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Economic Depreciation and Retirement of Canadian Assets: A Comprehensive Empirical Study

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Economic Depreciation and Retirement of Canadian Assets: A Comprehensive Empirical Study

by André Patry

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Abstract

This paper offers empirical evidence on the actual rates and forms of economic depreciation for a comprehensive set of assets. Using a Canadian micro database on the purchase and disposal of capital goods from Statistics Canada's Capital Expenditure Survey, the study estimates depreciation rates for 36 asset categories, which represent half of the Canadian business capital stock. Depreciation rates for the remaining assets are calibrated using the average age-price relationship from the estimation and surveyed service lives obtained from the Capital Expenditure Survey. The impact of the estimated depreciation rates on the Canadian capital stock and depreciation allowances is also presented.

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Note

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1 Introduction

Empirical studies of economic depreciation are critical for accurate measures of economic wealth and capital services. Although the neoclassical theory of capital accumulation has been rigorously developed since the 1960s, the empirical literature on depreciation has been much less fertile due to a lack of data. The absence of reliable empirical evidence has forced economists and statisticians to make assumptions on the forms and rates of depreciation for most of the assets in the economy. The OECD[1] and the US Bureau of Labor Statistics (*US BLS*) recently highlighted the risk of using broad assumptions to derive asset specific depreciation rates, and called for more empirical work on depreciation by placing it on the forefront of the research agenda for capital measurement.

This study, undertaken in collaboration with Statistics Canada (*STC*), contributes to the empirical literature by providing a comprehensive analysis of the forms and rates of economic depreciation for a wide range of assets. The updated depreciation rates are obtained in two stages. In the first stage, the study uses a unique source of micro data on self-reported transaction prices and retirements collected by *STC* to directly estimate age-price profiles for 36 assets in the Canadian capital stock. The methodology adopted for the estimation follows the broad outlines of the established literature (Hulten & Wykoff (1981a, 1981b, 1996) and Oliner (1993, 1996) among others).

The second stage consists of updating the econometric results to reflect recent trends in useful lives and calibrating depreciation rates for assets for which econometric estimates are unavailable in order to arrive at a final set of depreciation rates. Survey data on the expected service lives of new assets and average depreciation patterns from the econometric estimates enable us to obtain depreciation rates for all 155 assets tracked by *STC*.

The empirical results indicate that depreciation rates for buildings are much higher than those used by *STC* and the US Bureau of Economic Analysis (*US BEA*). A valuation bias in older buildings caused by accumulated improvements explains the low rates in the existing literature. Moreover, the results indicate that several building assets follow a hybrid straight-line/convex age-price profile similar to the one used by the *US BEA* prior to their 1995 revision. The geometric pattern is nonetheless a reasonable approximation of the hybrid profile. Depreciation rates for most M&E assets are also higher than *STC*'s official rates, albeit to a lesser extent than for buildings. A geometric pattern is a good approximation for the majority of the M&E assets. The results for engineering assets point to an increase in depreciation rates that is slightly higher than the increase for buildings. No general conclusion can be drawn on the actual form of the age-price profile for engineering assets since the relatively thin resale markets for used assets limit the number of direct estimates to three engineering assets.

The study is organized as follows. In the next section, the theoretical foundations underlying the measurement of economic depreciation are presented. A review of influential and recent empirical literature on the topic follows in the third section. The fourth section describes the data used for the study. The fifth presents the estimation framework, while the sixth and seventh

1. Organisation for Economic Co-operation and Development.

discuss the results for both the estimated and calibrated depreciation rates. Concluding remarks are drawn in the last section. To lighten the text, several tables and side analysis are presented in annexes.

2 Theoretical and empirical fundamentals

2.1 Theoretical background

Economic depreciation measures the loss in value of an asset at a point in time resulting from aging. It represents the net cost of selling a used asset and replacing it by a newer asset. Comparing relative prices at a point in time isolates the impact of aging by eliminating the effects of inflation and changes in supply and demand on real replacement costs. These factors, described as revaluation in the literature, do not affect depreciation as they impact all assets regardless of their age, leaving the real replacement cost and the depreciation rate unchanged.

The effects of aging on the value of an asset are explained by two events. First, the asset simply has fewer service years to produce income, and second, its ability to render current and future services declines as a result of lower productive capacity relative to that of newer assets. The decline in productive capacity may result from both deterioration (or physical wear and tear) and obsolescence. Obsolescence affects depreciation when older assets are less productive than newer and more technologically advanced assets.

Although not the first to allude to the notion[2], D. W. Jorgenson[3] significantly contributed to our understanding of the conceptual framework that links the price of an asset to its ability to generate rents. Accordingly, the price of an *s*-year old asset is equal to the present value of expected rents, which in turn is linked to the productive capacity of the asset:

2.1.1 $$P_s = \sum_{\tau=0}^{T=L-s} \frac{R_{s+\tau}}{(1+r)^{\tau+1}} = R_0 \sum_{\tau=0}^{T=L-s} \frac{\varphi_{s+\tau}}{(1+r)^{\tau+1}},$$

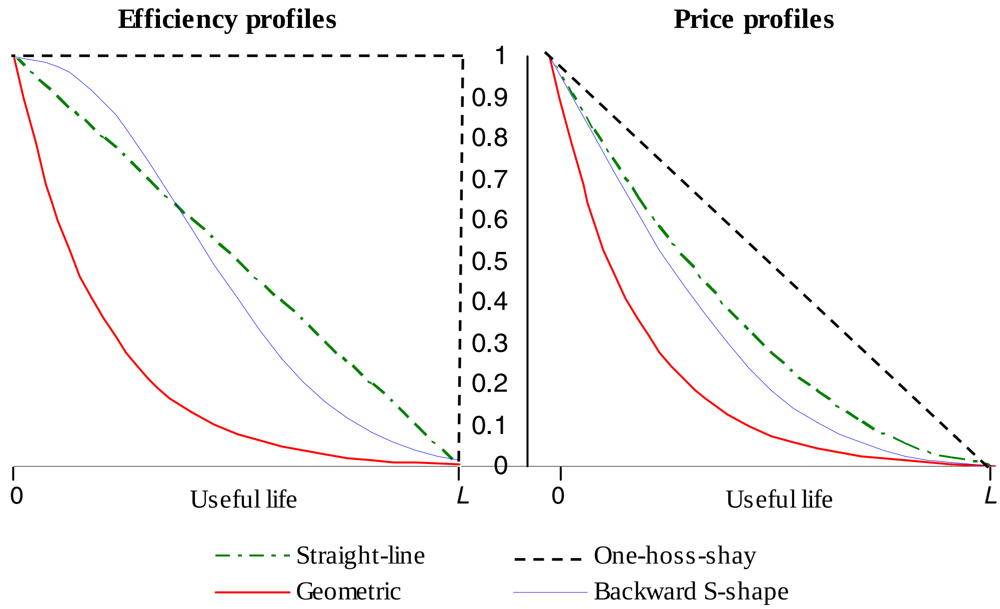
where $R_{s+\tau}$ are the expected rents generated by the asset of age s at each point in time (τ), L is the useful life, T is the remaining years of production and r is the discount rate. In the last part of the equation, $R_{s+\tau}$ is expressed as a function of the rents generated by a new asset (R_0) adjusted for the change in relative efficiency ($\varphi_{s+\tau}$) as the asset ages.

To appreciate the intricate relationship between efficiency and depreciation, Chart 2.1 depicts four types of efficiency profiles and their corresponding age-price profiles. Under the one-hoss-shay profile, the asset retains its full productive capacity up to its useful life. In this case, the

2. As mentioned in Diewert (2003), Walras (1874) and Böhm-Baweck (1891) were among the first to formulate the relationship between the price of an asset and the future flows of service it renders.
3. For a collection of his influential papers refer to Jorgenson, D. W. (1996-2001), “Investment: v. 1. Capital Theory and Investment Behavior, v. 2. Tax Policy and the Cost of Capital, v. 3. Lifting the Burden”, Cambridge, Massachusetts, MIT Press.

annual service generated by older assets will be exactly equal to that of a new asset (R_0) since there are no differences in efficiency. The resulting price change will equal the foregone annual service since the asset has one less period to produce income. Therefore, depreciation costs will be evenly distributed over the life of the asset, leading to a linear decline in price.[4]

Chart 2.1 Efficiency and price profiles for various types of efficiency decline



Contrary to the one-hoss-shay profile, the straight-line and the geometric efficiency profiles both produce convex age-price profiles. As the decline in efficiency becomes increasingly front-loaded, the age-price profile will become increasingly convex. Note that a geometric efficiency profile leads to a geometric age-price profile with the same rate of decay. Another efficiency profile discussed in the literature is the inverse S-shape profile. Under this process, the relative efficiency of the asset slowly declines in the early years of life but accelerates as it closes in on its useful life. The corresponding age-price profile resembles a straight-line changing to a convex shape as it gets closer the useful life.

Some authors consider total depreciation as the combination of age-related depreciation and capital losses/gains on an asset. In the second case, capital losses (gains) are encountered when the value of the asset decreases (increases) relative to other assets in the economy. This study focuses on the measurement of age-related depreciation and does not attempt to measure capital losses/gains.[5]

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4. Incorporating a rate of discount will produce slightly higher annual depreciation for older assets and will generate an age-price curve that is slightly bowed outwards. Higher annual depreciation for older assets arises from discounting since future flows of services for these assets are discounted on a shorter horizon than new assets.
5. For a recent study on capital losses/gains see Doms, M. E., W. E. Dunn, S. D. Oliner and D. E. Sichel (2003).

2.2 Empirical literature

Since it is quite difficult to obtain comprehensive data on efficiency profiles, empirical studies measuring economic depreciation have relied on transaction prices observed in used asset markets and theoretical retirement distributions to estimate the expected decline in value resulting from aging. The basic estimation framework was popularized by Hulten and Wykoff (1981a, 1981b, 1996) and consists of correcting the transaction prices with survival probabilities to circumvent a censored sample bias. The censored sample bias is embedded in the price data since transaction prices are for assets in operation only and do not represent the average experience as some assets are retired along the way with a price of zero.

Accordingly, the expected price of an asset, (V_s), is equal to its estimated price (P_s) on the used asset market corrected for the probability that the asset survives to age *s* (Sv_s). The survival probabilities are simply the residual of retirement probabilities (D_s).

2.2.1 $$V_s = Sv_s P_s = (1 - D_s) P_s$$

Hulten and Wykoff (1981a, 1981b and 1996) (*H&W* henceforth) have been by far the most cited studies in the empirical literature on depreciation. Their estimates were adopted in the mid-1990s by *STC* and the *US BEA*, and remain the key empirical reference point.

The authors estimated depreciation rates for 8 of the 32 assets identified in the U.S. National Income and Product Accounts (*NIPA*) at the time.[6] The price data were assembled using various appraisal books and surveys from the 1960s and 1970s. The survival probabilities were calibrated with right-skewed retirement distributions and service lives published by the US Department of Treasury in 1942. They concluded that the geometric depreciation rate was an acceptable approximation for the eight assets and assumed a geometric profile for the remaining 24 assets. By combining the average age-price relationship from their econometric estimates with the useful lives of these assets, they were able to calculate depreciation rates for the full set of assets.

Koumanakos and Hwang (1988, 1993) applied the *H&W* methodology to Canadian transaction prices collected in *STC*'s Capital Expenditure Survey (*CES*) for 1986. They estimated age-price profiles and geometric depreciation rates for 26 asset categories. Although the small number of observations prevented the authors from making firm conclusions on depreciation rates, they confirmed *H&W* findings of convex age-price patterns.

Oliner (1993) used an innovative methodology for estimating depreciation of mainframe computers. The study separated obsolescence from total age-related changes by including the computation and memory characteristics of mainframes computers in the model. The database was built from the Computer Price Guide[7], a quarterly bluebook that lists appraisal prices for various IBM computer mainframes on the used computer market. Contrary to other studies, the

6. They are: tractors, construction machinery, metalworking machinery, general industrial equipment, trucks, autos, industrial buildings and commercial buildings.
7. Computer Price Guide (Chappaqua, N.Y.: Computer Merchants Inc). Several issues.

author was able to directly estimate the retirement distribution for mainframes using data from International Data Corporation. The price and retirement databases span the 1970 to 1986 period. The author found obsolescence to be increasing over the period and statistical tests rejected a geometric depreciation rate. The results point to a mean useful life of 6.5 years for mainframe computers and a residual value of approximately 5% at the mean useful life. The author also used similar data and modeling approach to estimate depreciation rates for machine tools (Oliner (1996)).

The Productivity Program at Statistics Canada recently conducted two studies estimating depreciation rates. The first is from Gellatly, Tanguay and Yan (2002) who estimated economic depreciation rates for 33 asset categories using the same source of data on transaction prices and retirements (1985 to 1996) that is used in this study. Depreciation rates are generally higher then the ones found in the literature (Table 2.1.1) but the authors indicate that the geometric pattern is an accurate approximation for the majority of assets. The authors depart from the literature by directly estimating V_s in equation 2.2.1 using data on transaction prices and retirements simultaneously. Contrary to the previous studies, there is no need to use survival probabilities to correct for the censored sample bias since the probabilities are directly embedded in the modeling framework with retired observations being modeled with transaction prices. This approach requires an accurate sampling of the survival and retirement data points. An inspection of the CES database reveals that the retirement and survival data are unbalanced and do not represent an accurate sample of the capital stock when modelled together. In a recent report from the Micro Economic Analysis Division at Statistics Canada reviewing the different estimation framework used to estimate depreciation rates, the authors have made some corrections to the unbalanced sample[8]. The updated results produced much lower depreciation rates than the 2002 study.

Tanguay (2005) is the second research paper from the Productivity Program – it uses the same database as this study. The study proposes a novel estimation framework by attempting to directly model the future flows of rents generated by an asset. Recall from the previous section that the value of an asset decreases with age because the probability of retirement increases and the efficiency declines relative to newer assets. Tanguay (2005) models these two processes by making assumptions about the discount rate, the form of the efficiency profile and the form of the retirement distribution. A simultaneous estimation framework is adopted to force the estimators to respect the consistencies between the process of loss in value and the process of retirement. The results are generated using a discount rate of zero, a concave or constant capacity profile and a Weibull retirement distribution. The depreciation rates are higher than previous studies, but relatively in line with the most recent results generated by the model proposed by Gellatly, Tanguay and Yan (2002). The assumption of a zero discount rate is unconventional in calculating future flows of earnings but the author concludes that including a discount rate does not impact significantly the estimates: compared to the base results, a 2% discount rate changes the estimates by 5% on average. However, the impact of discounting is significant for office

8. An update of the estimates are presented in Depreciation Rates for the Productivity Accounts (15-206-XIE - No. 005), where the Productivity Program compares three estimation methodology – the method proposed by Gellatly, Tanguay and Yan (2002), the Hulten and Wykoff (1981a, 1981b and 1996) methodology, which was adopted for this study, and the approach devised by Tanguay (2005).

buildings, which accounts for about a third of the building capital stock: the depreciation rate estimate falls by 22% with a 2% discount rate.

To complement the literature review, Table 2.1.1 outlines depreciation estimates from key studies. Jorgenson (1996) and Fraumeni (1997) also provide a detailed review of the empirical literature.

Table 2.1.1 Depreciation rate estimates from the literature

Assets/Studies	Rate	Range from	Range to
		%	
Office buildings			
Hulten and Wykoff (1981a, 1981b, 1996)	2.5	…	…
Deloitte and Touche (2000)	3.5[1]	…	…
Baum and McElhinney (1997)	…	1.6[1]	2.9[1]
Tanguay (2005)	5.9	…	…
Gellatly, Tanguay and Yan (2002)	7.6	…	…
Gellatly, Tanguay and Yan (2007)	7.4	…	…
Industrial buildings			
Hulten and Wykoff (1981a, 1981b, 1996)	3.6	…	…
Deloitte and Touche (2000)	2.1[1]	…	…
Tanguay (2005)	9.1	…	…
Gellatly, Tanguay and Yan (2002)	13.0	…	…
Gellatly, Tanguay and Yan (2007)	9.7	…	…
Automobiles			
Hulten and Wykoff (1981a, 1981b, 1996)	…	30.0	33.0
Wykoff (1989)	33.0	…	…
Ackerman (1973)	31.0	…	…
Dunham (2003)	…	20.0[1]	37.0[1]
Peles (1988)	…	24.0[1]	28.1[1]
Tanguay (2005)	30.3	…	…
Gellatly, Tanguay and Yan (2002)	23.8	…	…
Gellatly, Tanguay and Yan (2007)	23.9	…	…
Trucks			
Hulten and Wykoff (1981a, 1981b, 1996)	25.4	…	…
Hall (1971)	17.0	…	…
Tanguay (2005)	23.8	…	…
Gellatly, Tanguay and Yan (2002)	23.8	…	…
Gellatly, Tanguay and Yan (2007)	19.1	…	…

… not applicable

Table 2.1.1 Depreciation rate estimates from the literature (continued)

Assets/Studies	Rate	Range from	to
		%	
Office furniture			
Hulten and Wykoff (1981a, 1981b, 1996)	12.0	…	…
Tanguay (2005)	25.9	…	…
Gellatly, Tanguay and Yan (2002)	30.3	…	…
Gellatly, Tanguay and Yan (2007)	23.0	…	…
Computers			
Oliner (1993)	30.0[1]	…	…
Doms, Dunn, Oliner and Sichel (2003)	…	22.0	35.0
Geske, Ramey and Shapire (2003)	41.1	…	…
Tanguay (2005)	53.1	…	…
Gellatly, Tanguay and Yan (2002)	58.8	…	…
Gellatly, Tanguay and Yan (2007)	47.2	…	…
Industrial machinery			
Hulten and Wykoff (1981a, 1981b, 1996)	12.0	…	…
Oliner (1996)	…	3.0	18.0
Tanguay (2005)	…	15.5	17.2
Gellatly, Tanguay and Yan (2002)	30.3	…	…
Gellatly, Tanguay and Yan (2007)	…	25.6	16.4
Ships			
Lee (1978)	…	12.0[1]	15.0[1]
Cockburn and Frank (1992) (Oil Tankers)	…	2.0[1]	4.0[1]
Tanguay (2005)	9.8	…	…
Gellatly, Tanguay and Yan (2002)	11.0	…	…
Gellatly, Tanguay and Yan (2007)	7.4	…	…
Tractors			
Hulten and Wykoff (1981a, 1981b, 1996)	…	16.3	18.0
Perry, Bayaner and Nixon (1992)	…	7.0[1]	11.0[1]
Hansen and Lee (1991)	8.3[1]	…	…
Tanguay (2005)	18.3	…	…
Gellatly, Tanguay and Yan (2002)	19.2	…	…
Gellatly, Tanguay and Yan (2007)	13.0	…	…
Aircraft			
Nelson and Caputo (1997)	…	5.5	12.1
Tanguay (2005)	8.4	…	…
Gellatly, Tanguay and Yan (2002)	6.7	…	…
Gellatly, Tanguay and Yan (2007)	8.1	…	…

… not applicable

1. Results exclude retirement effect on depreciation.

2.3 The declining balance rate

The relatively short list of assets in Table 2.1.1 compelled economists and accountants to rely on information on service lives (*L*) and declining balance rates (*DBR*) to calculate depreciation rates (γ) equation 2.3.1 for a broader range of assets. The *DBR* is essentially a calibration parameter that allows the calculation of depreciation rates when only information on service lives is available.

2.3.1 $$\gamma = \frac{DBR}{L}$$

Although the relationship between the *DBR* and the useful life is a generally accepted convention, the existing literature on depreciation does not often provide the intuition behind the standard definition. Prior to empirical studies using market data, researchers and *STC* commonly used a *DBR* of 2. Using a double declining balance rate offered an appealing connection between a straight-line age-price profile and an exponential profile. That is, the declining rate (γ) implied by the double declining balance rate and the useful life generates the same amount of depreciation costs as a straight-line profile. Equalizing the present values of depreciation outlays resulting from an exponential decline and a straight-line decline in equation 2.3.2, and solving for γ, yields an expression that tends to a *DBR* of 2 when the discount rate tends to zero.

2.3.2 $$\frac{\gamma}{\gamma + r} = \frac{1}{rL}\left(1 - e^{-rL}\right)$$

$$\gamma = \frac{r\left(1 - e^{-rL}\right)}{rL - \left(1 - e^{-rL}\right)}$$

$$\lim_{r \to 0} \gamma = \frac{2}{L}$$

The empirical studies conducted by *H&W*, which made use of market data, prompted *STC* and the academic community to move away from the double declining balance rate approach and to adopt the *H&W* estimates. Contrary to the double *DBR* calibration, which offers a link between the exponential and straight-line rates, the calibration proposed by *H&W* consists of calculating an average age-price profile from their direct estimates and applying it to assets where only data on service life is available.

