asset.

Appendix 3: Research project on economic planning

In the past when economic analysts have wanted information on capital stock in New Zealand they have often used an unofficial capital stock series from the Research Project on Economic Planning (RPEP) produced by Victoria University of Wellington or variants of it (for example, altering deflators and service lives).

The RPEP uses the perpetual inventory method (PIM) to estimate capital stock as part of an ongoing research programme which looks at New Zealand's macroeconomic performance. The prime purpose of the capital stock series was to produce gross capital stock measures for use in productivity studies (the model assumed that an asset's productive capacity remains constant over its life) but the project also produces complementary net capital stock series. The RPEP series was initiated by Professor Bryan Philpott and was first released in the late 1970s. It has been regularly updated and incorporates the latest official capital expenditure data contained in the published Statistics NZ National Accounts. The series is very accessible and the methodology transparent, which has contributed to its wide use. However it has been largely acknowledged that while it represents the best series available, there are several shortcomings which have restricted its use.

The published RPEP series is for annual real net and gross capital stock series from 1949/50 (year ended March) to the present. The series is analysed by 22 industry (NZSIC) groups and identifies two asset types: 'buildings and structures' and 'plant and equipment'.

In the absence of an official Statistics NZ series pre-1971/72, the RPEP, using various sources, established a database of nominal gross fixed capital expenditure and price indexes for the two asset types. The series begins in 1949/50 and was linked to the official series at their relevant 'starting' years (1971/72 for nominal capital expenditure, 1977/78 for the price indexes, and 1982/83 for constant price capital expenditure).

The RPEP methodology uses a PIM with the key aspects and assumptions being:

- Opening 1949/50 capital stock values. With a number of exceptions, these were largely derived by adjusting the historical book values from the balance sheets of company accounts and from other sources. For manufacturing industries, the RPEP had a real capital expenditure series available from 1910, and used this to construct a PIM based gross capital stock measure as at 31 March 1950, valued in 1949/50 prices. This provided an age-profile of manufacturing capital stock. This was then compared with the depreciated historic cost of assets for manufacturing as at 31 March 1950, and the ratios 1.5 for buildings and construction and 2.0 for plant and equipment were obtained. These ratios and the age-profiles were then assumed to hold across all industries and were used to adjust historic book values to a real gross capital stock equivalent for each industry group. This assumption implied that the rate of asset price change and the pace of investment over the 1910–1950 period was fairly common for all industry groups in the economy.
- Average asset lives and retirement distributions. The RPEP mainly used OECD average asset service life estimates given in various OECD publications. These were 40 years for buildings and structures and 16 years for plant and machinery. Retirement functions were chosen so that assets began to be retired 20 percent earlier than their average life, and this continued until 20 percent after their average service life. In both cases, minor variations were made for specific industry groups. The average service lives were found to be consistent with service life data collected via the 1992 Inland Revenue depreciation survey (see appendix 2 for more information on the Inland Revenue depreciation survey). There appeared to be no supporting evidence for the chosen retirement function.

Appendix 4: Asset lives

When looking at the service lives for assets used in the Statistics NZ PIM it is useful to compare how the service lives compare with other countries. The OECD often publishes this information (however most OECD countries which use the PIM to estimate capital stock and related statistics do not usually work with asset types as detailed as New Zealand does). Table A4.1 compares the average transport equipment average service lives across selected OECD countries.

Table A4.1 OECD transport equipment average service lives, in years(1)

