

Very Preliminary

Accounting for Consumers' Durables and Housing in the Canadian Productivity Accounts

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Abstract: This paper extends on an experimental basis the coverage of the Canadian productivity accounts from the business sector to the private economy and ascertains the quantitative impact on GDP, capital input and multifactor productivity growth. The private economy comprises the business sector itself and owner-occupied housing for which output at the industry level is hampered by several measurement problems. Using the aggregate production possibility frontier, owner occupied housing is accounted for on both the output and input, thereby mitigating the impact of measurement problems on the private economy. Under this framework, the purchase of new owner-occupied housing is included in investment, the flow of services from the corresponding installed stock of this asset is accounted in consumption on the output side. Owner-occupied dwellings capital services are also treated consistently in the capital input measure. A similar treatment is also applied to consumers' durable goods since these assets, much like owner-occupied dwellings, provide a flow of services over many periods. Over the 1981-2000 period, the impact of these methodological changes on the level of nominal GDP, growth of GDP and capital input is substantial. Nonetheless, the story on the business sector productivity revival in the late 1990s still holds true for the private economy.

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I. Introduction

The publication by the Canadian Productivity Accounts (CPA) of a variety of multifactor productivity growth measures for the business sector and its constituent industries reflects an important research theme in the measurement of economic performance. The method employed at the business sector level is based the production possibility frontier introduced by Jorgenson and Griliches (1967). Jorgenson (1990) provides an exposition of the method and a survey of results for the U.S., while Jorgenson and Stiroh (2000) and Harchaoui *et al.* (2004) are the most recent studies that employed this method for the U.S. and Canada, respectively, in the context of information technology. This framework captures substitutions among outputs of investment, consumption, exports and imports, as well inputs of capital and labour. Under this framework, the concept of business sector excludes general government, non-profit organisations and the Canadian System of National Accounts (CSNA) imputation of the rental value of owner-occupied dwellings.

This paper extends on an experimental basis the coverage of the Canadian productivity accounts from the business sector to the private economy. The private economy comprises the business sector itself and owner-occupied housing. The latter can be accounted in the aggregate multifactor productivity framework in two alternate ways. Under the bottom up approach, owner-occupied housing is treated as an industry which produces housing services that are consumed by the household to which the owner of the dwellings belongs. This industry is quite large and its real output is hampered by several measurement problems, thereby making its productivity trend and that of the aggregate private economy possibly unreliable. The top-down approach employs an aggregate production possibility frontier to describe how capital input, labour, and technology are used to create the private sector output of investment goods, consumption goods, and next exports. Under this approach, owner-occupied housing is accounted in both output and input, thereby alleviating the impact of the measurement problems on the productivity trend of the private economy.

Under the top down approach, exploited in this paper, the purchase of new owner-occupied housing is included in investment and the flow of services from the installed capital stock are added to consumption. Similarly, owner-occupied housing capital services are included in the capital input measure. We also treat consumers' durable goods symmetrically with housing capital since both are essentially investment goods that provide a flow of services over many periods. Thus, we measure the service flow from the stock of durables in lieu of

expenditure.¹ The purchase of consumer durables is recorded as capital investment and the service flow from the stock of durables as consumption, since the latter represents the portion actually consumed in a given period. The advantage of this treatment of consumers' durables is twofold: a) it makes the treatment of consumers' durables similar to that used in the System of National Accounts to account for rents of owner-occupied dwellings, and b) it also makes the treatment of consumers' durables symmetric to the one already in place in the productivity accounts for the measurement of producers' durable goods.

This approach is then employed to quantify the impact of accounting owner-occupied dwellings and consumers' durables on both the output and input sides of the aggregate production possibility frontier and, ultimately, the aggregate multifactor productivity performance of the Canadian private economy over the 1981-2000 period.

In the following section, we present an analytical framework based on the production possibility frontier. The data required to implement the notion of private economy in the CPA are also described therein. In Section III we present the results of these methodological changes and their impact on GDP, growth of GDP, capital input and multifactor productivity performance over the 1981-2000 period. Finally, we summarize our conclusions and outline the agenda for future research.

II. Accounting Framework

1. The Nature of the Proposed Changes

A flow of capital services may be divided between price and quantity with price as the rental rate and quantity as the amount of capital services utilized. Accounting problems arise from the fact that the supplier of the capital service and its ultimate user are typically within the same economic unit. An imputation is required for separation of outlay on capital services or property compensation into price and quantity components.

¹ Under the existing practice, personal expenditure is not a true measure of consumption. Under the existing conventions, purchases of consumers' durables are expensed in the period when transactions occur. Since durable goods have a service life of more than one year, this treatment fails to capture the service flow from the stock of durables throughout their length of life, thereby making the conventions for the measurement of consumers' durables not symmetrical with those of housing. This is by no means the first time that Statistics Canada explores the construction of estimates for the flow of services for consumer durables. See Johal (1992). A number of researchers have suggested that the System of National Accounts capitalize consumer durables (see Katz and Peskin (1980) for a review of this literature).

For property with an active rental market the price of capital services may be observed directly as the rental price for the use of a capital asset. The product of the rental price and the quantity of the asset used is the outlay on capital services or property compensation. This method for measuring capital services may be extended from rental property to property utilized by its owners if market rental values reflect the implicit rentals paid by owners for the use of their property. This method is used for imputation of the value of services on owner-occupied dwellings held by households in the CSNA (see Statistics Canada, 1990 for a description of this approach). The main obstacle to application of this method of imputation is the paucity of data on market rental values.

An alternative method for separation of price and quantity components of outlay on capital services or property compensation is based on the correspondence between asset prices and rental prices implied by the equality between the value of an asset and the discounted value of its services. The service price depends on the asset price, the rate of return, the rate of depreciation, and the tax structure. Given the quantity of assets held by each sector, the prices of the assets, rate of depreciation, and data on the tax structure, the rate of return for all assets used in the sector may be determined from total property compensation. Combining the rate of return with other components of the service price, factor outlay on capital may be separated into price and quantity components.

In the CSNA, much like its counterparts of other developed countries, the services of owner-occupied housing and structures utilized by households are included in the GDP. The flows of capital services resulting from investment in housing by owner-occupiers and investment in structures by households are not recorded in market transactions. The value of the service flow are imputed from data on rental values. The treatment of capital services from consumers' durables used by households is not symmetrical with that of housing and structures. Purchases of consumers' durables are treated as part of personal consumption expenditures but the service flow from these durables is not included in GDP.