For example, consider a depreciation profile where an exponential decline (10%) and a service life (25 years) is estimated. According to equation 2.3.1, the resulting *DBR* is 2.5 (*DBR* = γL). Applying this *DBR* to a service life of 15 years yields a depreciation rate of 17%. The estimated and calibrated age-price profiles have identical properties; losing 70% of their value at mid-life and reproducing the same residual value (*RV*) at their expected service life. The calibration proposed by *H&W* can be obtained using equation 2.3.3. Solving for γ yields an expression where the *DBR* is a function of the residual value at the service life. If we assume that a residual value in the range of 5% to 15% is reasonable, the *DBR* would fall in the interval of 3 and 1.9. This is much higher than a *DBR* of 0.91 currently used at *STC* and the *US BEA* for buildings and engineering structures, which suggests a residual value of 40% at the service life.

2.3.3 $$RV = 1 - \exp[-\gamma L]$$

$$\lambda = \frac{-\ln[RV]}{L} = \frac{DBR}{L}$$

In this study, we use this calibration to update the economic estimates to reflect recent trends in service lives and compute depreciation rates for assets where no direct estimation is available. For the assets where no specific *DBR* is estimated, a group average *DBR* is used to calculate depreciation rates. More details are presented in Section 6.

The *DBR* is a calibration parameter used to derive an exponential depreciation rate, but we need an annualized or geometric rate (δ), which is obtained from equation 2.3.4. Although exponential rates approximate geometric rates for low values of γ, such as the rates for buildings, they significantly overestimate the annual change for shorter-lived assets. For the sake of consistency, the adjustment is applied to all assets.

2.3.4 $$(1-\delta)^L = \exp(-\gamma L) \quad \longleftrightarrow \quad \delta = 1 - \exp[-DBR]^{\frac{1}{L}}$$

3 Database

STC collects the data required to estimate the Canadian capital stock in the *CES*. The survey gathers comprehensive data on capital expenditures on new assets and disposals of used assets. It covers approximately 80% of Canadian business investment with some 30,000 firms surveyed each year. The data relevant to this study is divided in two databases: the disposal database (*Section F* of the *CES*) and the expected service life database (*Section A* of the *CES*).

The disposal database is central to this study, enabling the direct estimation of depreciation rates for 36 major asset categories out of the 155 assets tracked by *STC*. The database contains micro data on the selling value of used assets, the age of the assets, and the corresponding gross book value (*GBV*). Note that the *GBV* includes the original investment value plus the capitalized improvements incurred over the life of the asset. The database used for this study covers the 1985 to 2001 period and includes more than 30,000 observations.

The second database contains information on the expected service lives of new assets. In the year of the investment, firms are asked to provide the amount spent on the asset as well as the expected service life. This information enables us to calculate the average expected service lives for 37 building, 59 engineering and 59 M&E assets. The database includes more than 125,000 observations covering the 1985 to 1990 and 1995 to 2001 periods.[9] This information is used to update the econometric estimates to reflect recent trends in service lives and to calibrate depreciation rates for assets where it is impossible to have econometric estimates due to data constraints.

An interesting feature of the data is that average service lives can be estimated in two ways. First, we can calculate an ex-ante service life using the information on the expected service lives surveyed at the time of investment. Second, the realized retirements are compiled in the disposal database when firms report discards by a zero selling value. This information enables us to estimate retirement distributions and mean service lives. Cross-referencing the ex-ante and ex-post service lives provides a valuable validation test for the service life estimates.

Box 3.1 Sample of the Capital Expenditure Survey questionnaire

SECTION A: Capital and Repair Expenditures

	Actual 2001			
Asset Code	New Assets Renovation Retrofit *(Include used fixed assets if imported)*	Purchase of Used Canadian Assets	Total Capital Expenditures *(sum of columns 2 and 3)*	Expected Useful Life of Assets in Column 2
Columns *(1)*	***(thousands of dollars)*** *(2)*	*(3)*	*(4)*	*(5)*
Land	100	xxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxx
Residential Construction	101	102	xxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxx
Codes 1001 – 5999[1]	NON-RESIDENTIAL CONSTRUCTION INCLUDE ADDITIONS TO WORK IN PROGRESS			
	(thousands of dollars)			Years
111	112	113	115	116
Codes 6001 – 9599[1]	MACHINERY AND EQUIPMENT INCLUDE ADDITIONS TO WORK IN PROGRESS			
	(thousands of dollars)			Years
336	337	338	340	341

SECTION F: Disposals/Sales/Write-downs of Fixed Assets

Asset Code	Selling Price	Gross Book Value	Age
Columns *(7)*	***(thousands of dollars)*** *(8)*	*(9)*	**Years** *(10)*
Land	604	733	XXXXXXXXXXXX
Residential Construction	605	606	607
Codes 1001 - 9599[1]	Non-Residential Construction/Machinery and Equipment		
611	612	613	614

The disposal database is used to calculate the price of a used asset normalized on the price of a new asset. This price ratio is calculated as the transaction value of a used asset divided by the value of the asset when new, which is equal to the *GBV* expressed in dollars of the selling year.

9. The service life question was excluded from the *CES* from 1991 to 1994. Also, 15 assets related to mining activities were dropped from the CES after 1990. The service lives for the three software assets are estimates from the *US BEA*.

By expressing the price as a ratio, revaluation effects and quantities[10] are eliminated, such that the estimates capture age-related changes in prices only.

More formally, the price ratio for asset *i* sold at age *s* (P_s^i) and initially purchased in year *t* is calculated by*:*

3.1.1 $$P_s^i = \frac{SV_{t+s}^i}{\frac{GBV_t^i}{Px_t^i}}$$

where *SV* is the transaction value and *Px* is the asset price deflator.[11]

A key data feature from the *CES* is accounting for the value of capitalized improvements in the overall cost of a building. Improvements affect the value of a structure by enhancing or maintaining the quality of aging structures. Evidence suggests the improvements outlays in buildings account for an important share of the total spending over its useful life therefore increasing or maintaining the value of assets as they age. Ignoring the contribution of improvements in the estimation of depreciation rates will result in lower estimates as the loss in value of older assets may be countered by additional improvements. Contrary to most of the studies, which only had access to data on selling prices, the *CES* accounts for capitalized improvements in total outlays (*GBV*), which allows the removal of the bias created by the value of improvements. There is a minor issue related to deflating the value of improvements to the selling year. Since improvements occur at different point in the life of an asset, the nominal value of the improvements reported in the *GBV* should be deflated accordingly. The strategy proposed to deflate improvements is presented in Annex A.

As it is often the case with age reporting surveys, the database suffers from digit-preference or age-heaping. In this database, the problem occurs for age in multiple of 5 years. The digit-preference is corrected by randomly distributing the clusters to adjacent ages. The random process follows a normal distribution where 60% of the observations have a 5-year multiple and the remaining observations are distributed over +/- 2 years of the cluster.[12]

The price database includes all assets that were sold, including assets no longer in operation that were sold for scrap and represent retirements. Unfortunately, the survey does not distinguish these assets from those in operation and ignoring the scrapped assets from the retirement estimation could influence the results. To circumvent this problem, we assume that assets sold at a transaction price of less than 6% of the initial purchase price have been scrapped. These

10. Quantities are embedded in the survey data since the *CES* surveys the consolidated values of transactions involving a given asset category. Therefore, several transactions occurred over the year may be reported as a single response.
11. The price deflators used for the study are *STC's* capital asset price indices. A comprehensive discussion on the concept underpinning the calculation of the price indices is presented in *Investment Flows and Capital Stock - Methodology 2001*.
12. This approach was chosen over the one suggested by Gellatly, Tanguay and Yan (2002) and Tanguay (2005). Their approach was found to allocate too much data to adjacent ages for certain assets, resulting in important clusters in the adjacent ages of the original cluster.

observations are therefore used in both the price estimation and retirement estimation. The impact of this assumption, along with that of the adjustment for deflating improvement and the correction for digit-preference, is presented in Annex A.

Lastly, outliers are identified and purged from the database. Although some quality controls are performed on the data, responses in the disposal database are subject to less rigorous quality inspections than responses in the expected service life database. The data is therefore filtered through an outlier identification process to eliminate extreme values of *GBV* and *SV*. A discussion of the outlier identification is provided in Annex A.

The filtering process leaves us with a database of 30,228 observations, or 91% of the initial database.[13] For the purpose of estimation, the disposal database is divided in two. The first is a price database where we have individual age-price observations that are used to estimate expected age-price profiles. This part of database has 16,821 observations with M&E assets accounting for 92% of the total. The second part contains information on realized retirements of assets that enable the estimation of retirement distributions. It has 13,407 observations with M&E assets accounting for 87% of the total.

4 Estimation framework

The estimation framework adopted for the study is similar to that used in the established literature. It consists of directly estimating age-price profiles using data on used asset prices, and then adjusting the estimates for the censored sample bias using retirement distributions. Contrary to most studies, which calibrate a retirement distribution around a mean service life, retirement probabilities in this study are directly estimated using observed retirements.

The standard methodology was chosen over the other models recently developed by the Productivity Program at Statistics Canada because of its simplicity and it imposes less restrictions on the data and the modeling. The model does not require assumptions on whether efficiency profiles are constant, convex or concave, nor does it require a discount rate. Moreover, retirement and survival data points are not used simultaneously to estimate retirement probabilities, hence no adjustment is needed to correct for the unbalanced sample resulting from the non-randomness of the disposal database.

4.1 Age-price profiles

Age-price profiles are estimated using transaction data on used asset markets and a Weibull specification. The Weibull was selected for its flexible properties and tractability. The relationship between the price ratio (P_s) of equation 4.1.1, and age (s) is expressed by:

13. Outliers in the automobile category account for 27% of total outliers while the data for the automobile category represents only 9% of total observations. The leasing and financial sectors report zero values for autos at the end of the leasing period, which is typically three or four years in the business sector. Given that autos last substantially longer in other business sectors, we have removed the data reported by the leasing and financing sectors.

4.1.1 $$P_s = \exp(-(\phi s)^{\sigma})$$

where ϕ and σ are the scale and shape parameters respectively. An interesting feature of the Weibull is that it reduces to an exponential form when σ is one.

A weighted least square regression is performed on the age-price observations using the linear form of the Weibull. The regression model is weighted by the importance of an observation in its age group.[14] The weights serve as proxy for quantities and are measured by the *GBV* in *2001* dollars. These weights are necessary to account for consolidated reporting in the *CES* (several transactions may be reported as a single response) and for the fact that some assets have more capital embedded in them (example: a two-floor building versus a twenty-floor building).

The linear transformation of the Weibull is carried out as follows:

4.1.2 $$\underbrace{\log(-\log(P_s))}_{y} = \sigma\log\phi + \sigma\underbrace{\log s}_{x}.$$

The corresponding *OLS* estimating equation is:

4.1.3 $$y = \alpha + \beta x + u.$$

The Weibull parameters are recovered by:

4.1.4 $$\sigma = \beta \quad \text{and} \quad \phi = \exp\left(\frac{\alpha}{\beta}\right).$$

4.2 Retirement distribution

The use of both the survival and retirement data to estimate the retirement probabilities would be the preferred estimation approach. Unfortunately, sampling problems with the *CES* disposal data do not allow mixing the survivor and retirement datasets without imposing restrictive assumptions on the data. The sample for the *CES* is designed to collect data on new investment; the data on disposals is collected as secondary information. No sampling is conducted by Statistics Canada to ensure a representative balance between the data on survivor and retirement. In addition, a key element is missing from the survivor data: assets surviving to a certain age but not sold. These assets are not covered by the *CES*. Given these important limitations and the fact that results from using retirement data only are in line with the expectation of managers (ex-ante service lives), this study opted to rely on retirement data only rather than a complete survival

14. The ex-post weighting of price data proposed by Tanguay and Lavallée (2006), and adopted by Tanguay (2005), to correct for inappropriate sampling of the price data across age groups has virtually no impact on the estimates because each age group has the same weight in the regression.

analysis, which would require important corrections to the data in order to yield plausible results[15].

The retirement distributions are estimated using standard likelihood estimation and a Weibull specification. The cumulative (*D*) and density (*f*) probability functions for retirement are respectively:

4.2.1 $$D(s;\lambda,\rho) = 1 - Sv(s;\lambda,\rho) = 1 - \exp\left[-(\lambda s)^{\rho}\right]$$

4.2.2 $$f(s;\lambda,\rho) = \lambda\rho(\lambda s)^{\rho-1}\exp\left[-(\lambda s)^{\rho}\right].$$

The resulting log-likelihood equation for the estimation is:

4.2.3 $$\ln\Lambda = \omega_i \sum_{i}^{n} \ln f(s_i;\lambda,\rho).$$

Parameters to estimate are the scale parameter, λ, and the shape parameter, ρ. As in the price estimation procedure, the likelihood is weighted by *GBV* in *2001* dollars (ϖ_i). However, contrary to the price estimation where the weights are calculated within each age group, the weights in the likelihood are calculated across the full sample.

The mean service life of the Weibull distribution is calculated by (4.2.4).

4.2.4 $$\hat{L} = \frac{1}{\hat{\lambda}}\Gamma\left(1 + \frac{1}{\hat{\rho}}\right),$$ where Γ is a gamma function[16].

4.3 Economic depreciation

The expected age-price profile is calculated by combining the estimated price profile and survival probabilities. The expected price of an asset at age *s* is expressed as:

4.3.1 $$V_s = (1 - D_s)P_s = Sv_s P_s .$$

15. The standard approach presented in Depreciation Rates for the Productivity Accounts (15-206-XIE - No. 005) uses a survival analysis to estimate the retirement probabilities. The estimates are sensitive to a re-weighting affecting the balance between survival and retirement data, and the assumption on scrap value, which allocates survival data points to retirements. These corrections allow the estimates from the survival model to be comparable to the estimates presented in this paper.

16. The gamma function with a shape parameter *n* is defined as $\Gamma(n) \equiv \int_0^{\infty} y^{n-1}e^{-y}dy$.

An interesting feature of this approach is that it enables the separation of the depreciation rate into the price decline sustained on the market and the loss in value resulting from retirement (equation 4.3.2).

$$\delta_s = \frac{V_s - V_{s+1}}{V_s} = \frac{Sv_s P_s - Sv_{s+1} P_{s+1}}{Sv_s P_s}$$

4.3.2

$$= \frac{(P_s - P_{s+1})}{P_s} + \left(\frac{Sv_s - Sv_{s+1}}{Sv_s}\right)\frac{P_{s+1}}{P_s} \quad ,$$

$$= \underbrace{\frac{(P_s - P_{s+1})}{P_s}}_{\textit{Price Decline}} + \underbrace{h_{s+1}\frac{P_{s+1}}{P_s}}_{\textit{Retirement}}$$

where h_{s+1} is the hazard rate, which is the probability of being retired at age $s+1$ conditional to surviving to s.

5 Empirical results

The absence of well developed transaction markets limits data availability to 36 out of the 155 assets (27 M&E, 6 building and 3 engineering). However, these assets represent a considerable portion of the Canadian business capital stock. The M&E assets cover close to 80% of the M&E stock, while the building and the engineering assets account for 57% and 13% of their respective capital stocks.

The following two subsections present estimation results for the age-price profiles and retirement distributions. The estimation results are presented in Table 5.1 and Table 5.2. The last subsection presents the depreciation rates derived from the estimates. Note that the depreciation rates presented in Table 5.3 will be updated in Section 6 to reflect recent trends in the useful lives.

5.1 Age-price profiles

On average, the estimated resale price of buildings (uncorrected for retirement) decreases by a little under 5% per annum. The decline in prices for industrial buildings is more rapid with prices decreasing by 6.0% on average. The average annual price decline for M&E assets is 19.6% with the fastest decline in *Computers* (41.0%).

Although engineering assets represent a third of the total business capital stock, the limited existence of used asset markets limits the estimation to 3 engineering assets. They are *Electrical*

Distribution Lines, *Telephone & Cablevision Lines* and *Communication Towers & Antennas*. The price profiles for engineering assets are consistent with a geometric average rate of 9.0% to 12.0%.

The parameters for the linear form of the Weibull are robust for the majority of assets. Both α and β are statistically significant at 1% for all assets. However, a relatively small number of observations results in slightly less precise estimates for 8 out of the 36 asset categories, particularly for the shape parameter, α[17]. Nevertheless, the price decline for the majority of these assets is in line with that of the more robust estimates.

The R-square statistic is satisfactory for all assets. Nevertheless, the Weibull was tested against polynomial models in which the explanatory variables included age, time and age-time as a cross term. The first model incorporated age as a polynomial expanding up to five degrees and the second had both age and the cross term expressed as a polynomial.

The Weibull was compared to the polynomial models for two reasons. First, comparing it to more complex functions provides information on whether the Weibull achieves the desired balance between flexibility and tractability. On this point, the Weibull model performed marginally better than the polynomial models in most cases. The second reason for estimating a polynomial specification is to examine whether all revaluation effects were eliminated from the price ratios. Recall that revaluation is eliminated from the price ratios by deflating the *GBV* to the selling year. If the price deflators were inaccurate, revaluation effects would remain embedded in the price ratios, therefore contaminating the depreciation estimates. Including time as an explanatory variable will capture any remaining revaluation effects, allowing an assessment of the accuracy of price deflators. The results indicate that the price deflators eliminate revaluation effects for most asset categories. The time variable is, however, significant for assets with a relatively small number of observations.

17. They are: for *All-Terrain Vehicles*, *Non-Computerized Communication Equipment*, *Underground Load, Haulage & Dump Equipment*, *Buses & Major Replacement Parts*, *Non-Office Furniture, Furnishings & Fixtures*, *Pollution Abatement & Control Equipment* and *Communication Towers & Antennas*.