<table>
<tr><th></th><th>Canada</th><th>USA</th><th>UK</th><th>Belgium</th><th>Finland</th><th>France</th><th>Germany</th><th>Iceland</th><th>Norway</th><th>Sweden</th><th>NZ(2)(3)</th></tr>
<tr><td>Rolling stock (rail)</td><td>28</td><td>28</td><td>30</td><td>15</td><td>10</td><td>25</td><td>34</td><td>14</td><td>35</td><td>35</td><td>25</td></tr>
<tr><td>Ships</td><td>35</td><td>27</td><td>20</td><td>15</td><td>10</td><td>22</td><td>26</td><td>37</td><td>-</td><td>-</td><td>18–25</td></tr>
<tr><td>Buses</td><td>10</td><td>14</td><td>10</td><td>7</td><td>10</td><td>10</td><td>10</td><td>14</td><td>7</td><td>6</td><td>18</td></tr>
<tr><td>Goods vehicles</td><td>10</td><td>10</td><td>10</td><td>7</td><td>10</td><td>10</td><td>8</td><td>14</td><td>7</td><td>3</td><td rowspan="2">5–24</td></tr>
<tr><td>Passenger cars</td><td>6</td><td>10</td><td>10</td><td>7</td><td>10</td><td>10</td><td>8</td><td>14</td><td>6</td><td>2</td></tr>
<tr><td>Aircraft</td><td>10</td><td>16</td><td>10</td><td>15</td><td>10</td><td>16</td><td>10</td><td>14</td><td>15</td><td>15</td><td>10–32</td></tr>
</table>

1. Organisation for Economic Co-operation and Development (1993).

2. New Zealand average service lives come from the lives used in the perpetual inventory method.

3. New Zealand doesn’t have a ‘passenger cars’ asset type but rather an asset type called ‘road vehicles’ and ‘goods vehicles’

Table A4.2 compares the average plant, machinery, and equipment average service lives for different industries across selected OECD countries (for the purpose of this comparison the asset lives were aggregated using 1996 gross fixed capital formation as weights). The key observations of this comparison are as follows:

- The asset lives that Statistics NZ uses for its plant, machinery, and equipment are generally close to the asset lives used by other OECD countries.
- All OECD countries in this comparison appear to be using similar asset lives for their plant, machinery and equipment asset types in most industries.
- New Zealand's asset lives are generally slightly lower than the asset lives used by Australia.

Table A4.2 OECD plant, machinery, and equipment average service lives, in years (1)

Industry	Canada	USA	Japan	Belgium	France	Germany	Italy	Norway	Sweden	Australia	New Zealand(2)
Agriculture	15	17	6	15	10	15	18	20	15	13	4–17
Forestry and logging	10	-	5	15	10	14	18	20	20	13	4–17
Fishing	3	-	-	15	16	14	18	6	-	13	4–17
Food, beverages, and tobacco	20	14	8	15	17	15	15	25	30	16	4–19
Textiles, apparel, and footwear	9	20	11	15	17	15	18	25	20	19	4–20
Wood and paper products	26	16	10	15	21	16	18	25	20	19	4–20
Printing, publishing, and recorded media	26	12	10	15	21	12	18	25	15	19	4–20
Petroleum, chemical, and plastics	22	16	12	15	21	16	16	25	30	19	4–19
Non-metallic minerals	30	15	12	15	21	15	16	25	30	19	4–20
Metal products	22	16	8	15	17	16	16	25	15	19	4–19
Machinery and equipment	26	19	9	15	17	14	16	25	30	19	4–19
Other manufacturing	22	27	13	20	21	17	15	25	35	19	4–20
Electricity, gas, and water	21	24	11	15	17	14	20	25	25	19	4–33
Construction	30	17	11	15	17	14	16	25	15	19	4–17
Wholesale and retail trade, restaurant and hotels	13	17	11	15	21	16	18	25	20	19	4–16
Transport and storage	35	26	15	20	17	18	18	25	35	25	4–18
Communication	10	12	5	15	13	10	18	12	10	13	4–16
Finance, insurance, real estate, and business services	20	11	10	15	21	12	-	15	15	16	4–16

1. Organisation for Economic Co-operation and Development (1993)

2. New Zealand average service lives come from the lives used in the perpetual inventory method. The lives are therefore not aggregated and instead a range is given. The lower bound of this range represents the asset type 'computers'.