In this paper, following the seminal treatment proposed by Christensen and Jorgenson (1973), we treat the services of owner-utilized consumers' durables used by households symmetrically with the services of owner-occupied housing and the structures of households. Purchases of new consumers' durables and owner-occupied dwellings are treated as private investment. We then impute the value of services of consumers' durables owned by households from rental values implied by the imputed service flow to GDP. This change increases the value of GDP and requires data for the imputation of the rental value of these capital services.

2. Measurement Framework

In the production possibility frontier employed in the CPA for the business sector, output consists of consumers spending on durable and non durable goods, investment spending delivered by the business sector to businesses, government and other components representing, among other things, net exports. These outputs are produced from an aggregate input, consisting of businesses' capital services and labour services. The aggregate input is augmented by multifactor productivity. This notion of business sector includes all of GDP except the output of general government, non-profit institutions and the rental value of owner-occupied real estate. Similar adjustments are made on the input side.

To expand the coverage of this framework from the business sector to the private economy, it is necessary to account for owner-occupied housing on both sides of the production possibility frontier in equation (1) shown below. On the output side, two adjustments are required: first, owner-occupied housing investment is added to the investment function; second, the services provided by the installed owner-occupied housing stock are included in consumption output in the production possibility frontier. The latter component is also added to the capital input side. The value of owner-occupied housing flow of services corresponds to the imputation made for the rental value of owner-occupied housing imputed in the official GDP. Accounting for owner-occupied housing would increase business sector GDP by the amount of investment of owner-occupied housing and its flow of services. Business sector capital input would increase by the same amount of capital services.

The notion of cost of capital is essential to obtain the imputed service flow from capital assets. In the business sector this accrues as capital income to the firms that employ these products as inputs. In the household sector, the flow of capital income must be imputed. This same type of imputation is used for housing in the CSNA. The rental value of tenant-occupied housing accrues to real estate firms as capital income, while the rental value of owner-occupied housing is imputed to households.

Under this proposed framework, we also need to treat consumers' durable goods symmetrically with owner-occupied housing capital since both are essentially investment goods that provide a flow of services over many periods. The idea of capitalizing consumer durables in the System of National Accounts has been discussed for many years (see Katz and Peskin 1980). Currently expenditures for consumer durables are treated as consumption expenditures rather than investment expenditures. Capitalizing consumer durables would reallocate expenditures for them from personal consumption expenditures to gross private domestic

investment and would increase GDP by the amount of services they provide equal to the rental value of the durables. These flow of services need also to be added to the capital input.

The production possibility frontier for the private economy can be represented as:

$$Y[C(t), I(t), O(t)] = A(t) \cdot X[K(t), L(t)], \quad (1)$$

where the aggregate consumption (C) consists of personal spending on non durable goods and the flow of services of durable goods and owner-occupied housing, investment (I) accounts business sector investment and investment spending on durable goods and owner-occupied housing. Capital input (K) includes the flow of services of business sector capital stock and those derived from owner-occupied housing and consumers' durable capital stocks. Labour input (L) and the other components of GDP (O), such as net exports, remain unchanged, but the scaling factor (A), which captures multifactor productivity, will be affected by these conceptual changes.

Under the standard assumptions of competitive product and factor markets, and constant returns to scale, Equation (1) can be transformed into an equation that accounts for the sources of economic growth:

$$w_C \Delta \ln C + w_I \Delta \ln I + w_O \Delta \ln O = v_K \Delta \ln K + v_L \Delta \ln L + \Delta \ln A, \quad (2)$$

where $\Delta x \equiv x_t - x_{t-1}$. \bar{w} denotes the average output shares and \bar{v} the average input shares of the subscripted variables; the shares are averaged over period t and $t-1$, and $w_C + w_I + w_O = v_K + v_L = 1.0$. We refer to the share-weighted growth rates in equation (2) as the contributions of the inputs and outputs.

3. Data Sources

This section provides a detailed summary of our methodology to calculate capital services. Starting with investment data, we calculate capital stocks using the perpetual inventory method, and then estimate the user cost of capital for each asset from national income data. These stocks are then aggregated using the user cost of capital to weigh individual assets to form an estimate of the flow of capital services.

Our primary data source for estimating the aggregate flow of capital services is the Final demand expenditures available from the Input-Output Tables of the CSNA and Investment and Capital Stock Division (ICSD). The CSNA data contain investment series from 1961 to the most recent benchmark year in current prices and chain-type quantity indices for a variety of non-residential assets and consumers' durable assets. These assets were reclassified into 28 non-residential assets and 13 different types of consumers' durable assets. An important caveat about

the underlying investment data is that it runs only through 1998. We have made several adjustments to extend the investment series to 2000 and make them consistent with more timely data available from the Income and Expenditures Accounts. Current and constant series for 4 categories and residential assets –singles, multiples, mobiles and cottages— from 1961 to the most current year were obtained from ICSD.

We controlled the total value of investment in major categories – machinery and equipment, non-residential structures– to correspond with Income and Expenditures Accounts aggregates. This adjustment maintains a consistent accounting for residential and non-residential investment series and purchases of consumers’ durables as inputs and outputs.

Table 1. Owner-Occupied Dwellings and Consumers' Durables by Major Asset Classes (Percent)

Owner-occupied dwellings	
Singles	2.0
Multiples	2.0
Mobiles	2.0
Cottages	2.0
Consumers' durables	
Furniture and floor covering	23.2
Kitchen appliance	15.0
Other durable	16.5
Computers and software	31.5
Video, Audio	18.3
Watches and jewellery	15.0
New passenger cars	23.6
Motor vehicles and accessories	55.0
Boats, motors and accessories	16.5
Pleasure, sporting and camping equipment	18.3
Trailers	18.3
Musical instruments and supplies	16.5
Bicycles and motorcycles	18.3

Capital stocks were then estimated using the perpetual inventory method and a geometric depreciation rate, based on Gellatly et al. (2002) for non-residential assets, Jorgenson *et al.* (1999) for durable goods and ICSD 2% rate for all residential assets.² Table 1 shows the residential and

² These depreciation rates were adopted from Grebler *et al* (1956), who analysed U.S. Federal Housing Administration field appraisal data from 1939. Using a sample of 1500 owner-occupied single family houses, on average 20 years old, the authors estimated a constant depreciation rate of 2%.

durables assets used to complement the business sector's assets employed in the CPA described in Harchaoui and Tarkhani (2002).

We use a rental price to impute a flow of consumer durable services and owner-occupied housing to be included in both consumption output and capital input.³ As shown in Harchaoui and Tarkhani (2002), the user cost formula could be based on either the internal or external rates of return assumptions. While the former exhausts capital compensation available in the economic accounts, the latter allows for a residual, allowing an extra return to compensate other forms of assets. The external rate of return approach is useful in the case where new assets, such as consumers' durables, need to be accounted in the economic accounts.