Table 5.1 Estimation results for age-price profiles

		α			β				Weibull parameters		
	Asset code	**Estimate**	**Standard error**	**Coefficient of variation**	**Estimate**	**Standard error**	**Coefficient of variation**	**R-square**	ϕ	σ	**Geometric approxi-mation**
		number		%	number		%		number		%
Building											
Manufacturing Plants	1001	-1.77	0.28	15.9	0.69	0.09	13.4	0.35	0.08	0.69	6.6
Warehouses, Refrigerated Storage and Freight Terminals	1006	-3.82	0.55	14.4	1.26	0.16	13.1	0.55	0.05	1.26	4.9
Maintenance Garages, Workshops and Equipment Storage Facilities	1008	-3.01	0.41	13.5	1.04	0.13	12.9	0.61	0.06	1.04	5.5
Office Buildings	1013	-2.83	0.29	10.4	0.94	0.09	9.6	0.54	0.05	0.94	4.7
Other Industrial and Commercial Buildings	1099	-2.81	0.68	24.2	0.96	0.21	21.4	0.43	0.05	0.96	5.2
Broadcasting and Communication Buildings	3001	-4.09	1.41	34.5	1.51	0.47	31.2	0.55	0.07	1.51	6.8
Machinery and equipment											
Office Furniture and Furnishing	6001	-1.37	0.49	36.0	0.83	0.20	23.5	0.35	0.19	0.83	16.8
Computers and Associated Hardware	6002	-0.33	0.11	34.2	0.67	0.07	11.1	0.30	0.61	0.67	41.0
Non-Office Furniture, Furnishings and Fixtures	6003	-1.30	0.56	42.8	0.76	0.23	30.3	0.32	0.18	0.76	15.5
Scientific, Professional and Medical Devices	6004	-2.18	0.77	35.5	1.18	0.29	24.8	0.52	0.16	1.18	15.1
Heating, Electrical, Plumbing, Air Conditioning and Refrigeration Equipment	6005	-1.43	0.31	21.9	0.85	0.12	14.4	0.49	0.19	0.85	16.4
Pollution Abatement and Control Equipment	6006	-3.14	1.40	44.5	1.38	0.47	34.4	0.48	0.10	1.38	10.2
Safety and Security Equipment	6007	-2.38	0.56	23.4	1.10	0.19	17.6	0.78	0.12	1.10	11.1
Motors, Generators, Transformers, Turbines, Compressors and Pumps	6009	-1.74	0.42	23.9	0.92	0.15	15.8	0.48	0.15	0.92	13.7
Heavy Construction Equipment	6010	-2.26	0.34	15.0	1.19	0.13	11.1	0.76	0.15	1.19	14.3
Tractors of All Types and Other Field Equipment	6011	-1.05	0.26	24.3	0.70	0.10	13.9	0.57	0.22	0.70	17.7
Capitalized Tooling and Other Tools	6012	-1.47	0.55	37.1	0.94	0.21	22.7	0.41	0.21	0.94	18.6
Drilling and Blasting Equipment	6013	-1.66	0.66	39.7	0.92	0.27	29.8	0.32	0.16	0.92	14.8
Underground Load, Haulage and Dump Equipment (such as slusher and muck cars)	6028	-1.77	0.81	45.9	0.91	0.30	33.2	0.47	0.14	0.91	13.0
Automobiles and Major Replacement Parts	6201	-1.07	0.22	20.3	0.65	0.12	18.5	0.30	0.19	0.65	15.5
Buses and Major Replacement Parts	6202	-1.33	0.56	42.2	0.89	0.20	22.0	0.44	0.23	0.89	19.7
Trucks, Vans, Truck Tractors, Truck Trailers and Major Replacement Parts	6203	-1.20	0.20	16.4	0.73	0.10	13.7	0.45	0.20	0.73	16.3
All - Terrain Vehicles and Major Replacement Parts	6204	-1.96	0.94	48.1	1.10	0.41	37.5	0.50	0.17	1.10	15.6
Locomotives, Rolling Stock, Street/Subway Cars, Other Rapid Transit and Major Parts	6205	-1.36	0.40	29.2	0.78	0.12	15.8	0.64	0.17	0.78	14.8
Ships and Boats	6206	-2.38	0.58	24.4	0.94	0.18	19.5	0.29	0.08	0.94	7.4
Other Transportation Equipment	6299	-0.54	0.21	39.5	0.51	0.09	18.5	0.23	0.35	0.51	23.2
Computerized Material Handling Equipment	6401	-3.56	1.13	31.8	1.91	0.50	26.0	0.64	0.16	1.91	15.4
Computerized Production Equipment for Manufacturing	6402	-2.13	0.47	22.0	1.19	0.16	13.8	0.61	0.17	1.19	15.9
Computerized Communication Equipment	6403	-1.37	0.29	21.6	0.95	0.10	10.5	0.41	0.24	0.95	20.8
Non-Computerized Material Handling Equipment	6601	-1.26	0.29	23.0	0.79	0.10	12.7	0.51	0.20	0.79	17.2
Non-Computerized Production Equipment for Manufacturing	6602	-1.70	0.39	23.1	0.97	0.13	13.2	0.57	0.17	0.97	15.9
Non-Computerized Communication Equipment	6603	-2.19	0.96	43.8	1.30	0.36	28.1	0.58	0.18	1.30	17.6
Other Machinery and Equipment (not specified elsewhere)	8999	-1.18	0.33	28.2	0.74	0.13	17.5	0.34	0.20	0.74	16.9
Engineering											
Electrical Distribution Lines - Overhead	2816	-1.98	0.59	30.1	0.93	0.18	19.0	0.52	0.12	0.93	11.0
Telephone and Cablevision Lines	3002	-2.77	0.54	19.6	1.33	0.20	15.3	0.60	0.12	1.33	12.2
Communication Towers and Antennas	3003	-2.23	1.21	54.1	0.94	0.44	47.5	0.27	0.09	0.94	8.7

α and β - parameters in equation 4.1.3

ϕ and σ - see equation 4.1.4

5.2 Retirement distribution

The shape (ρ) and scale (λ) parameters are statistically significant for all assets. Nevertheless, a relatively small number of observations result in slightly less robust estimates for ρ for 3 of the 36 assets.[18] The Weibull specification was also tested against other functional forms. It came out as the best overall fit on the observed dataset when compared to the Lognormal, Exponential, Beta and Gamma functions.

The shape of the retirement curve is primarily determined by ρ. When ρ is equal to 1 the retirement curve is geometric such that retirements are front-loaded. As ρ increases the retirement curve resembles a bell-shaped distribution with retirements being increasingly concentrated at the mean service life. The estimates indicate that the retirement distributions of buildings and M&E are reasonably symmetric on average with a little over half of the assets retired at the mean service life and some 3% remaining at twice the mean service life. The retirement distributions of engineering assets also suggest that half the assets are retired by the mean service life, but there are virtually no assets remaining at twice the service life.

Mean service lives are calculated using equation 4.2.4. The mean service life of buildings is generally close to 30 years, except for *Other Industrial and Commercial buildings*, which have an estimated mean service life of 21 years. A key finding is that the realized service lives from the estimation is similar to the ex-ante service lives of new buildings reported in the *CES*.

The average service life for M&E assets is 12 years with *Computers* registering the shortest service life at 4.8 years. Again, the realized service lives are similar to the ex-ante service lives for the majority of assets. However, the realized service lives are much greater than the ex-ante service lives for *ATVs*, *Heavy Construction Equipment*, *Trucks*, *Ships & Boats* and *Other Transportation Equipment*. For these asset categories, the small number of observations and very eclectic categories affect the precision of the estimates.

The mean service lives for engineering assets range from 18 years for *Telephone & Cablevision Lines* and *Communication Towers & Antennas* to 29 years for *Electrical Distribution Lines*. *Communication Towers & Antennas* is the only asset category where the estimated and ex-ante service lives diverge significantly.

18. They are: *Drilling and Blasting Equipment, ATVs* and *Ships & Boats.*

Table 5.2 Estimation results for retirement profiles

	Asset codes	λ Estimate	λ Standard error	λ Coefficient of variation	ρ Estimate	ρ Standard error	ρ Coefficient of variation	Mean service life Estimated	Mean service life Surveyed
		number		%	number		%	number	
Building									
Manufacturing Plants	1001	0.031	0.001	1.8	2.126	0.058	2.7	28.7	26.6
Warehouses, Refrigerated Storage and Freight Terminals	1006	0.030	0.001	4.0	1.813	0.099	5.4	30.1	32.2
Maintenance Garages, Workshops and Equipment Storage Facilities	1008	0.032	0.001	3.4	2.843	0.224	7.9	28.1	28.0
Office Buildings	1013	0.028	0.001	2.2	2.391	0.094	3.9	31.6	33.3
Other Industrial and Commercial Buildings	1099	0.042	0.002	4.4	2.220	0.162	7.3	20.9	23.9
Broadcasting and Communication Buildings	3001	0.030	0.001	4.0	3.357	0.298	8.9	30.0	30.6
Machinery and equipment									
Office Furniture and Furnishing	6001	0.100	0.001	0.8	2.746	0.046	1.7	8.9	8.3
Computers and Associated Hardware	6002	0.189	0.001	0.7	3.284	0.057	1.7	4.8	4.7
Non-Office Furniture, Furnishings and Fixtures	6003	0.101	0.002	1.7	2.696	0.084	3.1	8.8	9.4
Scientific, Professional and Medical Devices	6004	0.092	0.002	2.7	1.940	0.073	3.7	9.7	8.9
Heating, Electrical, Plumbing, Air Conditioning and Refrigeration Equipment	6005	0.058	0.001	2.4	2.450	0.111	4.5	15.2	12.5
Pollution Abatement and Control Equipment	6006	0.052	0.002	4.4	2.383	0.189	7.9	17.1	16.7
Safety and Security Equipment	6007	0.078	0.005	7.0	1.723	0.143	8.3	11.4	10.8
Motors, Generators, Transformers, Turbines, Compressors and Pumps	6009	0.046	0.001	2.0	2.476	0.089	3.6	19.3	15.3
Heavy Construction Equipment	6010	0.063	0.001	2.3	3.561	0.218	6.1	14.2	7.9
Tractors of All Types and Other Field Equipment	6011	0.073	0.003	3.5	2.478	0.150	6.1	12.1	9.4
Capitalized Tooling and Other Tools	6012	0.090	0.002	2.3	1.958	0.068	3.5	9.9	8.0
Drilling and Blasting Equipment	6013	0.071	0.004	5.6	2.703	0.302	11.2	12.5	11.1
Underground Load, Haulage and Dump Equipment (such as slusher and muck cars)	6028	0.075	0.003	4.7	2.268	0.170	7.5	11.9	10.2
Automobiles and Major Replacement Parts	6201	0.124	0.003	2.1	2.230	0.078	3.5	7.1	7.1
Buses and Major Replacement Parts	6202	0.054	0.001	2.7	3.592	0.252	7.0	16.6	12.6
Trucks, Vans, Truck Tractors, Truck Trailers and Major Replacement Parts	6203	0.088	0.001	1.1	2.288	0.045	2.0	10.1	7.1
All - Terrain Vehicles and Major Replacement Parts	6204	0.086	0.003	3.8	3.847	0.423	11.0	10.5	6.4
Locomotives, Rolling Stock, Street/Subway Cars, Other Rapid Transit and Major Parts	6205	0.038	0.001	1.9	4.449	0.263	5.9	24.3	23.3
Ships and Boats	6206	0.036	0.002	6.4	2.314	0.257	11.1	24.8	17.3
Other Transportation Equipment	6299	0.069	0.003	4.2	2.249	0.163	7.2	12.8	9.0
Computerized Material Handling Equipment	6401	0.069	0.003	4.6	2.305	0.174	7.5	12.9	13.4
Computerized Production Equipment for Manufacturing	6402	0.057	0.001	2.0	1.957	0.058	3.0	15.4	12.7
Computerized Communication Equipment	6403	0.072	0.002	2.6	2.004	0.081	4.1	12.3	9.5
Non-Computerized Material Handling Equipment	6601	0.064	0.001	1.8	2.278	0.066	2.9	13.9	10.6
Non-Computerized Production Equipment for Manufacturing	6602	0.055	0.001	1.0	2.177	0.033	1.5	16.2	14.0
Non-Computerized Communication Equipment	6603	0.078	0.002	2.4	2.049	0.072	3.5	11.4	11.1
Other Machinery and Equipment (not specified elsewhere)	8999	0.075	0.002	2.2	1.961	0.064	3.3	11.9	10.9
Engineering									
Electrical Distribution Lines - Overhead	2816	0.031	0.001	3.3	3.693	0.298	8.1	29.4	32.9
Telephone and Cablevision Lines	3002	0.050	0.002	3.4	2.616	0.177	6.8	17.9	20.5
Communication Towers and Antennas	3003	0.042	0.002	3.6	3.046	0.242	7.9	21.5	13.5

λ and β - parameters in equation 4.2.3

5.3 Economic depreciation

Combining the price and retirement estimates yields the expected price of an asset at each point in its useful life. The evidence suggests that age-price profile for buildings follows a straight-line pattern for the first 60% of value loss and then changes to a convex pattern. Interestingly, this is nearly identical to the depreciation pattern used by the *US BEA* before adopting the *H&W* estimates in the mid-nineties. The profile is consistent with anecdotal evidence stipulating that buildings lose less productive capacity early in their useful lives and then experience a more rapid decline as they get closer to their expected service life. An exception to the hybrid profile is the *Manufacturing Plants* category where the results clearly point to a convex profile. Sectoral and spatial specificities of capital in the manufacturing sector may explain part of the sharp fall in resale prices in the earlier years of existence.[19]

Given the difficulty of incorporating a hybrid profile in the capital stock and service measures, the estimated profiles are approximated using both a geometric and a linear model. Average absolute deviations from the estimated profiles are then computed to determine the best fit.[20] Table 5.3 summarizes the results of the geometric and linear approximations of the estimated profiles.

As would be expected from the estimated age-price profiles for buildings, the linear profile is a better approximation in the first half of the life while the geometric profile is a better fit in the second half. Overall, a geometric pattern is the best fit for *Manufacturing Plants* and *Office Buildings*, which depreciate at 8.7% and 6.2% respectively. The choice is less obvious for *Garages* and *Other Industrial & Commercial Buildings* where the geometric and linear rates provide comparable results on average. The linear profile is the best fit for *Warehouses* and *Broadcasting & Communication Buildings* despite overestimating depreciation in the second half of the useful life. On average, the geometric depreciation rate for buildings is 7.1%, leaving some 11% of the initial value at the mean service life.

The majority of M&E assets follow a convex depreciation pattern that is well approximated by a geometric rate. The average M&E asset depreciates at 23.0%. *Computers* experience the fastest decline with a depreciation rate of 45.8%.

A geometric pattern is clearly the best fit for *Electrical Distribution Lines – Overhead*, while the geometric and linear profiles provide comparable results on average for the other two engineering assets. The average geometric depreciation rate for engineering assets is 12.1%.

The results for the *DBR* point to an average value of 2.6 with the *DBR* for most assets falling between 2 and 3. This range is consistent with residual values at mean service life falling between 5% and 15%. On average, the estimates suggest a residual value of 9% with 80% of the assets in the 5.0% to 15.0% range. Depreciation is more front-loaded for M&E and engineering assets, where the residual values at the mean service life from the geometric estimates average 7% compared to 11% for buildings.

19. Ramey, V. A. and M. D. Shapiro (2001) provide evidence that sectoral specificity negatively impacted on the value of used assets discarded by three U.S. aerospace companies.
20. Details on the fit statistics are provided in Table B.1 in Annex B.

Table 5.3 Estimated depreciation rates

	Asset codes	Capital stock weight	Geometric profile: Rate	Geometric profile: DBR[3]	Geometric profile: Residual value at mean service life	Linear profile[1]	Confidence interval for corrected price profile (a=5%)[2]: Average deviation	Confidence interval for corrected price profile (a=5%)[2]: Geometric approximation: Lower	Confidence interval for corrected price profile (a=5%)[2]: Geometric approximation: Upper
		%		number			%		
Buildings									
Manufacturing Plants	1001	5.0	8.7	2.6	7.3	5.8	19.1	7.3	10.6
Warehouses, Refrigerated Storage and Freight Terminals	1006	1.2	6.3	2.0	14.0	3.9[1]	23.3	5.4	7.5
Maintenance Garages, Workshops and Equipment Storage Facilities	1008	0.8	6.8	2.0	13.9	4.2	22.9	5.8	8.0
Office Buildings	1013	7.5	6.2	2.0	13.2	3.9	14.7	5.6	7.0
Other Industrial and Commercial Buildings	1099	0.3	7.9	1.7	17.9	4.9[1]	27.1	6.5	10.0
Broadcasting and Communication Buildings	3001	0.5	7.2	2.3	10.5	4.2[1]	70.3	5.1	12.2
Building average	…	15.3	7.1	2.2	11.4	4.6	19.2	6.1	8.5
Machinery and equipment									
Office Furniture and Furnishing	6001	1.0	21.4	2.1	11.7	14.5	32.0	17.1	30.1
Computers and Associated Hardware	6002	3.3	45.8	2.9	5.4	39.4	19.1	41.0	51.9
Non-Office Furniture, Furnishings and Fixtures	6003	1.0	21.0	2.1	12.5	14.3	37.5	16.3	31.5
Scientific, Professional and Medical Devices	6004	0.3	18.9	2.0	13.1	12.5[1]	42.1	14.6	27.6
Heating, Electrical, Plumbing, Air Conditioning and Refrigeration Equipment	6005	0.3	18.3	3.1	4.6	12.7	26.4	15.0	23.7
Pollution Abatement and Control Equipment	6006	0.5	11.6	2.1	12.1	7.1[1]	66.8	8.1	21.7
Safety and Security Equipment	6007	0.1	15.4	1.9	14.8	10.1[1]	38.2	11.8	21.1
Motors, Generators, Transformers, Turbines, Compressors and Pumps	6009	0.5	15.0	3.1	4.3	10.5	27.5	12.2	20.1
Heavy Construction Equipment	6010	0.7	15.4	2.4	9.3	9.9[1]	16.7	13.8	17.6
Tractors of All Types and Other Field Equipment	6011	1.1	21.2	2.9	5.6	15.1	22.6	17.8	26.8
Capitalized Tooling and Other Tools	6012	0.4	22.5	2.5	8.1	16.1	39.3	17.3	33.5
Drilling and Blasting Equipment	6013	0.2	17.4	2.4	9.1	11.9	39.7	13.3	26.3
Underground Load, Haulage and Dump Equipment (such as slusher and muck cars)	6028	0.1	16.6	2.2	11.5	11.4	45.9	12.2	28.3
Automobiles and Major Replacement Parts	6201	1.7	24.7	2.0	13.2	17.4	19.8	21.7	28.7
Buses and Major Replacement Parts	6202	0.1	20.3	3.8	2.3	14.6	45.4	14.7	36.2
Trucks, Vans, Truck Tractors, Truck Trailers and Major Replacement Parts	6203	1.6	21.2	2.4	9.0	14.8	16.7	18.8	24.3
All - Terrain Vehicles and Major Replacement Parts	6204	0.1	17.7	2.0	12.9	11.4[1]	45.0	13.5	28.3
Locomotives, Rolling Stock, Street/Subway Cars, Other Rapid Transit and Major Parts	6205	0.5	15.3	4.0	1.8	11.2	31.1	11.6	23.5
Ships and Boats	6206	0.3	9.1	2.4	9.5	6.0	37.7	6.8	13.2
Other Transportation Equipment	6299	0.0	27.0	4.0	1.8	22.3	27.5	21.4	36.8
Computerized Material Handling Equipment	6401	0.1	16.5	2.3	9.8	9.5[1]	53.2	13.2	22.5
Computerized Production Equipment for Manufacturing	6402	3.2	17.5	3.0	5.1	11.6[1]	31.4	14.3	23.0
Computerized Communication Equipment	6403	2.5	23.2	3.2	3.9	16.7	32.5	18.6	30.9
Non-Computerized Material Handling Equipment	6601	0.3	19.7	3.1	4.7	14.4	24.2	16.2	25.6
Non-Computerized Production Equipment for Manufacturing	6602	3.7	17.6	3.1	4.3	12.1	28.6	14.2	23.6
Non-Computerized Communication Equipment	6603	0.7	19.7	2.5	8.2	12.9[1]	55.8	14.4	33.3
Other Machinery and Equipment (not specified elsewhere)	8999	0.5	21.1	2.8	6.0	15.0	27.7	17.0	28.2
Machinery and equipment average	…	24.9	23.0	2.8	6.9	16.9	28.9	19.2	29.5
Machinery and equipment average - excluding computers	…	21.6	19.5	2.8	7.1	13.5	30.4	15.9	26.1
Engineering									
Electrical Distribution Lines - Overhead	2816	2.6	11.4	3.6	8.3	7.9	37.9	8.5	18.7
Telephone and Cablevision Lines	3002	2.3	13.2	2.5	6.5	8.3	33.7	10.8	16.9
Communication Towers and Antennas	3003	0.4	10.1	2.3	6.0	6.6	61.3	6.8	20.9
Engineering average	…	5.3	12.1	3.0	7.3	7.9	37.9	9.4	18.1
Total assets	**…**	**45.5**	**16.4**	**2.6**	**8.5**	**11.7**	**26.7**	**13.7**	**21.1**
Total assets - excluding computers	**…**	**42.2**	**14.1**	**2.6**	**8.7**	**9.6**	**27.3**	**11.5**	**18.7**

… not applicable

1. The straight-line approximation provides an equivalent or better overall fit on the estimated price profile corrected for retirements than the geometric approximation. Fit statistics are presented in Table B.1.
2. Average deviations of the confidence intervals from the points estimate are calculated using the estimated price profile corrected for retirements which has depreciation rates varying with age. The geometric approximations presented are for the confidence intervals which also have depreciation rates varying with age.
3. DBR = Declining balance rate.

Confidence intervals were constructed for the estimated age-price profiles corrected for retirements.[21] The average deviation of the interval profiles from the estimated profile as well as the geometric approximations of the interval profiles are presented in Table 5.3. The 95 % confidence intervals are reasonable with the average deviation at 27% of the point estimate. The average deviation exceeds 40% of the point estimate for nine asset categories[22], representing 3% of the capital stock. In spite of the higher variance, the geometric estimate for most of the relatively less precise estimates generate a residual value at the mean service life that is consistent with the average decline of the more robust estimates.

Although the relatively small number of observations for the nine assets clearly contributes to wider confidence intervals, another possible explanation is that some asset categories may be defined broadly enough to include assets with different useful lives. After inspecting data on ex-ante service lives, none revealed the presence of important heterogeneity (refer to Annex C for descriptive statistics on ex-ante service lives).

6 Depreciation rates for Canadian assets

The previous section reported on the direct estimation of depreciation rates for 36 out of the 155 assets, using data from 1985 to 2001. In this section these rates are updated to reflect recent trends in useful lives, and depreciation rates are calculated for the remaining 119 assets. The methodology used to update the depreciation rates is presented in the next section followed by a discussion on the ex-ante service lives used in the new rates. The final results for depreciation rates, as well as their impact on the Canadian capital stock, are presented in the last section.