Appendix 5: Winfrey retirement functions

During the 1920s and 1930s, Robley Winfrey, an Iowa research engineer, collected information on the dates of instalment and retirement of 176 groups of industrial assets (Winfrey R, 1935). He was interested in the ways in which a group of assets (such as sleepers, motor cars, waterworks boilers, or asphalt pavements) that had been installed or constructed in a given year were retired over their total life-span. Winfrey plotted the 176 individual retirement functions showing when each member of each 'cohort' (group of assets installed in a given year) was retired from the capital stock, and concluded that they could be grouped into 18 'type' curves which he denoted by:

- L, S and R for left-modal, symmetrical and right-modal, representing skewness about the mean
- the numbers 0 through 6 for the flattest to the most peaked curves.

The 176 different kinds of assets were fairly evenly spread between the left-modal, symmetrical and right-modal curves although slightly more assets were assigned to the left-modal group. Over half of them had peaked retirement functions (numbers 3 to 6) indicating that retirements happen within a short space of each other. The 18 types of curves are shown in table A5.1.

Table A5.1 Winfrey retirement functions

Modality	Range of peaks	Curve types
Left-modal	6 ranging from 0 to 5	L0 to L5
Symmetric	7 ranging from 0 to 6	S0 to S6
Right-modal	5 ranging from 1 to 5	R1 to R5

Figures A5.1 and A5.2 illustrate the curve types of left-modal and right-modal Winfrey retirement functions respectively (the L5 curve is not included in figure A5.1 because of the extreme peakedness of the distribution). All the left-modal curves have more than 50 percent of assets retiring before the average asset life while all the right-modal curves have less than 50 percent of assets retiring before the average asset life.