Following Jorgenson *et al.* 1999, the following user cost formula was employed for consumers' durable assets:

$$c_{i,t} = [r_t - \pi_{i,t} + (1 + \pi_{i,t})\delta_i]P_{i,t-1},$$

with $r_t = \beta_t \dot{i}_t + (1 - \beta_t)\rho_t$, where:

- r_t = the weighted average of the debt and equity nominal returns,
- β_t = the debt to capital ratio measured as the ratio of consumers' credit to consumers' durables,
- \dot{i}_t = the interest cost of debt (t-bills rate for 3 months),
- ρ_t = is the imputed rate of return to equity.

Given the availability of data on property income for owner-occupied dwelling, the internal rate of return approach of the user cost of capital has been implemented for the sake of consistency with the approach exploited for the business sector. Nonetheless, the external rate of return approach has also been exploited to quantify the sensitivity of the results.

The value of property income R_t of owner-occupied dwellings is the total value of rent received from the various capital assets K_{it} in each time period t . This is defined as $R_t = \sum_i c_{it}K_{it}$ where the formula for the user cost c_{it} is:

$$c_{i,t} = [r_t^* - \pi_{i,t} + (1 + \pi_{i,t})\delta_i]P_{i,t-1} + t_t^p P_{i,t-1},$$

where $\pi_{i,t}$ is the capital gain of the asset i , $P_{i,t}$ is the price of the residential asset i , t_t^p is the property tax rate and δ is the depreciation

³ See Harchaoui and Tarkhani (2002) for the business sector's user cost of capital.

rate. The value of the internal rate of return r_i^* , the only unknown variable of this system, is determined residually as:

$$r_t^* = \frac{R_t + \sum_i [[\pi_{i,t} - (1 + \pi_{i,t})\delta_i] P_{i,t-1} - t_i^p P_{i,t-1}] K_{it}}{\sum_i P_{i,t-1} K_{it}}.$$

Alternatively, the user cost formula for owner-occupied dwellings can be defined on the basis of the external rate of return as in the case of consumers' durables:

$$c_{i,t} = [r_t - \pi_{i,t} + (1 + \pi_{i,t})\delta_i] P_{i,t-1} + t_i^p P_{i,t-1},$$

with $r_t = \beta_t i_t + (1 - \beta_t)\rho_t$, where β_t is the debt to capital ratio (ratio of mortgages to residential structures), i_t is the interest cost of debt (the conventional mortgage rate for 5 year). The remaining variables were defined above.

To estimate the imputed rate of return on equity, we assume that competition in the capital market makes the rate of return on equity in household sector equal to the rate of return on equity in the corporate sector. Thus, from the user cost of capital and rate of return formulas for the business sector, we deduct the imputed rate of return on equity.

For the business sector, the nominal rate of return for all asset type by industry is:

$$r_t = \frac{Y - K_t P_{t-1} \tau_t^p - K_t P_{t-1} (\delta_{k,t} - \pi_t) \left(\frac{1 - e_t - \tau_t^z t}{1 - \tau_t} \right)}{P_{t-1} K_t \left(\frac{1 - e_t - \tau_t^z t}{1 - \tau_t} \right)}$$

Y = The total capital compensation of the industry;
 K_t = The stock of capital k ;

We assume that the nominal rate of return is the same for all assets within a given industry; and the sum of the values of capital services over all assets is equal to total capital compensation.

Also, the nominal rate of return can be calculated from the following equation:

$$r_t = \beta \left[(1 - \tau_t) i_t - \pi_{k,t} \right] + (1 - \beta_t) \left[\frac{\rho_t - \pi_{k,t} (1 - \tau_{q,t}^g)}{(1 - \tau_{q,t}^e) \alpha_t + (1 - \tau_{q,t}^g) (1 - \alpha_t)} \right] + \pi_{k,t}$$

where:

α_t : The ratio of dividends to income after corporate taxes for the period t ;
 $\beta_{q,t}$: The ratio of debt capacity to the value of corporate capital stock for the period t ;
 $\tau_{q,t}^e$: The marginal tax rate on dividends for the period t ;
 $\tau_{q,t}^g$: The marginal tax rate on capital gains on corporate equities for the period t ;
 i_t : The rate of interest for the period t ;
 ρ_t : The imputed rate of return on equity for the period t ;