6.1 Methodology

As previously noted in section 2, the depreciation rates from the econometric estimates are updated using the *DBR* estimates and the new service lives. To calculate depreciation rates for the remaining 119 assets, we use the estimated *DBR* from the 36 assets and the asset specific service lives. This is done in two steps. First, we calculate average *DBR* for 19 asset groups created from the 155 *STC* asset categories with similar characteristics.[23] Geometric depreciation rates for the 119 assets are then calibrated using the asset group's *DBR*, the asset specific service lives and equation 2.3.4, which converts the exponential rate to its geometric equivalent. Given that direct estimates are available for only three engineering assets, the depreciation rates for the majority of the engineering assets are calculated using the average *DBR* for industrial buildings.

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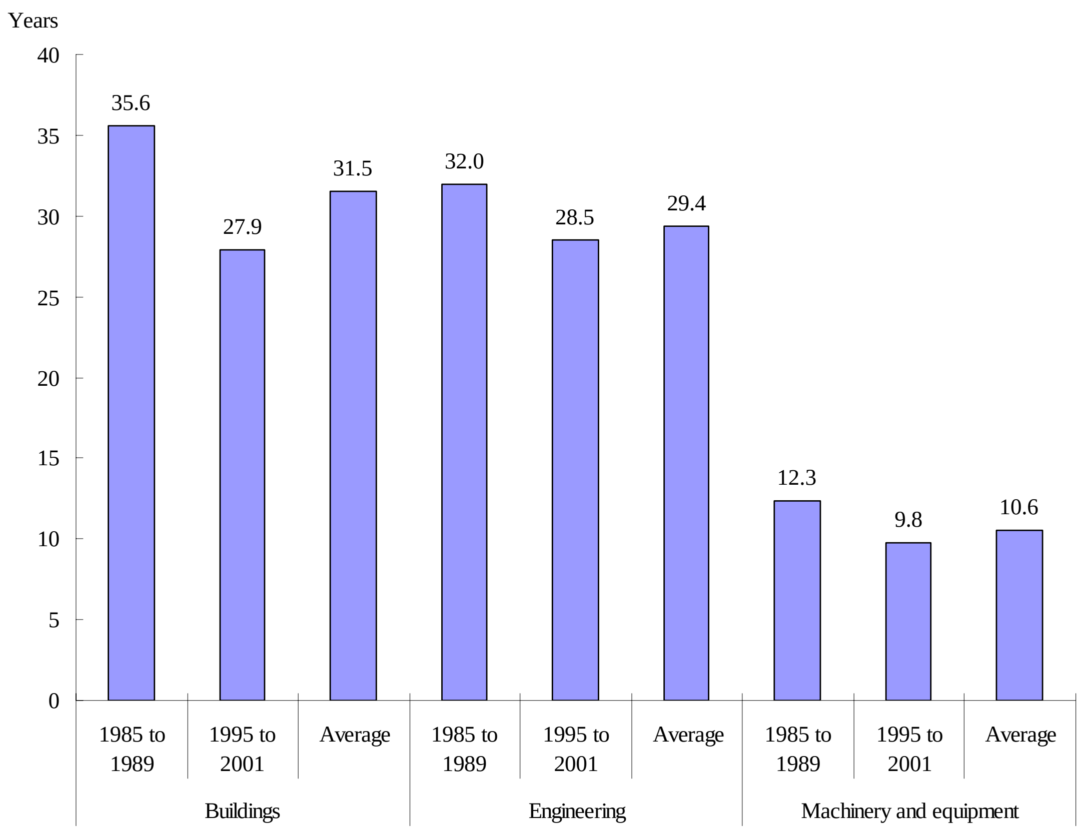
21. The confidence intervals for the corrected price profile are computed by combining the intervals from the price and retirement estimates. The variance used to calculate the intervals for the uncorrected price profile (P_s) is equal to: $\hat{\sigma}^2(P_s) = J_\alpha(s)^2 \hat{\upsilon}_\alpha{}^2 + 2J_\alpha(s)J_\beta(s)\hat{\upsilon}_{\alpha\beta} + J_\beta(s)^2 \hat{\upsilon}_\beta{}^2$, where J_α and J_β are the derivatives of P_s with respect to α and β, and υ is from the variance-covariance matrix for the OLS estimates.
22. *Broadcasting & Communication Buildings*, *Pollution Abatement & Control Equipment*, *Communication Towers & Antennas*, *Non-Computerized Communication Equipment*, *Computerized Material Handling Equipment*, *All - Terrain Vehicles*, *Buses & Major Replacement Parts*, *Underground Load*, *Haulage & Dump Equipment* and *Scientific, Professional & Medical Devices*.
23. A concordance of the assets to their groups is presented in Annex D.

The service lives used to calculate the final depreciation rates are from the ex-ante service lives compiled in the *CES*. The mean service life for buildings and engineering is approximately 30 years while the average for M&E is 11 years. As noted in Section 5.2, the ex-ante service lives are similar to the ex-post service lives for the majority of the assets. This evidence offers support for the use of ex-ante service lives in the calculation of depreciation rates.

The *CES* revealed notable declines in ex-ante service lives for the three major asset groups over 16 years (Chart 6.1). Compared to the late eighties, the expected service lives of buildings and M&E fell by 20% over the 1995 to 2001 period, while the mean service life of engineering assets declined by 10% over the same period. Among the important assets in the Canadian capital stock, notable declines in service lives were reported in *Office Buildings* and *Shopping Centers*, both decreasing by approximately 30%, and in *Computers*, which registered a 20% fall in its service life between the two periods.

To capture the downward trend in the service lives, the majority of the lives used to update the economic depreciation rates in the next section are 1995 to 2001 averages. Averages over the full period were used for assets with a small number of observations or in cases where the 1995 to 2001 average was inconsistent with external sources. The service lives used to update the economic depreciation rates are presented in Annex D.

Chart 6.1 Average ex-ante service lives for major asset categories (1985 to 2001)



To verify the precision of the mean service lives, the variance and the distribution of the service lives were inspected. The asset-specific distributions of the reported service lives as well as the descriptive statistics are presented in Annex C. The distributions generally follow a bell-shaped distribution with 66% of the observations within one standard deviation of the mean. The coefficient of variation for these distributions averages 40%. Although the variances are in a reasonable range for most asset categories, there are cases with higher variance. A higher variance may originate from heterogeneity within the asset categories, or from the fact that there are too few observations to generate a precise distribution around the mean service life. Among the top ten assets in each of the three major asset groups, there are three assets where the distributions suggest that heterogeneity is a concern. The distributions for *Indoor Recreational Buildings* and *Electrical Transformers, Static Converters & Inductors* are similar to a uniform distribution while that of *Aircrafts, Helicopters & Aircraft Engines* resembles an exponential distribution skewed to the left.

6.2 Final results

Updating the direct estimates to reflect more recent information on useful lives resulted in a substantial difference in only six of the 36 assets for which econometric results were available[24]. In contrast the new depreciation rates point to a widespread increase when compared to the official rates. Table 6.1 summarizes the results for major assets. A complete list of the results is presented in Annex D.

The proposed geometric depreciation rates for buildings[25] are, on average, almost triple the official rates used by *STC*. The increases are across the board with *Office Buildings* and *Shopping Centres* depreciating close to 6.0% per year and *Manufacturing Plants* depreciating at 10.0%. Although the mean service lives are relatively close to those currently used by *STC*, the estimates from this study point to an 11% residual value at the mean useful life while the official rates suggest 40%.

The depreciation rates currently used for building assets at *STC* and the *US BEA* are based on results from *H&W* (1981a, 1981b and 1996), which used a US survey on resale prices for 1972 and useful lives published by the US Department of Treasury in 1942 for capital cost deductions.[26] Despite being dated, their general findings have been replicated by Baum & McElhinney (1997) (hereafter *B&M*), who used rental costs prevailing in London, England in 1996 to estimate depreciation rates for buildings.

24. Assets where the difference in depreciation rates is more than 20% are: *Communication Towers & Antennas*, *Heating, Electrical, Plumbing, Air Conditioning & Refrigeration Equipment*, *Tractors, Motors & Generators*, *ATVs* and *Heavy Construction Equipment*.
25. This study estimates depreciation rates for non-residential buildings only. *STC* currently uses a depreciation rate of 2.0% for all residential buildings. The rate is calculated using a DBR of 1.5 and a service life of 75 years.
26. A recent report produced by the *US BLS* expressed concerns of using *H&W* building estimates. Particularly, the underlying survey year (1972) for the study do not represent the average experience as real estate prices literally exploded during the 70s. During this period, the price of buildings appreciated by 9% on average in the US, compared to a 3% average since 1981. Moreover, a regional dimension in highly volatile US real estate market may also have contaminated the data.

The *H&W* and *B&M* studies likely underestimate depreciation by ignoring the effects of improvement expenditures on the resale and rental values of buildings. They use only the resale prices in their estimation and do not account for the fact that improvements increase the value of older assets relative to newer assets. Such valuation bias will cause the age-price profile to pivot upwards, leading to depreciation rates that are decreasing with age. In this study, the valuation bias is excluded from the estimation since the price ratios account for the additional improvement expenses in the *GBV*.

To portray the importance of improvements in the value of buildings, the estimated price profile for *Office Buildings* is compared to the estimates from *H&W* and *B&M* in Chart 6.2. The retirement effects are excluded from the profiles in order to have all estimates on a common base. The price profiles from the *H&W* and *B&M* estimates level out when buildings get older and are more likely to include improvement expenses. At 40 years the estimated resale prices are both 50% of the price of a new building, while our estimates show a much faster decline with a price ratio of 15%. Since improvement expenses are minimal in the earlier years, the average of the depreciation rates estimated in the first five years of existence was used to extrapolate new price profiles for *H&W* and *B&M*. The *H&W* estimates show an average declining rate of 4.4% in the first five years while *B&M*'s estimates yield an average of 4.1%. These rates are much closer to the 4.7% rate (not corrected for retirements) estimated from this study.

Chart 6.2 Estimated price profiles for office buildings

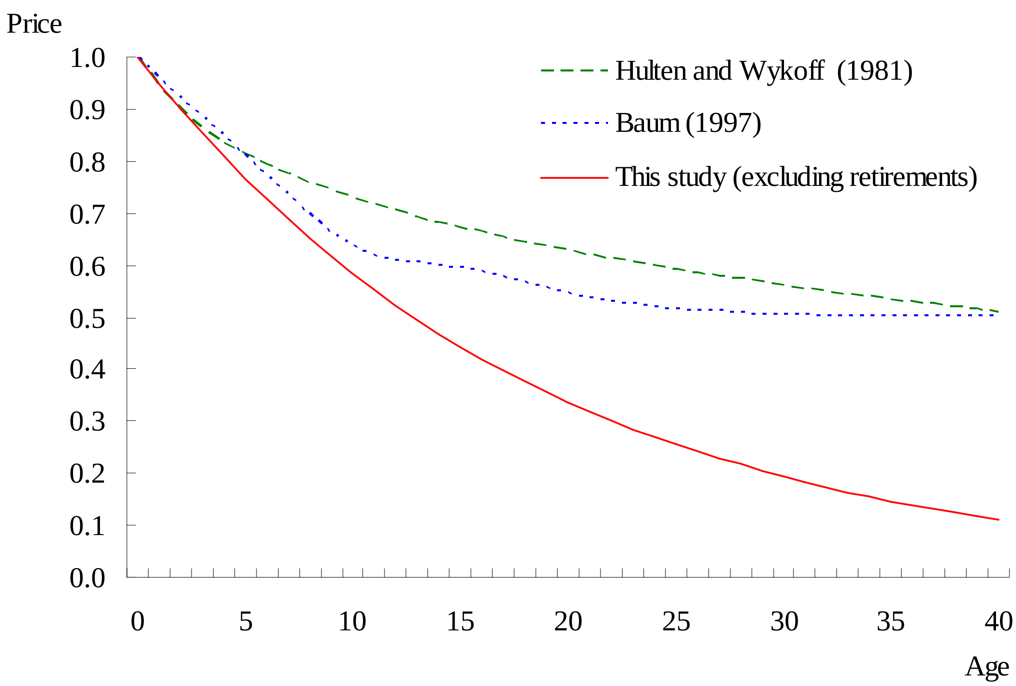


Table 6.1 Economic depreciation rates for major asset categories

	Asset codes	Depreciation rate		
		Estimated	Updated	Official
			%	
Buildings				
Office Buildings	1013	6.2	5.9	2.2
Manufacturing Plants	1001	8.7	9.9	3.0
Shopping Centers, Plazas and Stores	1016	.	6.4	2.4
Farm Buildings	1021	.	8.3	2.5
Warehouses, Refrigerated Storage and Freight Terminals	1006	6.3	6.0	2.5
Maintenance Garages, Workshops and Equipment Storage Facilities	1008	6.8	6.8	3.0
Restaurants, Fast Food Outlets, Bars and Nightclubs	1015	.	8.5	3.4
Hotels, Motels and Convention Centers	1014	.	5.5	2.2
Indoor Recreational Buildings	1019	.	6.3	2.5
Passenger Terminals - (such as air, boat, bus and rail)	2201	.	6.0	2.8
Top 10 average (representing 87% of the building capital stock)	…	7.1	7.2	2.5
Building average	…	7.1	7.3	2.6
Machinery and equipment				
Non-Computerized Production Equipment for Manufacturing	6602	17.6	20.1	9.7
Computers and Associated Hardware	6002	45.8	47.0	27.5
Computerized Production Equipment for Manufacturing	6402	17.5	21.2	11.0
Computerized Communication Equipment	6403	23.2	29.3	9.7
Automobiles and Major Replacement Parts	6201	24.7	24.7	41.3
Trucks, Vans, Truck Tractors, Truck Trailers and Major Replacement Parts	6203	21.2	28.8	23.6
Aircraft, Helicopter and Aircraft Engines	6207	.	19.4	9.7
Tractors of All Types and Other Field Equipment	6011	21.2	26.3	23.6
Office Furniture and Furnishing	6001	21.4	22.8	20.6
Electric Transformers, Static Converters and Inductors	9011	.	8.4	5.3
Top 10 average (representing 65% of the Machinery and equipment capital stock)	…	24.9	26.7	17.6
Machinery and equipment average	…	23.0	26.8	17.4
Engineering				
Production Facilities in Oil and Gas Engineering	3218	.	13.6	5.7
Development Drilling	3217	.	13.6	5.7
Production Plant - Hydraulic	2813	.	5.0	1.9
Rail track and Roadbeds	2204	.	6.2	2.3
Electrical Distribution Lines - Overhead	2816	11.4	10.3	1.9
Exploration Drilling	3216	.	13.6	5.7
Telephone and Cablevision Lines	3002	13.2	11.6	3.3
Gas Pipelines	3206	.	6.8	2.5
Electrical Transmission Lines - Overhead	2814	.	7.9	1.9
Mine site Development	3412	.	13.6	5.7
Top 10 average (representing 65% of the engineering capital stock)	…	12.3	10.5	3.9
Engineering average	…	12.1	9.8	3.6
Total average	**…**	**16.4**	**13.5**	**7.7**

. not available for any reference period
… not applicable

Moreover, the depreciation rate estimates for buildings from this study are in fact closer to the rates used by *STC* and the *US BEA* prior to adopting the *H&W* estimates. The previous depreciation rates used by *STC* for *Manufacturing Plants* and *Office Buildings* were respectively 6.9% and 5.0%, while the rates previously used by the U.S. agency for industrial and commercial buildings were 7.1% and 5.2%.[27]

Although proportionally less than for buildings, the increase in depreciation rates for M&E is substantial with the average rate increasing from 17.4% to 26.8%. Major assets with significant increases include: *Computers*, increasing from 27.5% to 47.0%, *Computerized Communication Equipment*, 9.7% to 29.3% and *Non-Computerized Production Equipment for Manufacturing*, 9.7% to 20.1%.

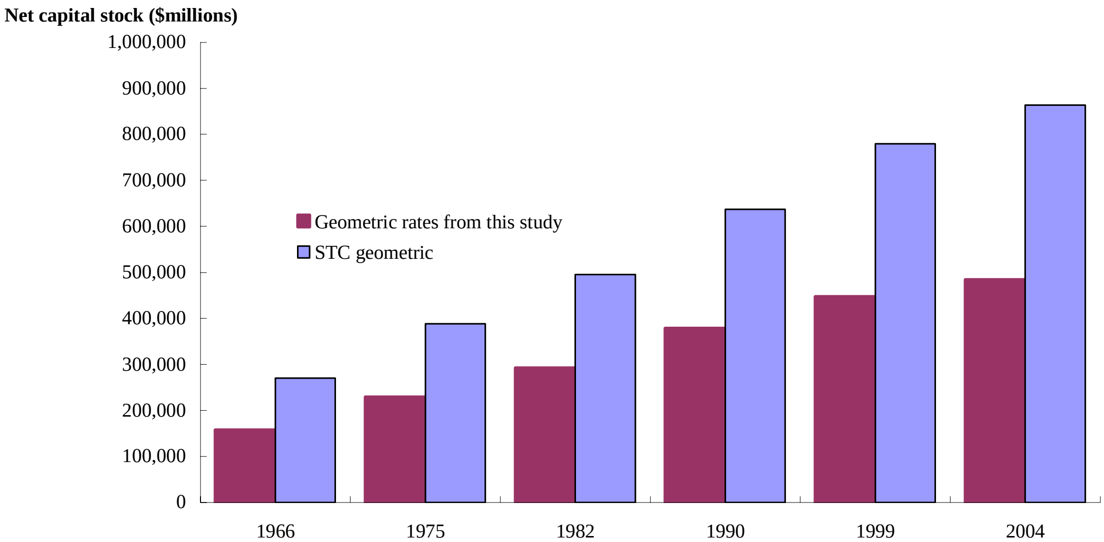
There are only 3 M&E assets experiencing declines in depreciation rates and the decline is significant only for *Automobiles* (from 41.0% to 24.7%). A strong increase in the service life for automobiles explains the lower depreciation rate. The official rate is currently based on a service life of 4 years, which corresponds to the service life reported by the leasing and financial sectors. This service life is more likely to correspond to the length of the lease rather than the actual useful life of the automobile. To capture the exit of leased automobiles from the leasing and financial sectors' capital stock, automobiles should depreciate at a pace of 24.7% until the end of the leasing period. At that point, they should be removed from the sectors' capital stock and allocated to other business sectors and to the stock held by households. The *US BEA* currently uses a similar methodology for their calculation of the automobile business stock.

The estimated rates for engineering assets increase slightly more relative to the official rates than the rates for buildings, rising from 3.6% to 9.8% on average. Again, the increase is across the board. Major increases are in electrical and communication lines.

The proposed depreciation rates impact significantly on the Canadian capital stock (Chart 6.3), reducing the business capital stock by 44% for 2004. Although year-to-year change in the capital stock is affected by the proposed estimates, the average growth rates over economic cycles are virtually unchanged (Table 6.2).