Figure A5.1 Left-modal Winfrey retirement functions

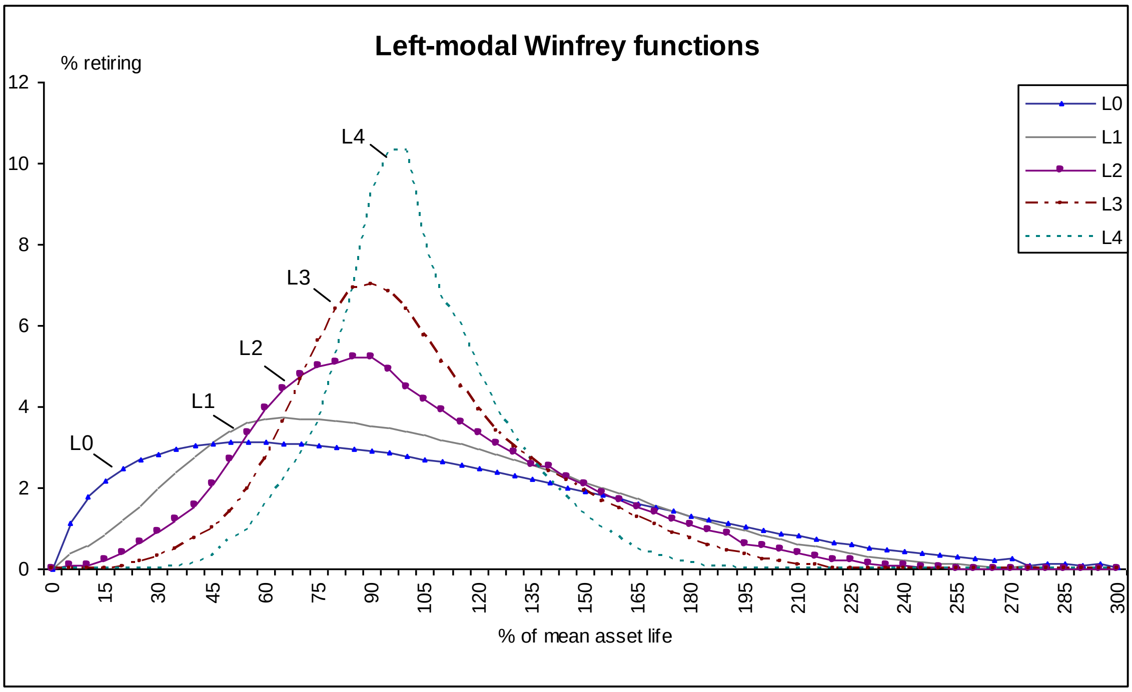
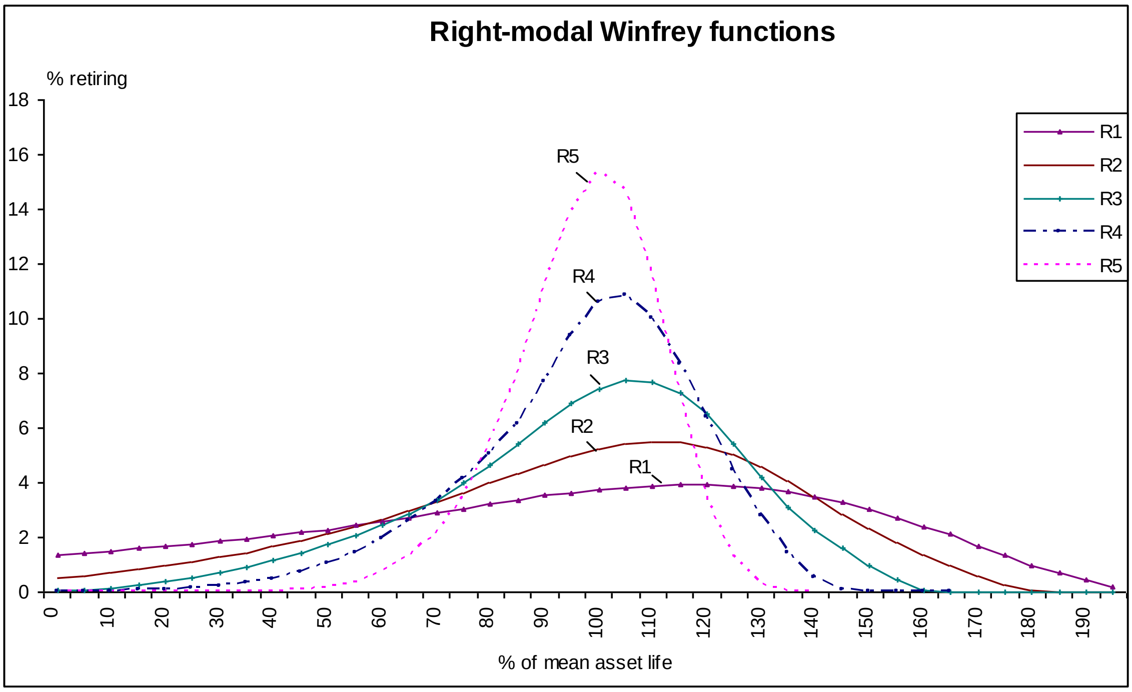


Figure A5.2 Right-modal Winfrey retirement functions



Winfrey retirement functions are used in the PIM of several countries. Ideally, Winfrey's work should be repeated to pick the correct retirement function for any economy by analysing similar data from that economy. However, such an exercise is not always feasible, as it is very costly and requires a long time period to monitor the large number of assets from the date of commissioning until retirement.

Appendix 6: Sector of ownership

The sector of ownership classification groups accounting units into three sectors:

- private
- central government
- local government.

This classification provides ownership detail within an industry framework. Each accounting unit is allocated to the sector that owns more than 50 percent of that entity. The coverage of each sector in terms of the New Zealand Standard Institutional Sector Classification (NZISC) is as follows:

Table A6.1 Sector of ownership by NZISC

Sector of ownership	Coverage in terms of NZISC
Private	11, 12 2211, 2221, 2291, 2311, 2411 33, 4, 5 (as owner-occupiers of dwellings)
Central government	131 21, 2212, 2222, 2292, 2312, 2412 31
Local government	132 2213, 2223, 2293, 2313, 2413 32

Appendix 7: Industry classification

The industry classification used is based on the Australian New Zealand Standard Industrial Classification 2006 (ANZSIC06).