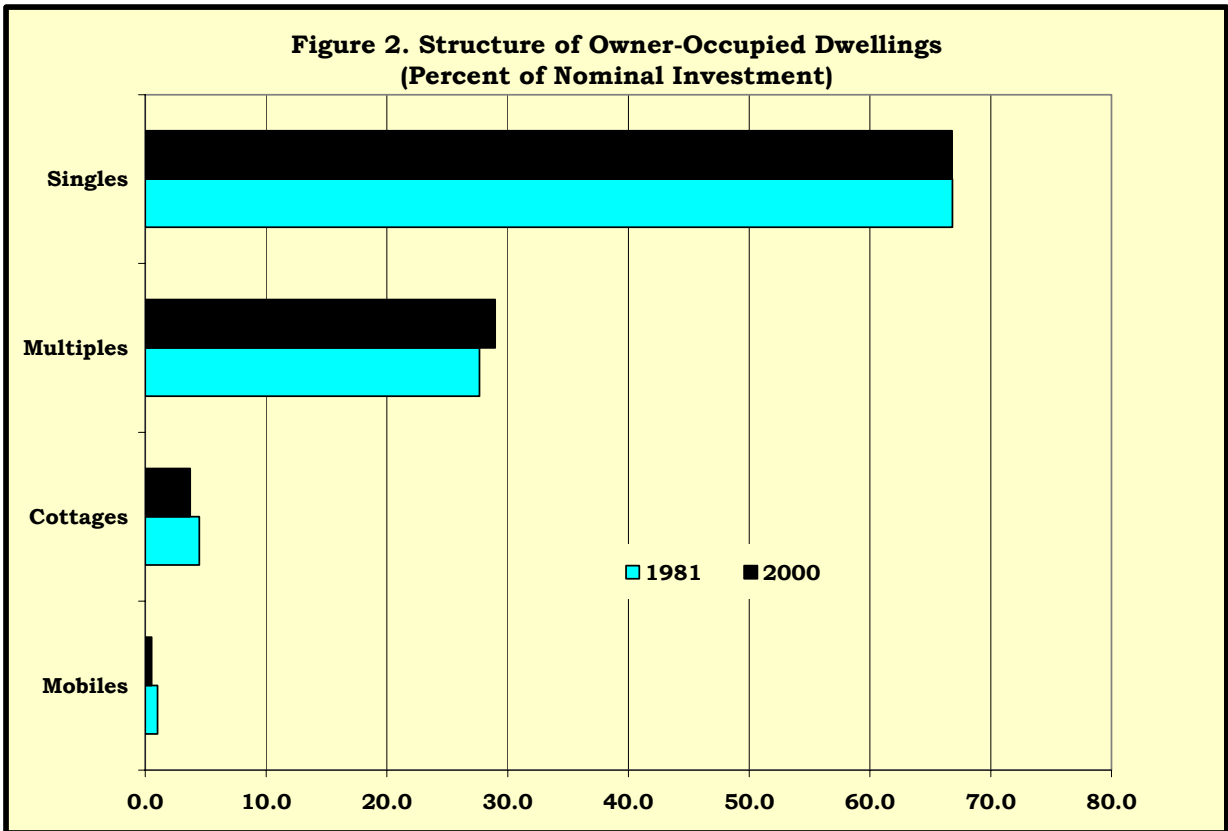
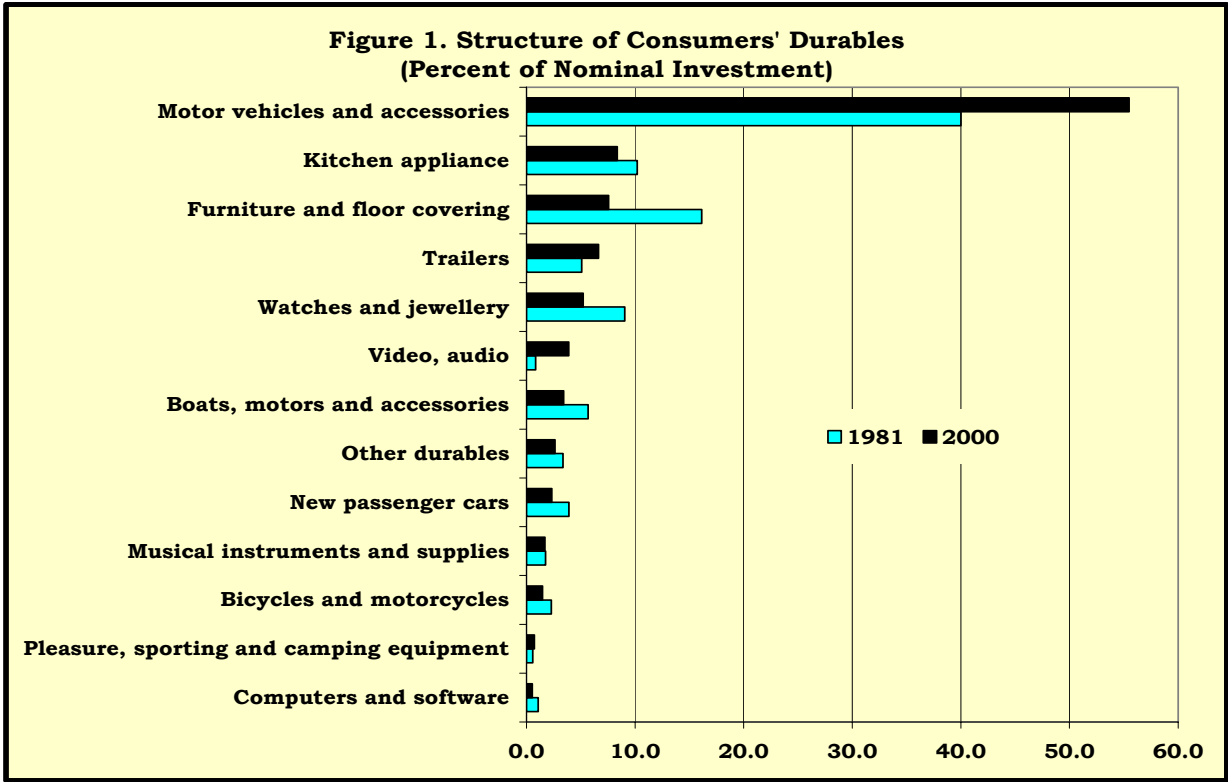
We then solve both equations for the imputed rate on equity ρ_t .

III. Empirical Results

The preceding section outlined our methodology for estimating the growth of capital services that is appropriate for an aggregate production function analysis. This process begins with real investment data by detailed asset, includes capital stock estimation via the perpetual inventory, and culminates in an estimate of total capital services that is based on the user cost methodology. This section documents the growth of investment, capital stock and capital services from 1981 to 2000, and its sub-periods. Next in this section, we present the impact of the accounting of the flow of services of consumers' durables and owner-occupied housing on the current price level of GDP, growth of real GDP, capital input and, accordingly, multifactor productivity growth.

1. Investment and Capital Stock

This section discusses the composition of households' non financial assets along with the trend in the quantity and the prices of individual assets. Figure 1 reports the distribution of consumers' durable assets in 1981 and 2000 as a share of household nominal investment spending. In 2000, motor vehicles and accessories accounted for 56% of households investment spending, compared with 40% in 1981. With less than 10%, furniture and floor covering and kitchen appliance, were the second largest assets in 2000. With the exception of motor vehicles and accessories and video and audio, the majority of other assets have experienced a decline in their share between 1981 and 2000. Figure 2 reports the share of owner-occupied housing assets in the total investment of housing. Unlike consumers' spending, the structure of investment in owner-occupied dwellings remained unchanged during the same period where about two-thirds of investment in housing is devoted to singles, followed far behind by multiples which represent close to 30%.