27. H&W (1981b)

Chart 6.3 Impact of depreciation rates on the non-residential capital stock of business sectors assets[1] (constant dollars)



1. Excludes the Mining and Oil & Gas sectors and government enterprises.

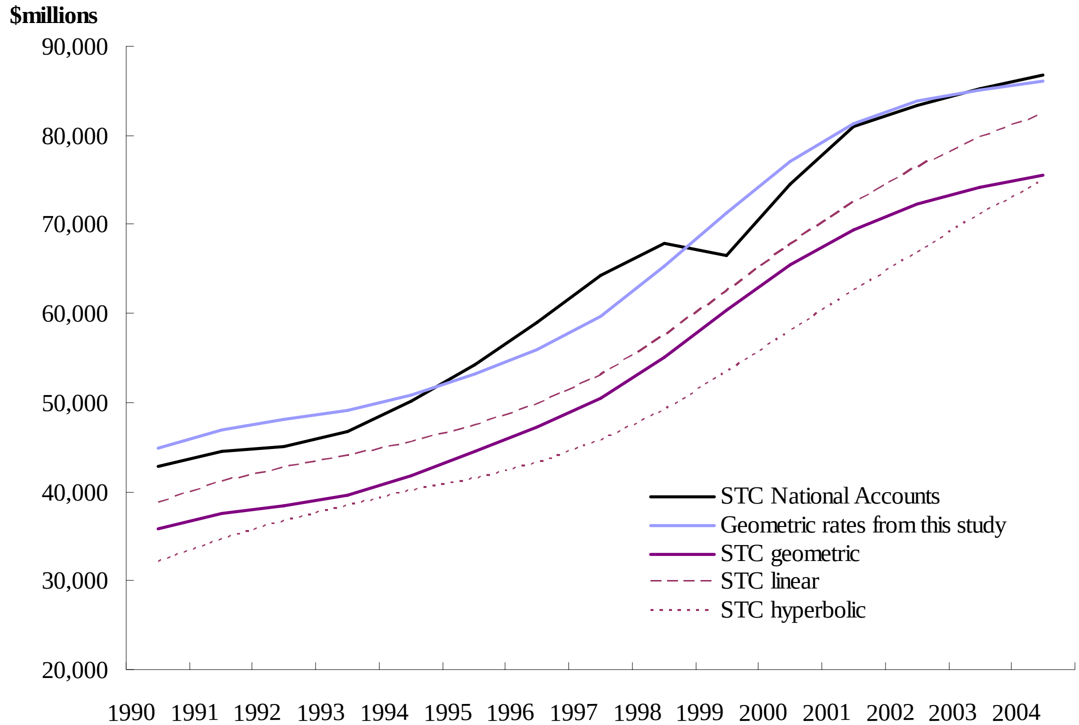
Table 6.2 Average growth rates of non-residential capital stock[1] by business cycle (1966 to 2004)

	1966 to 1974	1975 to 1981	1982 to 1989	1990 to 1999	1999 to 2004
			%		
STC geometric	4.2	3.9	3.0	2.4	2.4
Geometric rates from this study	4.5	4.1	3.0	2.1	2.1

1. Excludes the Mining and Oil & Gas sectors and government enterprises.

External data on depreciation allowances provide support for the new stock levels. The System of National Accounts Branch at *STC* currently uses data from a quarterly survey on accounting depreciation in Canada for their measurement of depreciation allowances. As can be seen in Chart 6.4, the depreciation allowances resulting from the new depreciation rates are very close to the surveyed depreciation allowances. The absolute deviation of the calculated from the surveyed series averages 3.6% for the last fifteen years. In contrast, the depreciation series generated from the official geometric rates is well below the surveyed depreciation allowances. The average deviation for this series is 15.4% for the same time frame. Among the three measures of depreciation currently used at *STC* (geometric, linear, and hyperbolic), the linear depreciation fairs best with an average deviation at 10%.

Chart 6.4 Impact of depreciation rates on the non-residential depreciation of business sector assets[1] (original-cost dollars)



1. Excludes the Mining and Oil & Gas sectors and government enterprises.

7 Conclusion

This study provides detailed information on depreciation patterns and retirement distributions for a comprehensive set of assets. Using a standard estimation framework and a rich micro database on the disposal of used assets and ex-ante surveyed service lives, depreciation rates for 155 assets are calculated.

The results indicate that the current official rates used at *STC* are substantially underestimated, particularly for buildings and engineering structures. External data on accounting depreciation allowances used in the national income and expenditure accounts at *STC* support the evidence put forward. Based on these results, the Investment and Capital Stock Division of Statistics Canada introduced these new rates of depreciation in the release of the Gross Fixed Assets (non-residential), available on CANSIM: table 031-002, in December 2006.

The relatively high depreciation rates for buildings are an unexpected finding. The estimates are almost three times the official rates. A valuation bias in the transaction prices of older buildings caused by accumulated improvements is likely responsible for the underestimation of depreciation rates in the literature. Interestingly, the estimated depreciation rates for buildings are very close to the rates used at *STC* and the *US BEA* prior to adopting the *H&W* estimates.

Another important finding from the study is that the empirical estimates for retirements are generally quite similar to the expected service lives reported in the *CES* for the majority of assets. This finding validates the use of survey data on expected service lives to calibrate depreciation rates for assets where econometric estimates are unavailable.

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Annex A: Data issues

A.1 Outlier identification strategy

Although some quality controls are performed on the data, responses in the disposal database are subject to less rigorous quality inspections than responses in the expected service life database. The disposal data is therefore filtered through an outlier identification process to eliminate extreme values of *GBV*, *SV* and age. The outliers are detected in a 6-step identification process.

In a first step, the extreme values of price ratios and gross book value are filtered out for surviving observations ($P_s > 0$). We systematically scan each age cohort and identify observations where the price ratio and its corresponding gross book value are both in either the first or last percentile. A total of 267 outliers are identified under this process, representing 0.8% of the initial database.

Similarly, we identify outliers for large *GBV* in the discards ($P_s = 0$). Contrary to the previous step, this process is not carried out by age cohort but across all retirement ages. Step 2 eliminates 344 observations or 1% of the initial database.

The third procedure identifies extreme values of *GBV* and price ratios that were missed by the first two processes. The outliers are detected using standard graphical inspection of the data and a sensitivity analysis assessing the impact of the extreme values on the estimates. This step purges 601 observations, representing 1.8% of the initial database.

The fourth step identifies abnormally low price ratios for relatively young buildings. These outliers may be the result of inaccurate responses, data capture errors or assets that were sold in the early years of life due to a poor business decision, a natural disaster or changes in the economic environment that resulted in “stranded capital”. To eliminate these observations, we systematically take out the observations that are below a convex beta curve extending from age 0 to a minimum life corresponding to a third of the mean service life. Overall this filter process takes out 51 observations or 0.2% of the initial database.

The fifth outlier filter binds the data to a maximum life. Some observations have unusually old age and might affect the depreciation rates by extending the age-price profile or affecting retirement estimates. To avoid this sort of bias in the estimates we limit the age of assets to 3 times the average surveyed service life. We eliminate 885 observations with this filter, representing 2.7% of the initial database.

The leasing and financial sectors report zero values for autos at the end of the leasing period, which is typically three or four years in the business sector. Given that autos last substantially longer in other business sectors, we have removed the data reported by the leasing and financing sectors. This last step accounts for 757 observations or 2.3% of the raw database.

Overall, the outlier identification process drops 8.8% of the initial database.

Table A.1 Observations and outliers for the disposal database

	Asset code	Initial database	Outliers in transactions	Outliers in discards	Additional outliers	Building filter
				number		
Manufacturing Plants	1001	1071	17	14	11	12
Warehouses, Refrigerated Storage and Freight Terminals	1006	379	10	6	9	6
Maintenance Garages, Workshops and Equipment Storage Facilities	1008	213	1	2	21	2
Office Buildings	1013	898	12	7	76	29
Other Industrial and Commercial Buildings	1099	229	6	3	23	2
Electrical Distribution Lines - Overhead	2816	103	1	2	0	0
Broadcasting and Communication Buildings	3001	92	4	1	4	0
Telephone and Cablevision Lines	3002	223	4	4	9	0
Communication Towers and Antennas	3003	170	5	1	9	0
Office Furniture and Furnishing	6001	3504	15	44	4	0
Computers and Associated Hardware	6002	3367	8	42	5	0
Non-Office Furniture, Furnishings and Fixtures	6003	911	6	10	0	0
Scientific, Professional and Medical Devices	6004	615	15	8	2	0
Heating, Electrical, Plumbing, Air Conditioning and Refrigeration Equipment	6005	467	10	10	28	0
Pollution Abatement and Control Equipment	6006	122	0	2	3	0
Safety and Security Equipment	6007	98	4	4	0	0
Motors, Generators, Transformers, Turbines, Compressors and Pumps	6009	735	18	10	7	0
Heavy Construction Equipment	6010	715	4	5	52	0
Tractors of All Types and Other Field Equipment	6011	495	5	4	0	0
Capitalized Tooling and Other Tools	6012	943	16	13	26	0
Drilling and Blasting Equipment	6013	165	0	2	9	0
Underground Load, Haulage and Dump Equipment (such as slusher and muck cars)	6028	192	7	4	16	0
Automobiles and Major Replacement Parts	6201	3004	8	11	1	0
Buses and Major Replacement Parts	6202	254	5	2	13	0
Trucks, Vans, Truck Tractors, Truck Trailers and Major Replacement Parts	6203	4228	8	25	0	0
All - Terrain Vehicles and Major Replacement Parts	6204	185	6	2	14	0
Locomotives, Rolling Stock, Street/Subway Cars, Other Rapid Transit and Major Parts	6205	273	4	4	18	0
Ships and Boats	6206	129	1	2	2	0
Other Transportation Equipment	6299	251	2	4	13	0
Computerized Material Handling Equipment	6401	152	4	2	5	0
Computerized Production Equipment for Manufacturing	6402	1086	8	12	28	0
Computerized Communication Equipment	6403	633	15	12	10	0
Non-Computerized Material Handling Equipment	6601	1481	10	13	27	0
Non-Computerized Production Equipment for Manufacturing	6602	3904	9	34	139	0
Non-Computerized Communication Equipment	6603	701	9	11	0	0
Other Machinery and Equipment (not specified elsewhere)	8999	1145	10	12	17	0
Total	**…**	**33133**	**267**	**344**	**601**	**51**

… not applicable

Table A.1 Observations an outliers for the disposal database (continued)

	Asset code	Maximum life	Outliers automobiles	Final database	Retirement observations	Price observations
				number		
Manufacturing Plants	1001	1	0	1016	683	333
Warehouses, Refrigerated Storage and Freight Terminals	1006	0	0	348	193	155
Maintenance Garages, Workshops and Equipment Storage Facilities	1008	1	0	186	100	86
Office Buildings	1013	0	0	774	368	406
Other Industrial and Commercial Buildings	1099	0	0	195	100	95
Electrical Distribution Lines - Overhead	2816	0	0	100	57	43
Broadcasting and Communication Buildings	3001	0	0	83	63	20
Telephone and Cablevision Lines	3002	0	0	206	118	88
Communication Towers and Antennas	3003	1	0	154	84	70
Office Furniture and Furnishing	6001	96	0	3345	2012	1333
Computers and Associated Hardware	6002	382	0	2930	1724	1206
Non-Office Furniture, Furnishings and Fixtures	6003	12	0	883	418	465
Scientific, Professional and Medical Devices	6004	20	0	570	360	210
Heating, Electrical, Plumbing, Air Conditioning and Refrigeration Equipment	6005	11	0	408	283	125
Pollution Abatement and Control Equipment	6006	1	0	116	94	22
Safety and Security Equipment	6007	2	0	88	76	12
Motors, Generators, Transformers, Turbines, Compressors and Pumps	6009	7	0	693	385	308
Heavy Construction Equipment	6010	27	0	627	82	545
Tractors of All Types and Other Field Equipment	6011	9	0	477	109	368
Capitalized Tooling and Other Tools	6012	57	0	831	468	363
Drilling and Blasting Equipment	6013	1	0	153	41	112
Underground Load, Haulage and Dump Equipment (such as slusher and muck cars)	6028	4	0	161	87	74
Automobiles and Major Replacement Parts	6201	13	757	2214	392	1822
Buses and Major Replacement Parts	6202	0	0	234	38	196
Trucks, Vans, Truck Tractors, Truck Trailers and Major Replacement Parts	6203	95	0	4100	960	3140
All - Terrain Vehicles and Major Replacement Parts	6204	27	0	136	45	91
Locomotives, Rolling Stock, Street/Subway Cars, Other Rapid Transit and Major Parts	6205	0	0	247	86	161
Ships and Boats	6206	1	0	123	29	94
Other Transportation Equipment	6299	3	0	229	86	143
Computerized Material Handling Equipment	6401	3	0	138	88	50
Computerized Production Equipment for Manufacturing	6402	14	0	1024	514	510
Computerized Communication Equipment	6403	10	0	586	365	221
Non-Computerized Material Handling Equipment	6601	25	0	1406	494	912
Non-Computerized Production Equipment for Manufacturing	6602	34	0	3688	1560	2128
Non-Computerized Communication Equipment	6603	12	0	669	380	289
Other Machinery and Equipment (not specified elsewhere)	8999	16	0	1090	465	625
Total	**…**	**885**	**757**	**30228**	**13407**	**16821**

… not applicable

A.2 Accounting for the timing of improvements in buildings

A key data issue for buildings is accounting for the value of improvements in the calculation of the price ratios. The value of improvements is necessarily embedded in the selling price as improvements enhance or maintain the quality of buildings. In order to have an accurate measure of the loss in capital invested in the building, the additional investments for improvements are also accounted for in the denominator or *GBV*.

Since improvements occur over the life of the asset, the nominal value of the improvements reported in the *GBV* should be deflated accordingly. The value of improvements is not separately identified in the disposal database, making it difficult to accurately deflate the *GBV*. To circumvent this problem, assumptions about the importance and timing of renovations are made to separate improvements expenses from the *GBV* and to deflate them over the appropriate period.

The assumptions on the importance of improvements are developed from data on renovation expenditures by detailed asset categories collected by the *CES* in the 1990s. According to the survey, the share of improvement expenditures in total investment for most buildings was stable at 20% from 1992 to 1997. Data from the US Census Bureau suggest a higher share, with improvements representing close to 40% of total investment in 1994.

A technical report prepared by Deloitte & Touche (2000) also raised the importance of improvements in the measurement of depreciation. Using survey data from property owners, they provided evidence on the timing and importance of renovations in total capital expenditure in buildings. According to the survey, renovation expenses for office buildings amount to approximately 30% of total capital expenses incurred over the lifetime, with the improvements distribution approaching a normal distribution centred on the 16 to 20 age interval.[28] This last piece of information is used to develop assumptions about the timing of improvements.

To summarize, the value of improvements is separated from the *GBV* using asset specific shares for improvements from the *CES* and a normal distribution of improvements centered between the mean useful life and a minimum life corresponding to a third of the useful life. Once the initial purchase price and cumulated improvements are separated, they are deflated from their proper event and then added back together. Therefore, equation 3.1.1 for building assets becomes:

A.1 $$P_i^s = \frac{SV_i^{t+s}}{\dfrac{IP_i^t}{Px_i^t} + \sum_{\tau=\frac{L}{3}}^{max\, s=L} \dfrac{IV^{t+\tau}}{Px_i^{t+\tau}}} \quad ,$$

where IP_i^t is the initial purchase price in year t and $IV^{t+\tau}$ are improvements occurring between a minimum life (*L/3*) and the mean useful life (*L*).

28. The study also presents depreciation rate estimates for buildings, but the authors do not correct for the valuation bias. The depreciation rate estimate for office building is 3.5%, not taking into account retirements.

Table A.2 Importance of improvement investment in total investment

Assets	CES[1] 1992 to1997 Average	U.S. Census[1] 1994	Deloitte & Touche LLP[2] 1999
		%	
Industrial buildings	.	.	57
Plants for manufacturing	8.9	.	.
Warehouses	14.4	.	.
Garages	16.7	.	.
Other industrial buildings	19.9	.	.
Office buildings	22.6	.	31
Retail buildings	19.6	.	18
Total all buildings	.	39.0	.

. not available for any reference period

1. CES = Capital Expenditure Survey. Share of renovation in total investment expenditure.
2. Calculations are based cumulated nominal investment over the life of a building.

A.3 Sensitivity analysis of assumptions

This section assesses the impact of selected assumptions adopted in this paper. They are: the procedure used to deflate the value of improvements to buildings discussed in Section A.2, the correction for digit preference and the correction for scrap value. Table A.3 presents the results for the depreciation rates and the average service lives when these assumptions are dropped from the estimation framework.

The assumption adopted to deflate improvements affects the level of the *GBV*, and consequently the price ratios and the weights in both the price and retirement estimations. Adopting a simpler procedure, which consists of deflating all of the value of the *GBV* from the purchase year, has practically no impact on the estimates. On average, depreciation rates for buildings increase by 4.1%, from 7.2% to 7.5%, while the average useful life is up by 3.0% (or 8 months). *Manufacturing Plants* and *Broadcasting & Communication Buildings* experience the largest increase in estimated depreciation rates, increasing by 7.0% and 8.8% respectively.

The impact of removing the correction for digit preference is difficult to predict as the data in age-heaping digits are randomly distributed to ages adjacent to the 5-year multiples. Results excluding this correction indicate that it has little impact on the estimates, lowering the average depreciation rate by 2.2%, from 16.5% to 16.2%. The average service life increases by 2.6% (or 2 months). Significant changes in depreciation rates are however noted in *Communication Towers & Antennas* and *Ships & Boats* where the depreciation rates vary by 20% compared to the base estimates.

Relaxing the assumption on modeling assets sold for scrap as retirements also has a small impact on the estimates. For the majority of assets (32 of the 36 assets), there is a reduction in the service life when the assumption is dropped (7.6% or 1.5 years on average). The average age of assets assumed to be sold for scrap is therefore greater than the average useful life calculated using retirements only. The drop in the average useful life increases the average depreciation rate by 4.7%, from 16.5% to 17.3%. Important increases are noted for *Computerized Material Handling Equipment* and *Scientific, Professional & Medical Devices* where depreciation rates increased by 30% and 23% respectively.

Table A.3 Sensitivity analysis of assumptions on estimates

	Asset code	Economic depreciation rates: Base estimates	Excluding renovation adjustment	Excluding correction for digit preference	Excluding scrap value adjustment
		%			
Buildings					
Manufacturing Plants	1001	8.4	9.0	8.5	9.1
Warehouses, Refrigerated Storage and Freight Terminals	1006	6.4	6.5	6.4	7.0
Maintenance Garages, Workshops and Equipment Storage Facilities	1008	6.9	7.0	6.9	7.6
Office Buildings	1013	6.4	6.5	6.2	6.1
Other Industrial and Commercial Buildings	1099	8.4	8.2	7.9	7.6
Broadcasting and Communication Buildings	3001	8.3	9.1	8.6	7.3
Building average	…	7.2	7.5	7.1	7.3
Machinery and equipment					
Office Furniture and Furnishing	6001	21.7	21.7	21.7	23.1
Computers and Associated Hardware	6002	46.0	46.0	45.8	47.7
Non-Office Furniture, Furnishings and Fixtures	6003	20.8	20.8	19.4	21.9
Scientific, Professional and Medical Devices	6004	19.3	19.3	18.9	23.7
Heating, Electrical, Plumbing, Air Conditioning and Refrigeration Equipment	6005	17.4	17.4	17.5	19.8
Pollution Abatement and Control Equipment	6006	11.6	11.6	11.5	11.7
Safety and Security Equipment	6007	15.7	15.7	15.5	15.6
Motors, Generators, Transformers, Turbines, Compressors and Pumps	6009	14.9	14.9	15.1	15.6
Heavy Construction Equipment	6010	17.4	17.4	15.4	17.3
Tractors of All Types and Other Field Equipment	6011	20.0	20.0	19.3	22.2
Capitalized Tooling and Other Tools	6012	25.2	25.2	22.6	23.1
Drilling and Blasting Equipment	6013	17.8	17.8	15.8	19.8
Underground Load, Haulage and Dump Equipment (such as slusher and muck cars)	6028	16.5	16.5	16.4	16.9
Automobiles and Major Replacement Parts	6201	26.3	26.3	25.0	29.0
Buses and Major Replacement Parts	6202	21.3	21.3	20.2	20.8
Trucks, Vans, Truck Tractors, Truck Trailers and Major Replacement Parts	6203	23.9	23.9	22.2	23.7
All - Terrain Vehicles and Major Replacement Parts	6204	18.4	18.4	16.3	20.2
Locomotives, Rolling Stock, Street/Subway Cars, Other Rapid Transit and Major Parts	6205	14.2	14.2	14.1	16.0
Ships and Boats	6206	10.6	10.6	8.5	10.0
Other Transportation Equipment	6299	29.3	29.3	26.3	27.7
Computerized Material Handling Equipment	6401	16.2	16.2	16.2	20.9
Computerized Production Equipment for Manufacturing	6402	17.5	17.5	16.5	18.2
Computerized Communication Equipment	6403	23.3	23.3	23.2	24.0
Non-Computerized Material Handling Equipment	6601	20.6	20.6	19.4	20.5
Non-Computerized Production Equipment for Manufacturing	6602	16.8	16.8	16.7	18.0
Non-Computerized Communication Equipment	6603	20.6	20.6	20.3	19.7
Other Machinery and Equipment (not specified elsewhere)	8999	19.7	19.7	20.0	22.1
Machinery and equipment Average	…	23.2	23.2	22.6	24.3
Machinery and equipment average - excluding computers	…	19.8	19.8	19.1	20.8
Engineering					
Electrical Distribution Lines - Overhead	2816	10.8	10.8	10.6	11.4
Telephone and Cablevision Lines	3002	13.8	13.8	13.9	15.7
Communication Towers and Antennas	3003	11.3	11.3	13.5	10.9
Engineering average	…	12.2	12.2	12.3	13.3
Total assets	**…**	**16.5**	**16.6**	**16.2**	**17.3**
Total assets - excluding computers	**…**	**14.2**	**14.4**	**13.9**	**14.9**

… not applicable

Table A.3 Sensitivity analysis of assumptions on estimates (continued)