Table A7.1 Industry groupings and classifications

AA Agriculture, Forestry and Fishing			
AA1	Agriculture	AA11	Horticulture and Fruit Growing
		AA12	Sheep, Beef, Cattle, and Grain Farming
		AA13	Dairy Cattle Farming
		AA14	Poultry, Deer, and Other Livestock Farming
AA2	Forestry and Logging	AA21	Forestry and Logging
AA3	Fishing, Aquaculture and Agriculture, Forestry and Fishing Support Services	AA31	Fishing and Aquaculture
		AA32	Agriculture, Forestry, and Fishing Support Services and Hunting and Trapping
BB Mining			
BB1	Mining	BB11	Mining
CC Manufacturing			
CC1	Food, Beverage, and Tobacco Product Manufacturing	CC11	Meat and Meat product Manufacturing
		CC12	Seafood Processing
		CC13	Dairy Product Manufacturing
		CC14	Fruit, Oil, Cereal, and Other Food Product Manufacturing
		CC15	Beverage and Tobacco Product Manufacturing
CC2	Textile and Apparel Manufacturing	CC21	Textile, Leather, Clothing, and Footwear Manufacturing
CC3	Wood and Paper Products Manufacturing	CC31	Wood Product Manufacturing
		CC32	Pulp, Paper, and Converted Paper Product Manufacturing

CC4	Printing	CC41	Printing
CC5	Petroleum, Chemical, Polymer, and Rubber Product Manufacturing	CC51	Petroleum and Coal Product Manufacturing
		CC52	Basic Chemical and Chemical Product Manufacturing
		CC53	Polymer Product and Rubber Product Manufacturing
CC6	Non-Metallic Mineral Product Manufacturing	CC61	Non-Metallic Mineral Product Manufacturing
CC Manufacturing (Cont.)			
CC7	Metal Product Manufacturing	CC71	Primary Metal and Metal Product Manufacturing
		CC72	Fabricated Metal Product Manufacturing
CC8	Machinery and Equipment Manufacturing	CC81	Transport Equipment Manufacturing
		CC82	Machinery and other Manufacturing
CC9	Furniture and Other Manufacturing	CC91	Furniture and Other Manufacturing
DD Electricity, Gas, Water and Waste Services			
DD1	Electricity, Gas, Water, and Waste Services	DD11	Electricity and Gas Supply
		DD12	Water, Sewerage, Drainage, and Waste Services
EE Construction			
EE1	Construction	EE11	Building Construction
		EE12	Heavy and Civil Engineering Construction
		EE13	Construction Services
FF Wholesale Trade			
FF1	Wholesale Trade	FF11	Wholesale Trade
GH Retail Trade and Accommodation			
GH1	Retail Trade	GH11	Motor Vehicle and Motor Vehicle Parts and Fuel Retailing
		GH12	Supermarket, Grocery Stores, and Specialised Food Retailing

		GH13	Other Store-Based Retailing and Non Store Retailing
GH2	Accommodation and Food Services	GH21	Accommodation and Food Services
II Transport, Postal and Warehousing			
II1	Transport, Postal, and Warehousing	II11	Road and Rail Transport
		II12	Rail, Water, Air, and Other Transport
		II13	Postal, Courier Transport Support, and Warehousing Services.
JJ Information Media and Telecommunications			
JJ1	Information Media and Telecommunications	JJ11	Information Media Services
		JJ12	Telecommunications, Internet, and Library Services
KK Financial and Insurance Services			
KK1	Financial and Insurance Services	KK11	Finance Services
		KK12	Insurance and Superannuation Services
		KK13	Auxiliary Finance and Insurance Services
LL Rental, Hiring, and Real Estate Services			
LL1	Rental, Hiring, and Real Estate Services	LL11	Rental and Hiring Services (except Real Estate)
		LL12	Owner-Occupied Housing
		LL13	Property Operators and Real Estate Services
MN Professional, Scientific, Technical, Administrative, and Support Services			
MN1	Professional, Scientific, and Technical Services	MN11	Professional, Scientific, and Technical Services
MN2	Administrative and Support Services	MN21	Administrative and Support Services