**Table 2. Growth Rates of Investment
(Average annual percentage rates of growth)**

	1981-2000		1981-1988		1988-2000		1988-1995		1995-2000	
	Price	Quantity	Price	Quantity	Price	Quantity	Price	Quantity	Price	Quantity
Consumer Durables	1.8	4.6	3.2	6.8	1.0	3.3	1.5	0.3	0.1	7.6
Furniture and floor covering	4.0	-1.5	7.1	-2.3	2.3	-1.0	5.7	-7.2	-2.4	8.5
Kitchen appliance	2.5	3.0	4.2	4.1	1.5	2.3	4.5	-3.1	-2.6	10.3
Computers and Software	-8.6	26.5	-11.3	42.0	-7.0	18.2	-4.1	17.5	-10.8	19.1
Video, audio	0.9	2.6	2.2	8.5	0.2	-0.6	2.2	-3.0	-2.5	2.9
Watches and jewellery	2.5	1.2	1.6	3.9	3.0	-0.3	3.6	-2.6	2.2	2.9
New passenger cars	5.8	2.6	6.0	6.7	5.6	0.2	7.2	-4.9	3.5	7.9
Motor vehicles and accessories	3.7	0.1	4.9	2.6	3.0	-1.3	6.2	-6.2	-1.3	6.0
Boats, motors and accessories	3.0	4.7	4.1	3.3	2.3	5.4	3.8	3.0	0.1	8.9
Pleasure, sporting and camping equipment	6.4	1.6	8.8	1.6	5.0	1.7	5.7	0.8	4.1	2.9
Trailers	4.0	2.4	4.8	2.8	3.6	2.2	5.1	-2.9	1.4	9.6
Musical instruments and supplies	5.4	-1.1	10.1	-10.2	2.7	4.7	2.3	10.8	3.4	-3.3
Bicycles and motorcycles	4.4	0.8	6.8	3.4	3.1	-0.7	6.9	-5.8	-2.1	6.9
Other durables	3.0	-0.2	4.2	0.4	2.3	-0.5	3.0	-3.4	1.2	3.8
Owner Occupied Dwellings	2.0	2.2	3.3	6.5	1.2	-0.1	2.4	-4.3	-0.5	6.1
Singles	2.3	2.3	3.9	6.9	1.3	-0.4	2.4	-5.5	-0.3	7.2
Multiples	2.3	2.5	4.0	6.9	1.3	0.0	2.6	-2.5	-0.4	3.6
Mobiles	2.1	-1.0	2.7	-11.2	1.7	5.4	2.9	2.5	0.0	9.6
Cottages	2.4	1.1	4.5	2.4	1.2	0.4	2.4	0.4	-0.5	0.4

Tables 2-4 present growth rates of four important data series—investment, capital stock and capital services—in both prices and quantities from 1981 to 2000 for consumers' durables and owner-occupied dwellings. To better understand aggregate trends, we present growth rates for each series for the major asset classes for the entire 1981-2000 period and for sub-periods: 1981-1988, 1988-2000, 1988-1995 and 1995-2000.

Table 2 shows that, at the aggregate level, investment in durable goods grew at 4.6% during the 1981-2000 period. The 1980s have experienced a rapid growth in the spending of consumers' durables, followed by a sharp slowdown in the 1990s (6.8% compared to 3.3%), due to the downturn of the Canadian economy in the early 1990s. During this period, consumers' durables investment advanced on average at a lacklustre 0.3% but vaulted to a 7.6% growth rate in the late 1990s. Investment in owner-occupied housing displayed a similar pattern, albeit with a deeper correction in the early 1990s, when it experienced a -4.3% decline on average, and recovered strongly in the subsequent period with an average 6.1%, a reflection of the housing market bubble.

There is a wide variation in the growth rates across different consumers' durable assets. The real investment growth rates ranged from -1.5% for furniture and floor covering to 26.5% for computers and software during the 1981-2000 period. The real investment in computers and software slowed from 42.0% per year during the 1981-1988 period to 17.5% for the 1988-1995 period. It rose, then, back to 19.1% per year during the 1995-2000 period. The enormous technological progress in the production of these high-tech capital goods has generated falling prices and fuelled the substitution towards information technology in households tangible assets nearly to the same extent as that occurring for businesses (see Harchaoui *et al.* 2004).

Owner-occupied dwellings increased at about half of the pace of consumers' durables during the 1981-2000 period (4.2% vs. 2.2%). Across different assets, the growth rate ranged from -1.0% for mobiles to 2.5% for multiples during this period. Owner-occupied dwellings show less variation in the growth rate across different assets and singles drove much of the growth of owner-occupied dwellings investment spending.

The trend in the growth rate of consumers' durables investment can be easily understood by examining the behaviour of relative prices. During the 1981-2000 period, the implicit price index of GDP for the private economy grew at 3.2% on average. The late 1990s experienced a modest 1.7% increase, compared to 4.6% during the 1980s. The relative price of consumers' durables investment declined at -1.4% during the 1981-2000 period. This modest decline is the result of relative price declines of

assets such as computers and software (-11.8%) and video and audio (-2.3%). Several assets, such as motor vehicles and accessories, kitchen appliance, bicycles and motorcycles and furniture and floor covering, experienced an acceleration in their relative price declines during the late 1990s. Following these relative price declines, households have followed a basic principle in economic—they have substituted towards relatively cheaper inputs.

The owner-occupied dwelling investment price declined at a -1.2% during the 1981-2000 period, reflecting to a large extent the price behaviour of singles and multiples, which account for the bulk of owner-occupied housing investment. Like some consumers' durables assets, singles and multiples have experienced an acceleration in their price declines during the late 1990s.

In response to these relative price changes in the late 1990s, households have invested in housing almost as rapidly as in furniture and floor covering and kitchen appliance. The rapid investment in these assets, however, appear to have different origins. The prices of owner-occupied dwelling assets have declined much more slowly, -0.3% per year for singles, versus -2.4% and -2.6% for furniture and floor covering and kitchen appliance, respectively, from 1995 to 2000. Complementarity between these assets is one possible explanation. A competing explanation is that the official price indexes used to deflate housing investment omit a large part of true quality improvements. This would lead to a substantial overstatement of price inflation and a corresponding understatement of real investment, capital services, and economic growth.

These investment patterns directly determine the growth of the capital stock reported in Table 3. For example, relatively fast high-tech equipment investment leads to faster capital stock growth rates and an increase in the capital stock share of equipment. The long-lived nature of other durable assets, however, makes this a slow transition process. The index of real capital stock of high-tech equipment, for example, has grown 28.5% per year over the 1981-2000 period, while single houses grew only 3.8%. The capital stock share of high-tech equipment in fixed reproducible capital in value terms, however, has marginally increased from 0.12% in 1981 to 0.83% in 2000. This small rise in the value share is due to the large increase in quantity of high-tech capital and the fall in the price of such capital.