	Asset code	Service lives: Base estimates	Service lives: Excluding renovation adjustment	Service lives: Excluding correction for digit preference	Service lives: Excluding scrap value adjustment
		number			
Buildings					
Manufacturing Plants	1001	28.7	28.8	28.1	26.6
Warehouses, Refrigerated Storage and Freight Terminals	1006	30.1	30.7	28.0	25.1
Maintenance Garages, Workshops and Equipment Storage Facilities	1008	28.1	28.7	28.1	24.1
Office Buildings	1013	31.6	33.3	31.7	31.7
Other Industrial and Commercial Buildings	1099	20.9	21.2	20.8	21.9
Broadcasting and Communication Buildings	3001	30.0	30.2	26.3	29.6
Building average	…	30.1	31.0	29.6	28.8
Machinery and equipment					
Office Furniture and Furnishing	6001	8.9	8.9	8.9	7.6
Computers and Associated Hardware	6002	4.8	4.8	4.7	4.2
Non-Office Furniture, Furnishings and Fixtures	6003	8.8	8.8	9.5	8.9
Scientific, Professional and Medical Devices	6004	9.7	9.7	9.6	6.3
Heating, Electrical, Plumbing, Air Conditioning and Refrigeration Equipment	6005	15.2	15.2	15.2	11.5
Pollution Abatement and Control Equipment	6006	17.1	17.1	16.2	16.5
Safety and Security Equipment	6007	11.4	11.4	11.3	11.2
Motors, Generators, Transformers, Turbines, Compressors and Pumps	6009	19.3	19.3	19.2	17.3
Heavy Construction Equipment	6010	14.2	14.2	14.8	10.4
Tractors of All Types and Other Field Equipment	6011	12.1	12.1	12.4	10.5
Capitalized Tooling and Other Tools	6012	9.9	9.9	10.9	9.4
Drilling and Blasting Equipment	6013	12.5	12.5	17.1	9.8
Underground Load, Haulage and Dump Equipment (such as slusher and muck cars)	6028	11.9	11.9	13.2	11.3
Automobiles and Major Replacement Parts	6201	7.1	7.1	7.1	5.3
Buses and Major Replacement Parts	6202	16.6	16.6	17.3	14.8
Trucks, Vans, Truck Tractors, Truck Trailers and Major Replacement Parts	6203	10.1	10.1	9.2	8.2
All - Terrain Vehicles and Major Replacement Parts	6204	10.5	10.5	14.6	8.5
Locomotives, Rolling Stock, Street/Subway Cars, Other Rapid Transit and Major Parts	6205	24.3	24.3	28.6	20.5
Ships and Boats	6206	24.8	24.8	31.2	20.7
Other Transportation Equipment	6299	12.8	12.8	14.5	11.9
Computerized Material Handling Equipment	6401	12.9	12.9	12.9	8.8
Computerized Production Equipment for Manufacturing	6402	15.4	15.4	20.9	13.8
Computerized Communication Equipment	6403	12.3	12.3	11.0	11.2
Non-Computerized Material Handling Equipment	6601	13.9	13.9	13.8	12.4
Non-Computerized Production Equipment for Manufacturing	6602	16.2	16.2	17.6	15.1
Non-Computerized Communication Equipment	6603	11.4	11.4	11.5	11.4
Other Machinery and Equipment (not specified elsewhere)	8999	11.9	11.9	11.5	10.7
Machinery and equipment Average	…	12.1	12.1	13.1	10.7
Machinery and equipment average - excluding computers	…	13.3	13.3	14.4	11.7
Engineering					
Electrical Distribution Lines - Overhead	2816	29.4	29.4	28.2	28.4
Telephone and Cablevision Lines	3002	17.9	17.9	18.4	13.3
Communication Towers and Antennas	3003	21.5	21.5	12.9	19.6
Engineering average	…	23.7	23.7	22.7	21.1
Total assets	**…**	**19.5**	**19.8**	**19.8**	**18.0**
Total assets - excluding computers	**…**	**20.7**	**21.0**	**21.0**	**19.1**

… not applicable

Annex B: Fit statistics for estimated, geometric and linear profiles

Table B.1 Fit statistics for estimated, geometric and linear profiles

		Residual value at end of each quarter of service life				Average absolute deviation[1] in each quarter of service life				
	Asset codes	1st quarter	2nd quarter	3rd quarter	4th quarter (service life)	1st quarter	2nd quarter	3rd quarter	4th quarter	Total
		number				%				
Structures										
Manufacturing Plants										
Estimate	1001	0.50	0.30	0.17	0.09	…	…	…	…	…
Geometric approximation	1001	0.53	0.28	0.15	0.08	6.2	1.0	2.1	1.6	3.7
Linear approximation	1001	0.59	0.18	0.00	0.00	11.4	5.2	18.9	12.3	10.6
Warehouses, Refrigerated Storage and Freight Terminals										
Estimate	1006	0.73	0.41	0.22	0.09	…	…	…	…	…
Geometric approximation	1006	0.63	0.38	0.24	0.14	8.7	6.9	1.4	3.9	5.7
Linear approximation	1006	0.73	0.42	0.15	0.00	1.4	1.2	2.4	11.1	3.0
Maintenance Garages, Workshops and Equipment Storage Facilities										
Estimate	1008	0.68	0.42	0.22	0.10	…	…	…	…	…
Geometric approximation	1008	0.61	0.38	0.23	0.14	4.8	5.8	1.9	2.6	4.2
Linear approximation	1008	0.71	0.41	0.12	0.00	2.0	1.7	5.3	13.3	4.3
Office Buildings	1013									
Estimate	1013	0.68	0.42	0.23	0.11	…	…	…	…	…
Geometric approximation	1013	0.64	0.38	0.23	0.14	2.3	4.1	1.7	1.4	2.7
Linear approximation	1013	0.73	0.41	0.10	0.00	3.6	2.6	6.8	15.2	5.5
Other Industrial and Commercial Buildings	1099									
Estimate	1099	0.73	0.50	0.31	0.17	…	…	…	…	…
Geometric approximation	1099	0.66	0.44	0.29	0.19	4.5	6.4	3.3	1.1	4.2
Linear approximation	1099	0.75	0.51	0.26	0.02	1.9	2.0	1.9	10.3	4.1
Electrical Distribution Lines - Overhead	2816									
Estimate	2816	0.43	0.19	0.07	0.02	…	…	…	…	…
Geometric approximation	2816	0.43	0.18	0.07	0.03	1.1	0.7	0.5	0.5	0.9
Linear approximation	2816	0.45	0.00	0.00	0.00	6.2	11.2	12.3	4.2	8.0
Broadcasting and Communication Buildings	3001									
Estimate	3001	0.73	0.39	0.13	0.04	…	…	…	…	…
Geometric approximation	3001	0.59	0.35	0.19	0.11	12.4	8.6	2.7	7.3	8.0
Linear approximation	3001	0.71	0.41	0.07	0.00	3.3	1.4	2.2	7.0	2.7
Telephone and Cablevision Lines	3002									
Estimate	3002	0.66	0.34	0.11	0.04	…	…	…	…	…
Geometric approximation	3002	0.57	0.32	0.16	0.09	9.5	5.1	2.5	5.5	6.0
Linear approximation	3002	0.67	0.34	0.00	0.00	1.2	1.1	7.3	6.2	3.0
Communication Towers and Antennas	3003									
Estimate	3003	0.61	0.37	0.18	0.08	…	…	…	…	…
Geometric approximation	3003	0.59	0.34	0.18	0.11	1.2	2.9	1.3	1.6	1.8
Linear approximation	3003	0.67	0.34	0.00	0.00	5.4	2.8	12.2	12.0	6.6
Machinery and equipment										
Office Furniture and Furnishing	6001									
Estimate	6001	0.63	0.41	0.25	0.14	…	…	…	…	…
Geometric approximation	6001	0.62	0.38	0.24	0.15	1.1	2.7	2.1	0.6	1.7
Linear approximation	6001	0.71	0.42	0.13	0.00	8.2	3.4	8.3	16.6	7.8

… not applicable

Table B.1 Fit statistics for estimated, geometric and linear profiles (continued)

	Asset codes	Residual value at end of each quarter of service life: 1st quarter	2nd quarter	3rd quarter	4th quarter (service life)	Average absolute deviation[1] in each quarter of service life: 1st quarter	2nd quarter	3rd quarter	4th quarter	Total
		number				%				
Computers and Associated Hardware	6002									
Estimate	6002	0.49	0.31	0.19	0.11	…	…	…	…	…
Geometric approximation	6002	0.54	0.29	0.16	0.09	5.5	1.3	3.2	2.3	3.7
Linear approximation	6002	0.61	0.21	0.00	0.00	11.9	9.5	19.1	10.9	11.4
Non-Office Furniture, Furnishings and Fixtures	6003									
Estimate	6003	0.62	0.42	0.26	0.15	…	…	…	…	…
Geometric approximation	6003	0.62	0.39	0.24	0.15	2.0	2.4	2.6	0.6	2.0
Linear approximation	6003	0.71	0.43	0.14	0.00	9.5	3.5	8.7	17.9	8.7
Scientific, Professional and Medical Devices	6004									
Estimate	6004	0.74	0.48	0.21	0.11	…	…	…	…	…
Geometric approximation	6004	0.66	0.43	0.23	0.15	8.1	6.4	1.5	3.7	5.0
Linear approximation	6004	0.75	0.50	0.12	0.00	0.7	1.6	3.5	13.5	3.5
Heating, Electrical, Plumbing, Air Conditioning and Refrigeration Equipment	6005									
Estimate	6005	0.54	0.25	0.11	0.04	…	…	…	…	…
Geometric approximation	6005	0.54	0.24	0.11	0.05	2.3	0.7	0.8	0.2	1.4
Linear approximation	6005	0.62	0.11	0.00	0.00	8.9	6.0	16.5	6.9	8.8
Pollution Abatement and Control Equipment	6006									
Estimate	6006	0.73	0.42	0.19	0.06	…	…	…	…	…
Geometric approximation	6006	0.61	0.37	0.23	0.12	11.0	7.8	1.7	5.6	6.9
Linear approximation	6006	0.72	0.43	0.15	0.00	2.4	1.1	1.7	8.6	2.7
Safety and Security Equipment	6007									
Estimate	6007	0.79	0.48	0.26	0.13	…	…	…	…	…
Geometric approximation	6007	0.72	0.43	0.26	0.16	6.4	5.8	1.4	2.4	4.3
Linear approximation	6007	0.80	0.50	0.20	0.00	0.7	2.3	2.7	13.2	3.9
Motors, Generators, Transformers, Turbines, Compressors and Pumps	6009									
Estimate	6009	0.53	0.24	0.10	0.04	…	…	…	…	…
Geometric approximation	6009	0.52	0.23	0.10	0.05	0.7	0.9	0.3	0.8	0.7
Linear approximation	6009	0.58	0.06	0.00	0.00	6.4	7.0	15.4	6.0	7.7
Heavy Construction Equipment	6010									
Estimate	6010	0.68	0.33	0.16	0.05	…	…	…	…	…
Geometric approximation	6010	0.61	0.31	0.19	0.10	6.7	4.5	1.2	4.2	4.6
Linear approximation	6010	0.70	0.31	0.01	0.00	1.3	1.8	10.2	9.0	3.9
Tractors of All Types and Other Field Equipment	6011									
Estimate	6011	0.46	0.26	0.14	0.07	…	…	…	…	…
Geometric approximation	6011	0.49	0.24	0.12	0.06	6.6	1.2	2.5	1.6	4.2
Linear approximation	6011	0.55	0.09	0.00	0.00	12.9	7.6	18.1	9.2	11.6
Capitalized Tooling and Other Tools	6012									
Estimate	6012	0.62	0.38	0.16	0.08	…	…	…	…	…
Geometric approximation	6012	0.60	0.36	0.17	0.10	1.7	1.9	0.5	1.4	1.5
Linear approximation	6012	0.68	0.36	0.00	0.00	5.3	2.6	13.7	10.3	6.7

… not applicable

Table B.1 Fit statistics for estimated, geometric and linear profiles (continued)

	Asset codes	Residual value at end of each quarter of service life: 1st quarter	2nd quarter	3rd quarter	4th quarter (service life)	Average absolute deviation[1] in each quarter of service life: 1st quarter	2nd quarter	3rd quarter	4th quarter	Total
		number				%				
Drilling and Blasting Equipment	6013									
Estimate	6013	0.59	0.34	0.18	0.08	…	…	…	…	…
Geometric approximation	6013	0.56	0.32	0.18	0.10	1.0	2.3	0.8	1.4	1.4
Linear approximation	6013	0.64	0.29	0.00	0.00	6.0	2.8	14.8	11.3	7.0
Underground Load, Haulage and Dump Equipment (such as slusher and muck cars)	6028									
Estimate	6028	0.72	0.43	0.24	0.12	…	…	…	…	…
Geometric approximation	6028	0.69	0.40	0.23	0.14	1.4	3.0	1.4	1.0	1.9
Linear approximation	6028	0.77	0.43	0.09	0.00	5.0	2.9	8.8	15.7	6.4
Automobiles and Major Replacement Parts	6201									
Estimate	6201	0.70	0.44	0.26	0.14	…	…	…	…	…
Geometric approximation	6201	0.75	0.43	0.24	0.14	5.0	1.2	2.4	1.0	2.6
Linear approximation	6201	0.83	0.48	0.13	0.00	12.3	6.8	8.5	17.2	10.0
Buses and Major Replacement Parts	6202									
Estimate	6202	0.40	0.17	0.07	0.02	…	…	…	…	…
Geometric approximation	6202	0.40	0.16	0.07	0.03	2.0	0.8	0.9	0.2	1.5
Linear approximation	6202	0.42	0.00	0.00	0.00	7.5	13.5	10.9	4.1	8.9
Trucks, Vans, Truck Tractors, Truck Trailers and Major Replacement Parts	6203									
Estimate	6203	0.59	0.32	0.20	0.09	…	…	…	…	…
Geometric approximation	6203	0.62	0.30	0.19	0.09	4.3	1.0	1.8	0.7	2.4
Linear approximation	6203	0.70	0.26	0.00	0.00	11.3	4.9	17.4	13.0	9.8
All - Terrain Vehicles and Major Replacement Parts	6204									
Estimate	6204	0.74	0.42	0.27	0.10	…	…	…	…	…
Geometric approximation	6204	0.68	0.38	0.26	0.14	5.5	5.9	2.1	2.5	4.6
Linear approximation	6204	0.77	0.43	0.20	0.00	2.4	2.1	4.6	12.1	4.4
Locomotives, Rolling Stock, Street/Subway Cars, Other Rapid Transit and Major Parts	6205									
Estimate	6205	0.36	0.17	0.08	0.03	…	…	…	…	…
Geometric approximation	6205	0.37	0.14	0.05	0.02	5.8	1.5	2.9	1.5	4.4
Linear approximation	6205	0.33	0.00	0.00	0.00	9.8	17.5	11.3	4.6	11.0
Ships and Boats	6206									
Estimate	6206	0.59	0.34	0.18	0.08	…	…	…	…	…
Geometric approximation	6206	0.57	0.32	0.18	0.10	1.5	2.4	0.7	1.5	1.7
Linear approximation	6206	0.64	0.29	0.00	0.00	4.7	2.8	13.9	12.0	6.3
Other Transportation Equipment	6299									
Estimate	6299	0.35	0.20	0.12	0.07	…	…	…	…	…
Geometric approximation	6299	0.39	0.15	0.06	0.02	14.3	2.7	6.0	5.0	10.7
Linear approximation	6299	0.33	0.00	0.00	0.00	17.6	20.7	14.7	8.3	16.5
Computerized Material Handling Equipment	6401									
Estimate	6401	0.77	0.37	0.11	0.02	…	…	…	…	…
Geometric approximation	6401	0.58	0.34	0.20	0.11	18.3	8.9	5.5	10.0	10.3
Linear approximation	6401	0.72	0.43	0.15	0.00	6.5	3.6	6.8	2.1	5.0

… not applicable

Table B.1 Fit statistics for estimated, geometric and linear profiles (continued)

	Asset codes	Residual value at end of each quarter of service life: 1st quarter	2nd quarter	3rd quarter	4th quarter (service life)	Average absolute deviation[1] in each quarter of service life: 1st quarter	2nd quarter	3rd quarter	4th quarter	Total
		number				%				
Computerized Production Equipment for Manufacturing	6402									
Estimate	6402	0.62	0.25	0.08	0.02	…	…	…	…	…
Geometric approximation	6402	0.56	0.26	0.12	0.06	6.5	2.5	2.7	3.5	4.1
Linear approximation	6402	0.65	0.19	0.00	0.00	1.6	2.8	12.2	4.6	4.0
Computerized Communication Equipment	6403									
Estimate	6403	0.46	0.21	0.08	0.03	…	…	…	…	…
Geometric approximation	6403	0.45	0.20	0.09	0.04	0.7	0.5	0.5	1.0	0.6
Linear approximation	6403	0.50	0.00	0.00	0.00	5.7	9.8	12.4	4.9	7.4
Non-Computerized Material Handling Equipment	6601									
Estimate	6601	0.50	0.28	0.12	0.06	…	…	…	…	…
Geometric approximation	6601	0.52	0.27	0.11	0.06	4.0	0.7	1.5	0.8	2.5
Linear approximation	6601	0.57	0.14	0.00	0.00	9.8	6.3	18.2	8.2	9.9
Non-Computerized Production Equipment for Manufacturing	6602									
Estimate	6602	0.48	0.21	0.09	0.03	…	…	…	…	…
Geometric approximation	6602	0.46	0.21	0.10	0.05	1.2	0.7	0.7	1.3	1.0
Linear approximation	6602	0.51	0.03	0.00	0.00	5.3	7.4	13.3	5.2	6.8
Non-Computerized Communication Equipment	6603									
Estimate	6603	0.74	0.35	0.13	0.04	…	…	…	…	…
Geometric approximation	6603	0.64	0.33	0.17	0.09	9.4	5.2	2.4	5.0	5.6
Linear approximation	6603	0.74	0.35	0.00	0.00	0.9	1.3	7.6	6.9	3.1
Other Machinery and Equipment (not specified elsewhere)	8999									
Estimate	8999	0.58	0.32	0.17	0.08	…	…	…	…	…
Geometric approximation	8999	0.62	0.31	0.15	0.07	5.1	1.0	1.6	1.2	2.8
Linear approximation	8999	0.70	0.25	0.00	0.00	11.8	5.2	17.7	11.1	10.2

… not applicable

1. Deviations are presented as average percent deviation from the estimated profile weighted by the estimated value loss at each age.