OO Public Administration and Safety			
OO1	Local Government	OO11	Local Government Administration
OO2	Central Government, Defence, and Public Safety	OO21	Central Government , Defence, and Public Safety
PP Education and Training			
PP1	Education and Training	PP11	Education and Training
QQ Health Care and Social Assistance			
QQ1	Health Care and Social Assistance	QQ11	Health Care and Social Assistance
RS Arts, Recreation and Other Services			
RS1	Arts and Recreation Services	RS11	Arts and Recreation Services
RS2	Other Services	RS21	Other Services

Appendix 8: Annual Enterprise Survey

The Annual Enterprise Survey (AES) is New Zealand's most comprehensive source of financial statistics and provides annual financial performance and financial position information about industry groups operating within New Zealand. The survey's population was about 450,000 businesses, of which 22,500 were in the sample for 2008. An abridged version of the Annual Enterprise Survey questionnaire that collects capital formation data for manufacturing and wholesale industries is given below.

Table A8.1 Extract of the Annual Enterprise Survey questionnaire

Fixed assets	
Include	**Exclude**
All fixed assets as shown in your books of account	Expenditure on maintenance
All fixed assets operated by your business under finance lease arrangements	Intangible assets such as goodwill
Leasehold improvements	

	BOOK VALUE at the beginning of financial year	ADDITIONS report at cost	DISPOSALS report at sale price	BOOK VALUE at the end of financial year	REVALUATIONS include gain/loss on sale	DEPRECIATION for reported year only
Land						
Buildings						
Motor vehicles and other transport equipment						
Computer software						
Computer hardware						
Lifting and handling equipment						
Furniture and fittings						
Other plant and machinery equipment						
All other fixed assets						
TOTAL fixed assets						

Intangible assets						
Computer software or database developed internally for own use						Amortisation In place of depreciation
Other intangible assets						
Capital work undertaken by own employees – capitalised labour and other related costs						

Appendix 9: Glossary

Below is a list of the technical terms used in this report. Most of these definitions come from Organisation for Economic Co-operation and Development (2001a).

Age-efficiency profile	The age-efficiency profile of an asset describes the change (usually the decline) in the efficiency of an asset as it ages. Efficiency in this context refers to the asset's ability to produce a quantity of capital services for a given amount of inputs.
Age-price profile	The age-price profile of an asset describes the change (usually the decline) in the price of an asset as it ages.
Assets	Assets are entities that must be owned by some unit, or units, and from which economic benefits are derived by their owner(s) by holding or using them over a period of time.
Balance sheet	A balance sheet is a statement, drawn up at a particular point in time, of the values of assets owned by an institutional unit or sector and of the financial claims (liabilities) against the owner of those assets.
Capital services	Capital services are the productive inputs, per period, that flow to production from a capital asset. The value of capital services is the quantity of services provided by the asset multiplied by the price of those services.
Capital stock	Capital stock refers to stocks of fixed assets that are used as inputs into the production process
Constant prices	A stock of assets is expressed in constant prices when all members of the stock are valued in the prices of a single base period.
Consumption of fixed capital	Consumption of fixed capital represents the reduction in the value of the fixed assets used in production during the accounting period that results from physical deterioration, normal obsolescence or normal accidental damage.
Current prices	A stock of assets is expressed in current prices when all members of the stock are valued in the prices of the year in question.
Discount rate	The discount rate is an interest rate used to convert a future income stream to its present value.
Disposals	Disposals of assets occur when assets leave the capital stock of a producer, either to be scrapped or to be used in production by another producer.
Efficiency reduction parameter	An efficiency reduction parameter is an input into the equation for a hyperbolic age-efficiency profile.
Financial assets	Financial assets are assets in which there is a counterpart liability on the part of another unit. They mostly consist of financial claims but also include monetary gold, special drawing rights allocated by the International Monetary Fund (IMF) and shares in corporations.