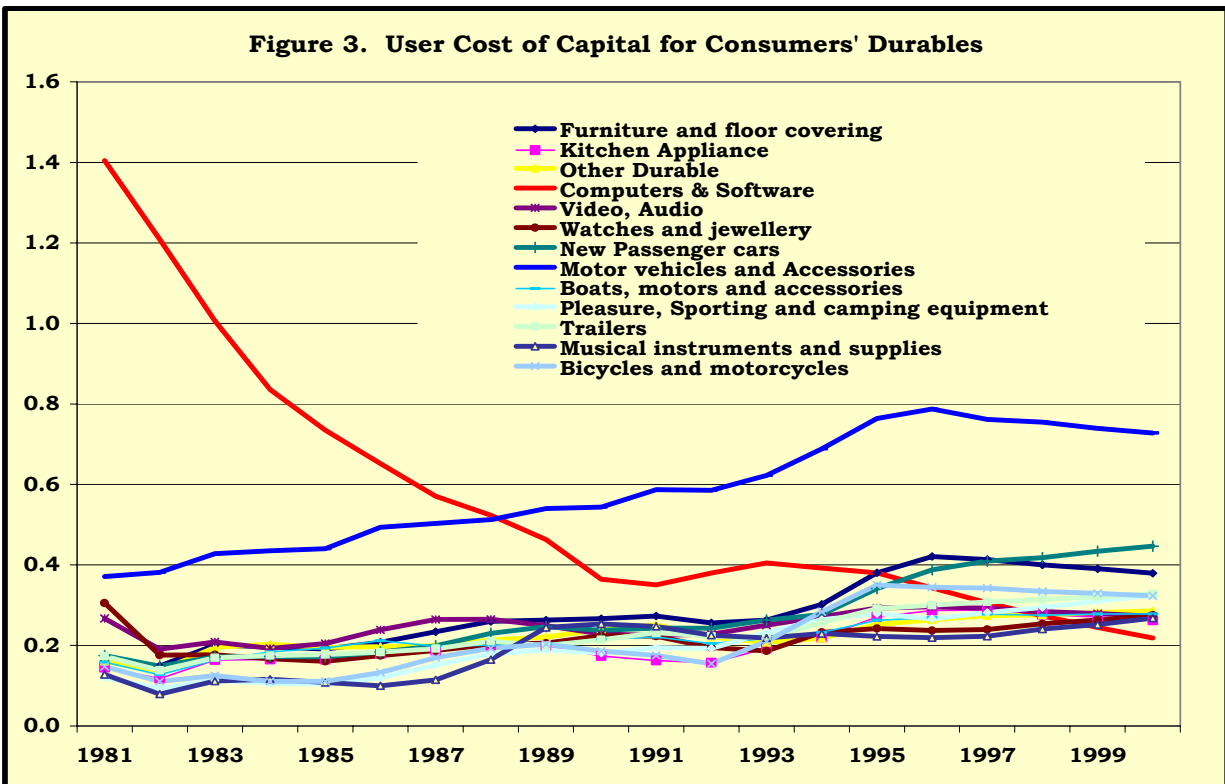
**Table 3. Growth Rates of Capital Stock
(Average annual percentage rates of growth)**

	1981-2000		1981-1988		1988-2000		1988-1995		1995-2000	
	Price	Quantity	Price	Quantity	Price	Quantity	Price	Quantity	Price	Quantity
Consumer Durables	4.3	1.5	5.6	3.3	3.6	0.5	5.5	-0.5	0.9	1.8
Furniture and floor covering	4.0	-2.5	7.1	-1.5	2.3	-3.0	5.7	-3.5	-2.4	-2.4
Kitchen appliance	2.5	1.7	4.2	3.1	1.5	0.9	4.5	0.5	-2.6	1.6
Computers and Software	-8.6	28.5	-11.3	44.2	-7.0	20.1	-4.1	21.1	-10.8	18.7
Video, audio	0.9	4.3	2.2	10.9	0.2	0.6	2.2	1.7	-2.5	-0.9
Watches and jewellery	2.5	1.0	1.6	2.8	3.0	-0.1	3.6	0.2	2.2	-0.5
New passenger cars	5.8	1.6	6.0	4.3	5.6	0.0	7.2	-1.3	3.5	1.9
Motor vehicles and accessories	3.7	-0.6	4.9	1.4	3.0	-1.7	6.2	-5.6	-1.3	4.0
Boats, motors and accessories	3.0	2.7	4.1	1.1	2.3	3.6	3.8	2.5	0.1	5.1
Pleasure, sporting and camping equipment	6.4	1.2	8.8	1.1	5.0	1.3	5.7	0.5	4.1	2.6
Trailers	4.0	-0.2	4.8	-1.8	3.6	0.8	5.1	-0.5	1.4	2.6
Musical instruments and supplies	5.4	2.6	10.1	2.0	2.7	2.9	2.3	1.8	3.4	4.4
Bicycles and motorcycles	4.4	1.0	6.8	4.1	3.1	-0.8	6.9	-1.2	-2.1	-0.2
Other durables	3.0	-0.2	4.2	1.0	2.3	-0.9	3.0	-1.5	1.2	-0.1
Owner Occupied Dwellings	2.3	3.6	3.9	4.1	1.3	3.3	2.5	3.4	-0.3	3.1
Singles	2.3	3.8	3.9	4.5	1.3	3.5	2.4	3.5	-0.3	3.3
Multiples	2.3	3.4	4.0	3.7	1.3	3.2	2.6	3.4	-0.4	2.9
Mobiles	2.1	-0.2	2.7	-0.6	1.7	0.1	2.9	-0.5	0.0	0.9
Cottages	2.4	3.2	4.5	3.9	1.2	2.8	2.4	2.9	-0.5	2.6

Much like for the investment series, the burst of the Canadian economy in the early 1990s has had a significant impact on consumers' durables capital stock as well. In contrast, owner-occupied dwellings capital stock experienced a somewhat steady increase during last two decades, a reflection of a lower depreciation rate compared to that of consumers' durables goods. Just as the investment series, capital stock of consumers' durables assets report a wider variation in their growth rates, compared to their owner-occupied dwellings counterparts.