Annex C: Ex-ante service lives

Table C.1 Statistics for ex-ante service lives, major group - buildings

		Descriptive statistics						Cumulative distribution					
	Asset code	Obser-vation	Average	Standard deviation	Mode	Median	Estimated lives	$^1/_3$ Life	$^2/_3$ Life	Life	$1^1/_3$ Life	$1^2/_3$ Life	2 Life
				number							%		
Commercial and institutional buildings													
Laboratories, Research and Development Centers	1004	469	32.4	11.6	40.0	30.0	.	4.6	20.8	52.7	90.1	96.9	98.8
Automotive Dealerships	1012	109	24.5	11.3	20.0	25.0	.	7.0	27.8	58.4	81.1	96.0	96.0
Office Buildings	1013	4138	33.3	14.4	40.0	40.0	31.6	12.0	25.4	45.5	75.3	97.6	100.0
Hotels, Motels and Convention Centers	1014	237	36.0	11.5	40.0	40.0	.	5.4	13.0	36.5	79.6	100.0	100.0
Restaurants, Fast Food Outlets, Bars and Nightclubs	1015	280	23.0	8.3	20.0	23.0	.	0.4	21.9	51.8	89.3	89.3	99.1
Shopping Centers, Plazas and Stores	1016	1375	30.7	13.5	40.0	40.0	.	14.5	33.2	44.2	86.5	100.0	100.0
Theatres, Performing Arts and Cultural Centers	1018	89	31.8	13.9	20.0	25.0	.	6.6	41.7	53.7	77.1	98.7	99.7
Indoor Recreational Buildings	1019	187	31.2	13.8	20.0	30.0	.	15.0	31.2	53.8	78.5	100.0	100.0
Educational Buildings	1201	698	34.7	11.2	40.0	40.0	.	6.6	13.5	46.1	83.3	99.6	100.0
Student Residences	1202	72	39.1	14.5	40.0	40.0	.	6.9	20.4	21.4	96.1	98.0	98.0
Religious Buildings	1203	109	45.6	11.2	50.0	50.0	.	0.3	8.0	48.8	93.9	96.6	100.0
Hospitals and Other Health Centres	1204	873	35.1	13.1	40.0	40.0	.	8.7	19.3	42.4	71.2	100.0	100.0
Nursing Homes	1205	156	35.6	10.8	40.0	40.0	.	3.9	12.8	40.6	81.4	100.0	100.0
Day Care Centers	1206	21	28.0	11.6	20.0	25.0	.	2.8	3.3	62.4	74.3	91.7	97.7
Libraries	1207	34	35.9	12.0	40.0	40.0	.	0.2	18.3	41.8	69.7	100.0	100.0
Historical Sites	1208	16	23.3	8.8	20.0	25.0	.	0.0	16.5	48.2	84.5	85.8	100.0
Penitentiaries, Detention Centers and Courthouses	1209	98	35.4	11.6	40.0	40.0	.	0.0	6.3	49.6	79.0	94.0	100.0
Museums, Science Centers and Public Archives	1210	67	46.2	17.3	20.0	50.0	.	3.2	17.1	38.6	85.1	98.4	98.4
Fire Stations	1211	50	26.4	7.1	25.0	25.0	.	0.8	5.1	66.0	93.3	100.0	100.0
Post Offices	1212	42	18.2	3.9	15.0	15.0	.	0.0	0.0	57.9	92.2	100.0	100.0
Armouries, Barracks, Drill Halls and Other Military Type Structures	1214	23	22.3	6.9	25.0	25.0	.	0.0	15.9	33.4	97.9	97.9	97.9
Other Institutional/Governmental Buildings	1299	110	28.6	12.0	40.0	25.0	.	9.0	14.5	51.6	65.9	91.8	100.0
Other Building Constructions	1999	1	30.0	0.0	30.0	30.0	.	0.0	0.0	100.0	100.0	100.0	100.0
Passenger Terminals - (such as air, boat, bus and rail)	2201	369	32.9	12.5	30.0	30.0	.	1.4	23.0	58.4	92.3	93.1	100.0
Broadcasting and Communication Buildings	3001	381	30.6	14.1	30.0	30.0	30.0	13.1	22.1	63.6	86.4	93.2	93.3
Industrial buildings													
Manufacturing Plants	1001	4579	26.6	10.2	20.0	25.0	28.7	1.2	13.9	61.1	73.9	96.4	100.0
Warehouses, Refrigerated Storage and Freight Terminals	1006	1634	32.2	11.1	20.0	33.0	30.1	5.7	23.4	49.9	88.1	100.0	100.0
Grain Elevator and Terminals	1007	188	30.0	9.3	20.0	30.0	.	3.2	22.7	71.2	91.4	100.0	100.0
Maintenance Garages, Workshops and Equipment Storage Facilities	1008	1076	28.0	12.0	20.0	25.0	28.1	1.9	20.3	54.1	68.6	94.3	97.4
Railway Shops and Engine Houses	1009	119	32.1	11.9	50.0	25.0	.	0.7	10.6	69.5	73.3	99.3	99.4
Aircraft Hangars	1010	155	26.7	10.1	30.0	30.0	.	1.2	24.5	49.6	74.1	100.0	100.0
Service Stations	1011	179	17.4	7.1	20.0	16.0	.	6.9	15.8	59.1	85.9	92.1	97.3
Farm Buildings	1021	79	27.0	11.3	20.0	25.0	.	0.0	14.8	65.8	78.6	87.4	100.0
Bunkhouses, Dormitories, Camp Cookeries and Camps	1022	36	13.3	4.7	10.0	12.0	.	0.2	7.0	71.0	74.5	98.7	98.7
Other Industrial and Commercial Buildings	1099	753	23.9	11.1	20.0	20.0	20.9	2.1	25.4	52.1	79.7	96.0	96.3
Mine Buildings	3401	199	12.2	6.0	10.0	10.0	.	0.5	22.2	73.6	79.7	95.8	95.8
Mine Buildings for Beneficiation Treatment of Minerals (excluding smelters and refineries)	3402	84	13.1	4.9	10.0	12.0	.	0.2	16.5	59.2	79.0	98.0	99.8

. not available for any reference period

Table C.2 Statistics for ex-ante service lives, major group - machinery and equipment

	Asset code	Obser-vation	Average	Standard deviation	Mode	Median	Estimated lives	$^1/_3$ Life	$^2/_3$ Life	Life	$1^1/_3$ Life	$1^2/_3$ Life	2 Life
		Descriptive statistics						Cumulative distribution					
		number						%					
Computers													
Computers and Associated Hardware	6002	13438	4.7	1.8	5.0	5.0	4.8	1.7	30.8	86.2	88.8	94.7	95.0
Computerized equipment													
Computerized Material Handling Equipment	6401	721	13.4	5.3	10.0	15.0	12.9	0.6	17.9	48.0	78.4	95.3	100.0
Computerized Production Equipment for Manufacturing	6402	4381	12.7	5.9	10.0	10.0	15.4	3.6	25.8	56.4	74.5	96.1	99.2
Computerized Communication Equipment	6403	3747	9.5	4.5	5.0	10.0	12.3	7.3	32.8	38.3	83.4	93.2	95.2
Computerized Production Process - Crushers and Grinders	6410	116	12.6	4.4	10.0	12.0	.	0.2	12.2	72.8	82.4	97.7	100.0
Computerized Production Process - Other	6413	85	14.6	7.0	10.0	15.0	.	24.9	29.6	50.1	50.1	97.0	99.6
Other Computerized Machinery and Equipment	6499	144	8.2	4.8	5.0	8.0	.	11.8	47.8	54.1	84.3	90.7	93.8
Furniture equipment													
Office Furniture and Furnishing	6001	12611	8.3	3.9	10.0	8.0	8.9	2.4	44.1	54.2	85.4	90.5	96.9
Non-Office Furniture, Furnishings and Fixtures	6003	3881	9.4	3.8	10.0	10.0	8.8	1.1	19.7	43.3	87.7	94.1	94.3
Heavy machinery													
Motors, Generators, Transformers, Turbines, Compressors and Pumps	6009	2587	15.3	7.6	10.0	15.0	19.3	9.8	39.2	59.8	83.6	92.4	95.3
Heavy Construction Equipment	6010	1175	7.9	4.5	5.0	5.0	14.2	5.8	54.8	64.4	83.3	85.8	94.8
Tractors of All Types and Other Field Equipment	6011	753	9.4	5.5	10.0	7.0	12.1	1.7	44.0	55.6	79.0	83.3	83.9
Drilling and Blasting Equipment	6013	295	11.1	4.8	5.0	10.0	12.5	3.6	32.5	54.8	87.8	93.0	99.4
Underground Load, Haulage and Dump Equipment (such as slusher and muck cars)	6028	305	10.2	4.5	10.0	10.0	11.9	1.0	28.4	76.8	84.2	87.4	99.4
Equipment attached to buildings													
Heating, Electrical, Plumbing, Air Conditioning and Refrigeration Equipment	6005	2564	12.5	5.2	10.0	10.0	15.2	1.3	17.1	61.3	79.0	97.2	99.5
Pollution Abatement and Control Equipment	6006	697	16.7	4.7	10.0	17.0	17.1	2.5	17.9	54.3	96.2	98.0	100.0
Safety and Security Equipment	6007	978	10.8	4.9	10.0	10.0	11.4	0.8	26.3	65.3	75.5	90.1	99.0
Sanitation Equipment	6008	317	10.7	4.5	10.0	10.0	.	1.8	24.6	65.5	77.8	90.5	100.0
Non-computerized equipment													
Non-Computerized Material Handling Equipment	6601	3396	10.6	4.9	10.0	10.0	13.9	3.9	31.7	61.2	71.8	89.3	100.0
Non-Computerized Production Equipment for Manufacturing	6602	7125	14.0	5.2	10.0	14.0	16.2	6.1	12.2	53.4	72.7	96.4	99.1
Non-Computerized Communication Equipment	6603	2384	11.1	3.8	5.0	11.0	11.4	3.2	16.2	50.6	90.5	97.6	99.6
Non-Computerized Production Process - Crushers and Grinders	6610	180	15.0	6.7	10.0	15.0	.	7.9	41.6	58.2	88.4	97.2	99.2
Non-Computerized Production Process - Other	6613	142	12.8	5.9	10.0	10.0	.	1.5	19.1	61.3	74.9	94.2	97.7

. not available for any reference period

Table C.2 Statistics for ex-ante service lives, major group - machinery and equipment (continued)

		Descriptive statistics						Cumulative distribution					
	Asset code	Observation	Average	Standard deviation	Mode	Median	Estimated lives	$\frac{1}{3}$ Life	$\frac{2}{3}$ Life	Life	$1\frac{1}{3}$ Life	$1\frac{2}{3}$ Life	2 Life
		number						%					
Other transport equipment													
Locomotives, Rolling Stock, Street/Subway Cars, Other Rapid Transit and Major Parts	6205	397	23.3	7.7	20.0	25.0	24.3	3.7	14.0	48.6	84.9	99.8	100.0
Ships and Boats	6206	299	17.3	10.4	10.0	18.0	24.8	17.5	36.7	48.5	75.1	84.8	93.0
Aircraft, Helicopter and Aircraft Engines	6207	792	14.8	5.4	15.0	15.0	.	11.2	27.8	57.2	100.0	100.0	100.0
Other Transportation Equipment	6299	517	9.0	4.1	10.0	10.0	12.8	0.5	33.0	49.5	87.4	92.9	92.9
Road transport equipment													
Automobiles and Major Replacement Parts[1]	6201	3881	3.7	1.7	5.0	3.0	7.1	0	17.4	77.1	93.4	94.7	95.7
Buses and Major Replacement Parts	6202	420	12.6	4.6	10.0	12.0	16.6	4.0	20.1	58.1	82.5	100.0	100.0
Trucks, Vans, Truck Tractors, Truck Trailers and Major Replacement Parts	6203	5868	7.1	3.3	5.0	6.0	10.1	0.0	44.8	64.5	72.5	94.3	95.3
All - Terrain Vehicles and Major Replacement Parts	6204	424	6.4	2.4	5.0	5.0	10.5	0.0	1.7	71.4	72.5	98.7	99.5
Scientific equipment													
Scientific, Professional and Medical Devices	6004	3573	8.9	3.6	10.0	10.0	9.7	0.8	28.1	47.4	88.8	94.6	96.4
Tooling equipment													
Capitalized Tooling and Other Tools	6012	3169	8.0	4.9	10.0	6.0	9.9	14.7	46.2	65.1	80.3	86.5	91.6
Software[2]													
Software, Own-Account	6021	.	.	.	.	.	.	.	.	.	.	.	.
Software, Pre-Package	6022	2394	5.1	2.3	5.0	5.0	.	2.9	29.8	81.5	88.2	91.2	97.7
Software, Custom-Design	6023	.	.	.	.	.	.	.	.	.	.	.	.
Other machinery and equipment													
Salvage Equipment	6014	26	15.4	5.7	10.0	17.0	.	3.8	41.2	42.4	93.4	100.0	100.0
Industrial Containers (transportable types)	6015	301	9.3	6.1	5.0	8.0	.	11.8	47.0	53.6	78.7	87.0	87.0
Navigational Aids and Weather Measurement Equipment	6016	223	11.1	4.4	15.0	15.0	.	0.2	33.1	47.4	98.8	98.8	100.0
Other Machinery and Equipment (not specified elsewhere)	8999	4596	10.9	6.8	10.0	10.0	11.9	7.4	34.4	69.6	83.5	84.4	94.9
Machinery and equipment related to electricity production													
Gas Generators and Turbines	9001	69	22.9	5.3	20.0	20.0	.	0.0	2.6	67.7	94.6	99.7	99.9
Steam and Vapour Turbines	9002	20	26.3	6.4	30.0	29.0	.	0.0	0.0	44.7	87.7	100.0	100.0
Electric Motors and Generators	9010	43	23.9	9.6	20.0	20.0	.	0.0	14.4	66.9	80.5	92.0	100.0
Electric Transformers, Static Converters and Inductors	9011	139	30.3	8.4	25.0	28.0	.	0.2	20.7	54.9	96.8	100.0	100.0
Electric Switchgear and Switching Apparatus	9012	70	28.0	7.3	20.0	27.0	.	0.0	0.7	53.4	94.7	97.9	100.0

. not available for any reference period

Table C.2 Statistics for ex-ante service lives, major group - machinery and equipment (continued)

		Descriptive statistics						Cumulative distribution					
	Asset code	Obser-vation	Average	Standard deviation	Mode	Median	Estimated lives	1/3 Life	2/3 Life	Life	1 1/3 Life	1 2/3 Life	2 Life
		number						%					
Electric Control and Protective Equipment	9013	1	15.0	0.0	15.0	15.0	.	0.0	0.0	100.0	100.0	100.0	100.0
Measuring, Checking or Automatically Controlling Instruments and Apparatus	9015	238	23.0	9.9	20.0	20.0	.	1.0	29.8	53.3	88.1	91.6	94.4
Electricity Meters	9091	140	23.9	3.9	25.0	25.0	.	0.7	2.2	42.4	98.7	100.0	100.0
Electric Water Heaters	9092	59	13.4	4.4	10.0	12.0	.	0.0	11.3	58.3	80.6	97.2	100.0
Nuclear Reactor Parts, Fuel Elements and Heavy Water	9093	10	20.1	1.3	20.0	20.0	.	0.0	0.2	98.5	98.5	100.0	100.0
Hydraulic Turbines	9094	21	37.3	13.9	20.0	48.0	.	0.0	38.4	38.7	99.7	99.9	100.0
Boilers	9095	24	26.2	5.2	20.0	29.0	.	0.0	0.7	39.9	98.2	100.0	100.0
Other Machinery and Equipment	9099	172	16.9	8.1	10.0	15.0	.	0.5	47.2	53.3	77.2	97.0	97.2
Machinery and equipment specific to mining and oil and gas production[3]													
Raise Borers and Raise Climbers	6027	.	9.0	.	.	.	.	.	.	.	.	.	.
Mine Hoists, Cages, Ropes and Skips	6029	.	9.0	.	.	.	.	.	.	.	.	.	.
Computerized Production process - Flotation and Cyanidation	6411	.	9.0	.	.	.	.	.	.	.	.	.	.
Computerized Production process - Gravitational Concentrating Devices	6412	.	9.0	.	.	.	.	.	.	.	.	.	.
Non-Computerized Production process - Flotation and Cyanidation	6611	.	9.0	.	.	.	.	.	.	.	.	.	.
Non-Computerized Production process - Gravitational concentrating devices	6612	.	9.0	.	.	.	.	.	.	.	.	.	.

. not available for any reference period

1. The ex-post service life is used for the calculation of economic depreciation for automobiles.
2. The economic depreciation rate for software assets are from the US Bureau of Economic Analysis (BEA) estimates.
3. Average service life based on Investment and Capital Stocks Division's calculation for 1985 to 1990 period. The assets were not included in the Capital Expenditure Survey (CES) after 1990.

Table C.3 Statistics for ex-ante service lives, major group - engineering

	Asset code	Descriptive statistics: Obser-vation	Average	Standard deviation	Mode	Median	Estimated lives	Cumulative distribution: 1/3 Life	2/3 Life	Life	1 1/3 Life	1 2/3 Life	2 Life
		number						%					
Engineering													
Oil Refineries	1002	146	22.6	4.6	20.0	20.0	.	0.0	4.1	55.6	99.9	100.0	100.0
Natural Gas Processing Plants	1003	17	25.1	6.6	25.0	25.0	.	4.7	12.6	73.0	93.8	100.0	100.0
Pollution, Abatement and Controls	1005	415	23.1	8.2	20.0	20.0	.	1.9	23.2	51.8	90.1	93.5	99.8
Parking lots and Parking Garages	1017	789	25.9	12.8	20.0	20.0	.	1.6	27.2	59.3	69.2	91.0	100.0
Outdoor Recreational (such as parks, open stadium, golf courses and ski resorts)	1020	144	22.2	8.6	20.0	20.0	.	1.0	23.5	53.2	90.7	91.6	98.8
Waste Disposal Facilities	1213	97	25.4	12.4	20.0	20.0	.	6.9	28.0	54.8	62.9	96.7	100.0
Docks, Wharves, Piers and Terminals	2001	286	28.1	11.4	40.0	29.0	.	3.0	11.8	48.5	69.6	91.6	100.0
Dredging and Pile Driving	2002	49	21.2	10.3	40.0	20.0	.	6.2	18.3	73.7	81.7	81.7	100.0
Breakwaters	2003	4	10.4	9.6	0.0	10.0	.	0.0	41.5	87.5	87.5	87.5	94.1
Canals and Waterways	2004	16	47.7	18.1	25.0	60.0	.	1.4	35.7	35.7	98.2	100.0	100.0
Irrigation and Land Reclamation Projects	2005	44	44.9	15.1	20.0	40.0	.	2.1	22.7	55.7	100.0	100.0	100.0
Other Marine Construction	2099	66	31.0	15.6	10.0	25.0	.	21.5	27.8	59.8	67.7	100.0	100.0
Highways, Roads and Streets (including logging roads)	2202	1185	24.8	15.1	10.0	20.0	.	5.4	39.6	64.5	71.2	82.4	100.0
Runways (including lighting)	2203	99	30.0	11.5	20.0	40.0	.	13.1	36.0	48.9	100.0	100.0	100.0
Rail track and Roadbeds	2204	349	36.9	13.5	20.0	43.0	.	1.0	46.4	48.3	50.6	100.0	100.0
Bridges, Trestles and Overpasses	2205	340	35.6	19.7	40.0	40.0	.	27.9	34.2	39.2	53.5	90.5	96.6
Tunnels	2206	38	56.6	17.7	40.0	70.0	.	0.0	16.6	37.9	100.0	100.0	100.0
Other Transportation Engineering	2299	104	30.0	9.7	40.0	30.0	.	3.9	19.9	64.3	99.6	100.0	100.0
Reservoirs (including dams)	2401	100	39.0	15.2	50.0	40.0	.	4.0	37.4	37.7	87.2	100.0	100.0
Trunk and Distribution Mains for Waterworks	2402	212	28.4	13.2	40.0	25.0	.	0.3	25.4	56.0	65.6	85.4	100.0
Water Pumping Stations and Filtrations Plants	2412	42	35.6	13.7	10.0	40.0	.	18.1	22.9	23.5	100.0	100.0	100.0
Water Storage Tanks	2413	10	10.6	4.6	5.0	10.0	.	0.0	38.2	51.8	54.5	100.0	100.0
Other Waterworks Construction	2499	159	23.9	12.1	20.0	25.0	.	11.3	25.0	47.6	77.1	92.9	99.3
Sewage Treatment and Disposal Plants (including pumping stations)	2601	196	22.2	11.1	20.0	20.0	.	0.4	43.1	66.8	80.9	80.9	92.5
Sanitary and Storm Sewers, Trunk and Collection Lines and Open Storm Ditches	2602	280	28.8	13.0	20.0	25.0	.	4.5	18.9	59.8	68.6	83.3	99.5
Lagoons	2603	64	27.0	13.7	10.0	25.0	.	0.8	27.1	68.6	73.1	84.4	100.0
Other Sewage System Construction	2699	49	21.9	10.1	20.0	20.0	.	5.9	24.3	62.5	81.3	83.8	99.7
Electric Power Construction	2801	388	23.4	8.5	20.0	20.0	.	0.7	24.4	50.3	83.7	91.2	99.9
Production Plant - Steam	2811	41	39.9	8.3	30.0	40.0	.	0.0	3.3	51.4	98.7	98.7	100.0
Production Plant - Nuclear	2812	13	42.4	14.3	50.0	50.0	.	0.0	11.8	46.6	89.5	100.0	100.0
Production Plant - Hydraulic	2813	68	45.8	15.3	50.0	50.0	.	0.0	21.3	37.1	89.3	97.0	100.0
Electrical lines													
Electrical Transmission Lines - Overhead	2814	88	43.2	10.9	25.0	49.0	.	0.0	9.8	35.3	92.5	100.0	100.0
Electrical Transmission Lines - Underground	2815	28	45.0	9.5	25.0	45.0	.	0.0	10.5	78.2	100.0	100.0	100.0
Electrical Distribution Lines - Overhead	2816	214	32.9	10.4	25.0	30.0	29.4	0.0	12.0	61.2	78.9	99.9	100.0
Electrical Distribution Lines - Underground	2817	178	34.6	9.6	25.0	32.0	.	0.1	2.9	57.8	92.2	96.9	100.0

. not available for any reference period

Table C.3 Statistics for ex-ante service lives, major group - engineering (continued)