Fixed assets	Fixed assets are tangible or intangible assets produced as outputs from processes of production that are used repeatedly or continuously in other processes of production for more than one year.
Gross capital stock	Gross capital stock is the value of all fixed assets still in use when a balance sheet is drawn up, at the actual or estimated current purchasers' prices for new assets of the same type, irrespective of the age of the assets.
Gross fixed capital formation	Gross fixed capital formation is measured by the total value of a producer's acquisitions, less disposals, of fixed assets during the accounting period, plus certain additions to the value of non-produced assets (such as land or subsoil assets) realised by the productive activity of institutional units.
Historic prices	The historic price is the price that was actually paid for an asset when it was first acquired by a resident user. It is a synonym for 'acquisition price'.
Hyperbolic age-efficiency profile	A hyperbolic age-efficiency profile is a type of age-efficiency profile where efficiency declines slowly in the earlier period and at an increasing rate towards the end of the asset’s life.
Intangible fixed assets	Intangible fixed assets are non-financial produced fixed assets that consist of exploration, computer software, entertainment, literary or artistic originals and other intangible fixed assets intended to be used for more than one year.
Intangible non-produced assets	Intangible non-produced assets entitle the owners to engage in certain specific activities or to produce certain specific good or services and exclude other institutional units from doing so except with the permission on the owner (eg patented entities and purchased goodwill).
Inventories	Inventories are stocks of outputs still held by units that produced them prior to their being further processed, sold or delivered to other units and stocks of products acquired from other units which are intended to be used primarily for purposes of production or consumption.
Net capital stock	Net capital stock is described as the sum of the written-down values of all the fixed assets still in use when a balance sheet is drawn up.
Non-financial assets	Non-financial assets are the opposite of financial assets and are assets where no counterpart liability exists
Non-produced assets	Non-produced assets are non-financial assets that come into existence other than through processes of production.
Perpetual inventory method (PIM)	The perpetual inventory method (PIM) produces an estimate of the stock of fixed assets in existence and in the hands of producers by estimating how many of the fixed assets installed as a result of gross fixed capital formation undertaken in previous years have survived to the current period.

Produced assets	Produced assets are non-financial assets that have come into existence as outputs from processes that fall within the production boundary of the SNA.
Productive capital stock	The productive capital stock is the stock of a particular type of asset after assets of different ages have been converted into standard efficiency units. This is done by adjusting the older assets in the stock to account for their reduced efficiency in producing capital services.
Rentals	Rentals are the incomes earned by an asset during each accounting period. They are equal to the quantity of capital services produced by the asset, such as tonne-kilometres in the case of a truck, multiplied by the unit price of those services.
Retirements	Retirements occur when capital assets are withdrawn from the capital stock at the end of their service lives. Retirements are synonymous with 'discards' and 'scrapping'.
Service life	The service life of an asset is the total period during which it remains in use, or ready to be used, in a productive process. During its service life an asset may have more than one owner. This is also referred to as the ‘asset life’.
Tangible fixed assets	Tangible fixed assets are non-financial produced assets that consist of dwellings; other buildings and structures; machinery and equipment and cultivated assets.
Tangible non-produced assets	Tangible non-produced assets are natural assets where ownership can be established and transferred (eg land, subsoil assets)
Valuables	Valuables are goods of considerable value that are not used primarily for purposes of production or consumption but are held as stores of value over time.

Acronyms used in this report

ABS	Australian Bureau of Statistics
AES	Annual Enterprise Survey
ANZIND	(An Australian and New Zealand Industrial classification)
ANZSIC	Australian and New Zealand Standard Industrial Classification
BLS	Bureau of Labor Statistics
CFK	consumption of fixed capital
CP	current prices
CPI	consumers price index
GKS	gross capital stock
GFKF	gross fixed capital formation
IMF	International Monetary Fund
IRD	Inland Revenue Department
KP	constant prices
NIE	national income and expenditure
NKS	net capital stock
NV	net value
NZISC	New Zealand Standard Institutional Sector Classification
NZSIC	New Zealand Standard Industry Classification
NZSNA	New Zealand System of National Accounts
OECD	Organisation for Economic Co-operation and Development
PKS	productive capital stock
PIM	perpetual inventory method
RPEP	Research Project on Economic Planning
SNA	System of National Accounts