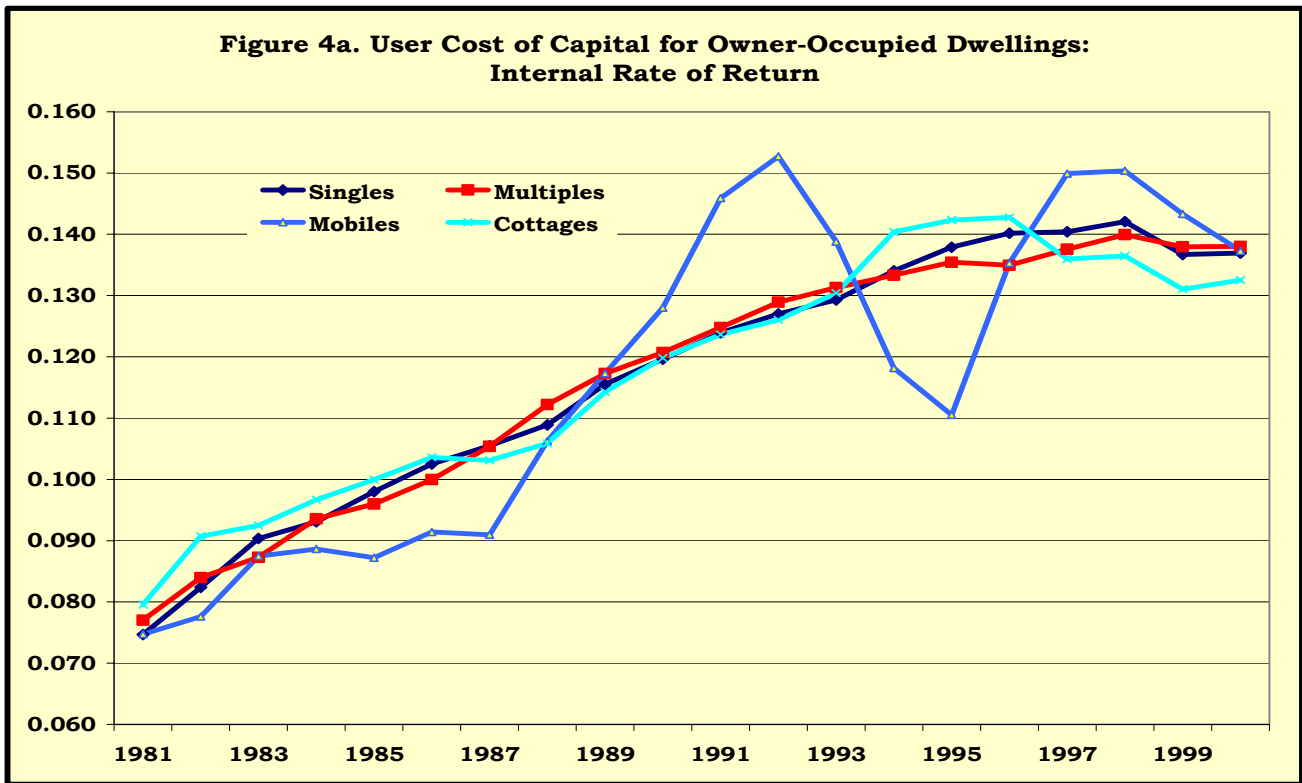
2. User Cost and Capital Services

Figure 3 presents the major trends in the price of consumers' durable asset services. The user cost of computers and software durable goods displays a downward trend, reflecting the rapid declines in the price of these assets. In contrast, the user cost of all other assets have shown an upward trend. The level of motor vehicles' user cost is the highest and shows the most rapid increase due primarily to its depreciation rate, the highest of all consumers' durable goods. During the late 1990s, it begun to show a modest decline as a result of the drop in the asset prices.



Estimates of user cost for owner-occupied dwellings have been derived under the internal and external rate of return assumptions. Figure 4a shows the trend of the user cost of capital during the 1981-2000 period using the internal rate of return assumption. Owing to similarities in the

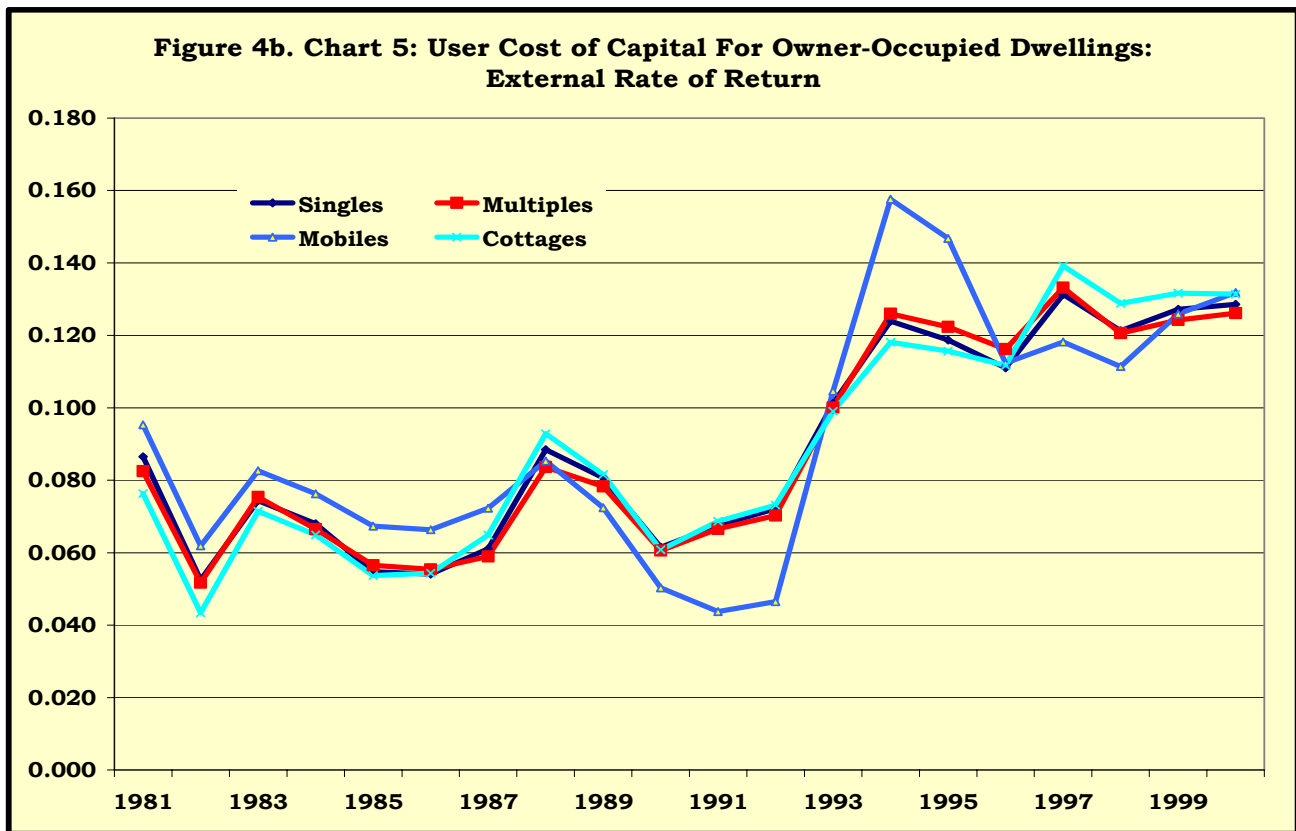
depreciation rates and in the trend of asset prices, the user cost across the different owner-occupied dwelling assets displays a similar level and a steady increasing trend, albeit with higher volatility for mobiles. Under the external rate of return assumption, Figure 4b shows that the user cost experienced a major upward shift in the early 1990s which doubled its level from the previous period. This sharp increase is largely attributable to the drop in the growth of residential assets prices from 3.3% to 1.2% in the 1990s, compared to the 1980s (see Table 1). Apart from this change, the user cost of capital for residential assets still shows a similar pattern across different assets with mobiles reporting the highest volatility.