	Asset code	Obser-vation	Average	Standard deviation	Mode	Median	Estimated lives	1/3 Life	2/3 Life	Life	1 1/3 Life	1 2/3 Life	2 Life
		Descriptive statistics						Cumulative distribution					
				number							%		
Engineering													
Other Construction (not specified elsewhere)	2899	44	35.4	11.1	25.0	30.0	.	1.1	2.1	55.1	88.6	88.7	100.0
Communication engineering													
Telephone and Cablevision Lines	3002	551	20.5	7.3	20.0	20.0	17.9	0.5	18.0	57.3	81.9	97.4	100.0
Communication Towers and Antennas	3003	524	13.5	6.4	10.0	10.0	21.5	0.0	15.1	55.7	85.1	89.8	93.9
Engineering													
Other Communication Engineering	3099	80	15.6	5.5	5.0	15.0	.	2.9	39.8	51.4	89.2	97.8	99.8
Gas Mains and Services	3201	219	38.2	9.5	40.0	38.0	.	0.1	7.6	51.2	92.7	99.9	100.0
Pumping Stations, Oil	3202	54	9	8	6	6	.	0	83.1	86.2	86.3	86.3	87.1
Pumping Stations, Gas	3203	51	32	9	40	33	.	3.3	15.5	34.8	98.1	99.1	100
Bulk Storage	3204	292	23.1	10.8	20.0	20.0	.	2.0	29.2	55.5	80.2	85.2	97.5
Oil Pipelines	3205	92	23.3	10.4	18.0	18.0	.	0.7	20.1	58.4	79.4	81.2	100.0
Gas Pipelines	3206	149	33.4	8.2	40.0	32.0	.	0.3	1.0	50.4	94.9	99.8	100.0
Exploration Drilling[1]	3216	.	16.0	.	.	.	.	.	.	.	.	.	.
Development Drilling[1]	3217	.	16.0	.	.	.	.	.	.	.	.	.	.
Production Facilities in Oil and Gas Engineering[1]	3218	.	16.0	.	.	.	.	.	.	.	.	.	.
Enhanced Recovery Projects[1]	3219	.	16.0	.	.	.	.	.	.	.	.	.	.
Drilling Expenditures, Pre-Mining, Research and Other Costs[1]	3220	.	16.0	.	.	.	.	.	.	.	.	.	.
Geological and Geophysical Expenditures[1]	3221	.	16.0	.	.	.	.	.	.	.	.	.	.
Other Oil and Gas Facilities	3299	74	36.1	8.7	40.0	38.0	.	2.1	7.4	48.2	95.0	100.0	100.0
Mining Engineering - Below Surface (shafts, drifts, daises and other)	3403	107	14.6	5.6	10.0	15.0	.	4.2	33.0	65.9	67.8	92.9	99.0
Tailing Disposal Systems and Settling Ponds	3404	142	14.4	7.3	10.0	15.0	.	17.9	35.0	46.4	69.9	81.8	97.2
Minesite Exploration[1]	3411	.	16.0	.	.	.	.	.	.	.	.	.	.
Minesite Development[1]	3412	.	16.0	.	.	.	.	.	.	.	.	.	.
Exploration and Deposit Appraisal - Off mine sites[1]	3413	.	16.0	.	.	.	.	.	.	.	.	.	.
Other Engineering Construction	4999	7	18.4	3.6	20.0	20.0	.	0.0	11.4	21.4	100.0	100.0	100.0
Other Construction (1999/ Other Buildings)	5999	521	20.8	9.7	20.0	20.0	.	3.5	31.2	59.9	82.5	88.0	99.8

. not available for any reference period

1. Average service life based on Investment and Capital Stocks Division's calculation for 1985 to 1990 period. The assets were not included in the Capital Expenditure Survey after 1990.

Annex D: Economic depreciation rate estimates

Table D.1 Economic depreciation rate estimates, major group - buildings

	Asset code	Estimated lives 1985 to 2001	Estimated depreciation rate	Surveyed lives 1985 to 2001	Updated service lives	DBR[1]	Geometric depreciation rate
		number	%	number			%
Commercial and institutional buildings							
Laboratories, Research and Development Centers	1004	.	.	32.4	31.6	2.0	6.2
Automotive Dealerships	1012	.	.	24.5	24.5	2.0	8.0
Office Buildings	1013	31.6	6.2	33.3	33.3	2.0	5.9
Hotels, Motels and Convention Centers	1014	.	.	36.0	36.0	2.0	5.5
Restaurants, Fast Food Outlets, Bars and Nightclubs	1015	.	.	23.0	23.0	2.0	8.5
Shopping Centers, Plazas and Stores	1016	.	.	30.7	30.7	2.0	6.4
Theatres, Performing Arts and Cultural Centers	1018	.	.	31.8	31.8	2.0	6.2
Indoor Recreational Buildings	1019	.	.	31.2	31.2	2.0	6.3
Educational Buildings	1201	.	.	34.7	34.7	2.0	5.7
Student Residences	1202	.	.	39.1	39.1	2.0	5.1
Religious Buildings	1203	.	.	45.6	45.6	2.0	4.4
Hospitals and Other Health Centres	1204	.	.	35.1	35.1	2.0	5.6
Nursing Homes	1205	.	.	35.6	35.6	2.0	5.6
Day Care Centers	1206	.	.	27.9	28.0	2.0	7.0
Libraries	1207	.	.	35.9	35.9	2.0	5.5
Historical Sites	1208	.	.	23.3	23.3	2.0	8.4
Penitentiaries, Detention Centers and Courthouses	1209	.	.	35.4	35.4	2.0	5.6
Museums, Science Centers and Public Archives	1210	.	.	46.2	46.2	2.0	4.3
Fire Stations	1211	.	.	26.4	26.4	2.0	7.4
Post Offices	1212	.	.	18.2	18.2	2.0	10.6
Armouries, Barracks, Drill Halls and Other Military Type Structures	1214	.	.	22.3	22.3	2.0	8.7
Other Institutional/Governmental Buildings	1299	.	.	28.6	28.6	2.0	6.9
Other Building Constructions	1999	.	.	30.0	30.0	2.0	6.6
Passenger Terminals - (such as air, boat, bus and rail)	2201	.	.	32.9	33.0	2.0	6.0
Broadcasting and Communication Buildings	3001	30.0	7.2	30.6	30.6	2.3	7.1
Industrial buildings							
Manufacturing Plants	1001	28.7	8.7	26.6	25.1	2.6	9.9
Warehouses, Refrigerated Storage and Freight Terminals	1006	30.1	6.3	32.2	32.0	2.0	6.0
Grain Elevator and Terminals	1007	.		30.0	30.0	2.3	7.5
Maintenance Garages, Workshops and Equipment Storage Facilities	1008	28.1	6.8	28.0	28.0	2.0	6.8
Railway Shops and Engine Houses	1009	.	.	32.1	32.7	2.3	6.9
Aircraft Hangars	1010	.	.	26.7	26.7	2.3	8.4
Service Stations	1011	.	.	17.4	17.4	2.3	12.6
Farm Buildings	1021	.	.	27.0	27.0	2.3	8.3
Bunkhouses, Dormitories, Camp Cookeries and Camps	1022	.	.	13.3	13.3	2.3	16.1
Other Industrial and Commercial Buildings	1099	20.9	7.9	23.9	23.8	1.7	7.0
Mine Buildings	3401	.	.	12.2	12.2	2.3	17.5
Mine Buildings for Beneficiation Treatment of Minerals (excluding smelters and refineries)	3402	.	.	13.1	13.1	2.3	16.3

. not available for any reference period

1. DBR = declining balance rate

Table D.2 Economic depreciation rate estimates, major group - machinery and equipment

	Asset code	Estimated lives 1985 to 2001	Estimated depreciation rate	Surveyed lives 1985 to 2001	Updated service lives	DBR[3]	Geometric depreciation rate
		number	%		number		%
Computers							
Computers and Associated Hardware	6002	4.8	45.8	4.7	4.6	2.9	47.0
Computerized equipment							
Computerized Material Handling Equipment	6401	12.9	16.5	13.4	13.5	2.3	15.8
Computerized Production Equipment for Manufacturing	6402	15.4	17.5	12.7	12.5	3.0	21.2
Computerized Communication Equipment	6403	12.3	23.2	9.5	9.3	3.2	29.3
Computerized Production Process - Crushers and Grinders	6410	.	.	12.6	12.6	3.1	21.7
Computerized Production Process - Other	6413	.	.	14.6	14.6	3.1	19.0
Other Computerized Machinery and Equipment	6499	.	.	8.2	8.2	3.1	31.0
Furniture equipment							
Office Furniture and Furnishing	6001	8.9	21.4	8.3	8.3	2.1	22.8
Non-Office Furniture, Furnishings and Fixtures	6003	8.8	21.0	9.4	9.4	2.1	19.8
Heavy machinery							
Motors, Generators, Transformers, Turbines, Compressors and Pumps	6009	19.3	15.0	15.3	15.9	3.1	17.9
Heavy Construction Equipment	6010	14.2	15.4	7.9	7.9	2.4	26.0
Tractors of All Types and Other Field Equipment	6011	12.1	21.2	9.4	9.4	2.9	26.3
Drilling and Blasting Equipment	6013	12.5	17.4	11.1	11.2	2.4	19.2
Underground Load, Haulage and Dump Equipment (such as slusher and muck cars)	6028	11.9	16.6	10.2	10.2	2.2	19.2
Equipment attached to buildings							
Heating, Electrical, Plumbing, Air Conditioning and Refrigeration Equipment	6005	15.2	18.3	12.5	12.0	3.1	22.5
Pollution Abatement and Control Equipment	6006	17.1	11.6	16.7	16.9	2.1	11.7
Safety and Security Equipment	6007	11.4	15.4	10.8	11.0	1.9	15.9
Sanitation Equipment	6008	.		10.7	10.7	2.3	19.3
Non-computerized equipment							
Non-Computerized Material Handling Equipment	6601	13.9	19.7	10.6	10.6	3.1	25.1
Non-Computerized Production Equipment for Manufacturing	6602	16.2	17.6	14.0	14.0	3.1	20.1
Non-Computerized Communication Equipment	6603	11.4	19.7	11.1	11.1	2.5	20.1
Non-Computerized Production Process - Crushers and Grinders	6610	.	.	15.0	15.0	3.0	18.1
Non-Computerized Production Process - Other	6613	.	.	12.8	12.8	3.0	20.9
Other transport equipment							
Locomotives, Rolling Stock, Street/Subway Cars, Other Rapid Transit and Major Parts	6205	24.3	15.3	23.3	23.3	4.0	15.9
Ships and Boats	6206	24.8	9.1	17.3	17.3	2.4	12.7
Aircraft, Helicopter and Aircraft Engines	6207	.	.	14.8	14.8	3.2	19.4
Other Transportation Equipment	6299	12.8	27.0	9.0	8.7	4.0	37.2

. not available for any reference period

Table D.2 Economic depreciation rate estimates, major group - machinery and equipment (continued)

	Asset code	Estimated lives 1985 to 2001	Estimated depreciation rate	Surveyed lives 1985 to 2001	Updated service lives	DBR[3]	Geometric depreciation rate
		number	%	number			%
Road transport equipment							
Automobiles and Major Replacement Parts	6201	7.1	24.7	7.1	7.1	2.0	24.7
Buses and Major Replacement Parts	6202	16.6	20.3	12.6	12.9	3.8	25.5
Trucks, Vans, Truck Tractors, Truck Trailers and Major Replacement Parts	6203	10.1	21.2	7.1	7.1	2.4	28.8
All - Terrain Vehicles and Major Replacement Parts	6204	10.5	17.7	6.4	6.3	2.0	27.6
Scientific equipment							
Scientific, Professional and Medical Devices	6004	9.7	18.9	8.9	8.9	2.0	20.3
Tooling equipment							
Capitalized Tooling and Other Tools	6012	9.9	22.5	8.0	8.0	2.5	26.9
Software[1]							
Software, Own-Account	6021	.	.	5.0	5.0	2.0	33.0
Software, Pre-Package	6022	.	.	3.0	3.0	2.4	55.0
Software, Custom-Design	6023	.	.	5.0	5.0	2.0	33.0
Other machinery and equipment[2]							
Salvage Equipment	6014	.	.	15.4	15.4	2.6	15.8
Industrial Containers (transportable types)	6015	.	.	9.3	9.3	2.6	24.8
Navigational Aids and Weather Measurement Equipment	6016	.	.	11.1	11.1	2.6	21.1
Other Machinery and Equipment (not specified elsewhere)	8999	11.9	21.1	10.9	10.5	2.8	23.5
Machinery and equipment related to electricity production[2]							
Gas Generators and Turbines	9001	.	.	22.9	22.9	2.6	10.9
Steam and Vapour Turbines	9002	.	.	26.4	26.3	2.6	9.6
Electric Motors and Generators	9010	.	.	23.9	23.9	2.6	10.5
Electric Transformers, Static Converters and Inductors	9011	.	.	30.3	30.3	2.6	8.4
Electric Switchgear and Switching Apparatus	9012	.	.	28.0	28.0	2.6	9.0
Electric Control and Protective Equipment	9013	.	.	15.0	15.0	2.6	16.2
Measuring, Checking or Automatically Controlling Instruments and Apparatus	9015	.	.	23.0	23.0	2.6	10.9
Electricity Meters	9091	.	.	23.9	23.9	2.6	10.5
Electric Water Heaters	9092	.	.	13.4	13.4	2.6	18.0
Nuclear Reactor Parts, Fuel Elements and Heavy Water	9093	.	.	20.1	20.1	2.6	12.3
Hydraulic Turbines	9094	.	.	37.3	37.3	2.6	6.8
Boilers	9095	.	.	26.2	26.2	2.6	9.6
Other Machinery and Equipment	9099	.	.	16.9	16.9	2.6	14.5

. not available for any reference period

Table D.2 Economic depreciation rate estimates, major group - machinery and equipment (continued)

	Asset code	Estimated lives 1985 to 2001	Estimated depreciation rate	Surveyed lives 1985 to 2001	Updated service lives	DBR[3]	Geometric depreciation rate
		number	%		number		%
Machinery and equipment specific to mining and oil and gas production[2]							
Raise Borers and Raise Climbers	6027	.	.	9.0	9.0	2.6	25.5
Mine Hoists, Cages, Ropes and Skips	6029	.	.	9.0	9.0	2.6	25.5
Computerized Production process - Flotation and Cyanidation	6411	.	.	9.0	9.0	2.6	25.5
Computerized Production process - Gravitational Concentrating Devices	6412	.	.	9.0	9.0	2.6	25.5
Non-Computerized Production process - Flotation and Cyanidation	6611	.	.	9.0	9.0	2.6	25.5
Non-Computerized Production process - Gravitational concentrating devices	6612	.	.	9.0	9.0	2.6	25.5

. not available for any reference period

1. The economic depreciation rates for software assets are from the US Bureau of Economic Analysis (BEA) estimates.
2. Use average declining balance rate (DBR) from machinery and equipment excluding computers to calculate depreciation rates
3. DBR = declining balance rate

Table D.3 Economic depreciation rate estimates, major group - engineering

	Asset code	Estimated lives 1985 to 2001	Estimated depreciation rate	Surveyed lives 1985 to 2001	Updated service lives	DBR[1]	Geometric depreciation rate
		number	%		number		%
Engineering							
Oil Refineries	1002	.	.	22.6	22.6	2.3	9.9
Natural Gas Processing Plants	1003	.	.	25.1	25.1	2.3	8.9
Pollution, Abatement and Controls	1005	.	.	23.1	22.5	2.3	9.9
Parking lots and Parking Garages	1017	.	.	25.9	25.9	2.3	8.6
Outdoor Recreational (such as parks, open stadium, golf courses and ski resorts)	1020	.	.	22.2	22.2	2.3	10.0
Waste Disposal Facilities	1213	.	.	25.4	25.4	2.3	8.8
Docks, Wharves, Piers and Terminals	2001	.	.	28.1	28.1	2.3	8.0
Dredging and Pile Driving	2002	.	.	21.2	21.2	2.3	10.4
Breakwaters	2003	.	.	10.4	10.4	2.3	20.2
Canals and Waterways	2004	.	.	47.7	47.7	2.3	4.8
Irrigation and Land Reclamation Projects	2005	.	.	44.9	44.9	2.3	5.1
Other Marine Construction	2099	.	.	31.0	31.0	2.3	7.3
Highways, Roads and Streets (including logging roads)	2202	.	.	24.8	23.7	2.3	9.4
Runways (including lighting)	2203	.	.	30.0	30.0	2.3	7.5
Rail track and Roadbeds	2204	.	.	36.9	36.9	2.3	6.2
Bridges, Trestles and Overpasses	2205	.	.	35.6	35.6	2.3	6.4
Tunnels	2206	.	.	56.6	56.6	2.3	4.0
Other Transportation Engineering	2299	.	.	30.0	30.0	2.3	7.5
Reservoirs (including dams)	2401	.	.	39.0	42.1	2.3	5.4
Trunk and Distribution Mains for Waterworks	2402	.	.	28.4	28.4	2.3	7.9
Water Pumping Stations and Filtrations Plants	2412	.	.	35.6	35.6	2.3	6.4
Water Storage Tanks	2413	.	.	10.6	10.6	2.3	19.8
Other Waterworks Construction	2499	.	.	23.9	23.9	2.3	9.3
Sewage Treatment and Disposal Plants (including pumping stations)	2601	.	.	22.2	22.2	2.3	10.0
Sanitary and Storm Sewers, Trunk and Collection Lines and Open Storm Ditches	2602	.	.	28.8	28.8	2.3	7.8
Lagoons	2603	.	.	27	27	2.3	8.3
Other Sewage System Construction	2699	.	.	22	22	2.3	10.1
Electric Power Construction	2801	.	.	23	24	2.3	9.3
Production Plant - Steam	2811	.	.	40	40	2.3	5.7
Production Plant - Nuclear	2812	.	.	43	42	2.3	5.4
Production Plant - Hydraulic	2813	.	.	46	46	2.3	5.0
Electrical lines							
Electrical Transmission Lines - Overhead	2814	.	.	43	43	3.6	7.9
Electrical Transmission Lines - Underground	2815	.	.	45	45	3.6	7.6
Electrical Distribution Lines - Overhead	2816	29	11.4	33	33	3.6	10.3
Electrical Distribution Lines - Underground	2817	.	.	35	35	3.6	9.8
Engineering							
Other Construction (not specified elsewhere)	2899	.	.	35	35	2.3	6.4

. not available for any reference period

Table D.3 Economic depreciation rate estimates, major group – engineering (continued)

	Asset code	Estimated lives 1985 to 2001	Estimated depreciation rate	Surveyed lives 1985 to 2001	Updated service lives	DBR[1]	Geometric depreciation rate
		number	%		number		%
Communication engineering							
Telephone and Cablevision Lines	3002	18	13.2	20	20	2.5	11.6
Communication Towers and Antennas	3003	22	10.1	13	13	2.3	15.7
Engineering							
Other Communication Engineering	3099	.	.	16	16	2.3	13.9
Gas Mains and Services	3201	.	.	38	40	2.3	5.7
Pumping Stations, Oil	3202	.	.	9	9	2.3	22.1
Pumping Stations, Gas	3203	.	.	32	32	2.3	7.1
Bulk Storage	3204	.	.	23	23	2.3	9.8
Oil Pipelines	3205	.	.	23	23	2.3	9.6
Gas Pipelines	3206	.	.	33	33	2.3	6.8
Exploration Drilling	3216	.	.	16	16	2.3	13.6
Development Drilling	3217	.	.	16	16	2.3	13.6
Production Facilities in Oil and Gas Engineering	3218	.	.	16	16	2.3	13.6
Enhanced Recovery Projects	3219	.	.	16	16	2.3	13.6
Drilling Expenditures, Pre-Mining, Research and Other Costs	3220	.	.	16	16	2.3	13.6
Geological and Geophysical Expenditures	3221	.	.	16	16	2.3	13.6
Other Oil and Gas Facilities	3299	.	.	36	36	2.3	6.3
Mining Engineering - Below Surface (shafts, drifts, daises and other)	3403	.	.	15	15	2.3	14.9
Tailing Disposal Systems and Settling Ponds	3404	.	.	14	14	2.3	15.0
Minesite Exploration	3411	.	.	16	16	2.3	13.6
Minesite Development	3412	.	.	16	16	2.3	13.6
Exploration and Deposit Appraisal - Off mine sites	3413	.	.	16	16	2.3	13.6
Other Engineering Construction	4999	.	.	18	18	2.3	12.0
Other Construction (1999/ Other Buildings)	5999	.	.	21	21	2.3	10.4

. not available for any reference period

1. DBR = declining balance rate