We now move to estimates of capital services flows, where the individual assets of consumers’ durable goods and residential housing are aggregated using rental prices as weights. We refer to the difference between growth in capital services and capital stock as the growth in capital composition; this represents substitution towards assets with higher marginal products.

Table 4 presents the trends in the prices and quantities of capital services over the 1981-2000 period and its sub-periods. For owner-occupied dwellings, the estimates of capital services are shown under the two alternate rates of return discussed above.

Trends in the growth of the capital stock are major determinants of the growth of the capital services, and the relatively modest growth in the consumers' durables capital stock during the 1981-2000 period is mirrored by a modest capital services growth. Consumers' durables capital services growth exceeds moderately capital stock growth at the aggregate level, however, which reflects the ongoing substitution of short-lived equipment for long-lived structures. This shift in composition is measured as increases in capital quality. All else being equal, a short-lived asset has a higher depreciation rate and thus a relatively higher service price. As a consequence, the fast growing short-lived assets receive a higher weight in the capital service aggregation compared to their weight in the aggregate capital stock. For individual asset classes, these results show capital service growth identical to capital stock in most periods, which implies that asset substitution does not occur within these assets classes due to the lack of asset details beyond these classes.



The rate of growth of consumers' durable capital services fell to 0.4% per year in the 1990s from 3.6% in the 1980s. This sharp slowdown is the result in the slump of the Canadian economy during the early 1990s when the growth of consumers' durables experienced a 0.5% decline.

**Table 4. Growth Rates of Capital Services
(Average annual percentage rates of growth)**

	1981-2000		1981-1988		1988-2000		1988-1995		1995-2000	
	Price	Quantity	Price	Quantity	Price	Quantity	Price	Quantity	Price	Quantity
Consumer Durables	3.4	1.6	3.6	3.6	3.4	0.4	4.9	-0.5	1.2	1.8
Furniture and floor covering	4.6	-2.5	6.9	-1.5	3.2	-3.0	5.6	-3.5	-0.1	-2.4
Kitchen appliance	3.2	1.7	4.7	3.1	2.3	0.9	4.4	0.5	-0.6	1.6
Computers and Software	-9.3	28.5	-13.2	44.2	-7.0	20.1	-4.5	21.1	-10.5	18.7
Video, audio	0.1	4.3	-0.1	10.9	0.2	0.6	1.4	1.7	-1.4	-0.9
Watches and jewellery	-0.6	1.0	-5.8	2.8	2.6	-0.1	2.6	0.2	2.6	-0.5
New passenger cars	5.1	1.6	4.0	4.3	5.7	0.0	5.8	-1.3	5.5	1.9
Motor vehicles and accessories	3.6	-0.6	4.7	1.4	3.0	-1.7	5.9	-5.6	-1.0	4.0
Boats, motors and accessories	3.0	2.7	3.4	1.1	2.8	3.6	3.9	2.5	1.2	5.1
Pleasure, sporting and camping equipment	5.4	1.2	5.9	1.1	5.1	1.3	6.5	0.5	3.1	2.6
Trailers	3.4	-0.2	2.9	-1.8	3.8	0.8	4.7	-0.5	2.4	2.6
Musical instruments and supplies	4.0	2.6	3.7	2.0	4.1	2.9	4.4	1.8	3.8	4.4
Bicycles and motorcycles	4.2	1.0	3.9	4.1	4.4	-0.8	8.9	-1.2	-1.6	-0.2
Other durables	3.1	-0.2	4.2	1.0	2.4	-0.9	2.4	-1.5	2.5	-0.1
Internal Rate of Return										
Owner Occupied Dwellings	3.2	3.6	5.5	4.1	1.9	3.3	3.2	3.4	0.0	3.1
Singles	3.2	3.8	5.5	4.5	1.9	3.5	3.4	3.5	-0.1	3.3
Multiples	3.1	3.4	5.5	3.7	1.7	3.2	2.7	3.4	0.4	2.9
Mobiles	3.3	-0.2	5.2	-0.6	2.2	0.1	0.6	-0.5	4.4	0.9
Cottages	2.7	3.2	4.2	3.9	1.9	2.8	4.3	2.9	-1.4	2.6
External Rate of Return										
Owner Occupied Dwellings	2.2	3.6	0.4	4.1	3.3	3.3	4.7	3.4	1.3	3.1
Singles	2.1	3.8	0.3	4.5	3.2	3.5	4.3	3.5	1.6	3.3
Multiples	2.3	3.4	0.2	3.7	3.5	3.2	5.6	3.4	0.6	2.9
Mobiles	1.7	-0.2	-1.6	-0.6	3.7	0.1	8.1	-0.5	-2.1	0.9
Cottages	2.9	3.2	2.8	3.9	2.9	2.8	3.2	2.9	2.6	2.6

The late 1990s have seen a recovery in the growth of these assets, though their growth remained only half of that posted during the 1980s. Owing to the same level of detail, both of consumers' durables capital services and capital stock show a similar growth at the individual asset level. Prices of capital services tend to increase more rapidly than asset prices, with the largest differences occurring for furniture and floor covering, kitchen appliance and trailers, which altogether accounted for close to one third of consumers' durable investment in 2000 (see Figure 1).

Whether based on internal or external rate of return, owner-occupied dwellings' capital services present the same growth rates. During the 1981-2000 period, capital services grew at 3.6% on average. The growth was 4.1% during the 1981-1988 period and slowed down to 3.3% in the subsequent period. Singles have consistently shown the most rapid growth, particularly during the 1980s when their capital services grew 4.5% on average, the fastest growth over the last twenty years. There is no difference between the growth of capital services and capital stock, reflecting the lack of compositional change across different assets. This is primarily due to that fact that depreciation rates and capital gains do not vary much.

3. Impact on GDP, Capital Input and Productivity

The objective is to quantify the impact of accounting for the flow of consumers' durable goods and owner-occupied housing on GDP, capital input and, accordingly, multifactor productivity growth.

Recall that under our extended framework the purchase of new housing and consumers' durables are included in investment. We treat these two types of capital consistently and include both housing and consumers' durable assets services flow in the capital stock measure, and the flow of services from the installed stock of each in consumption output and capital input in the aggregate production possibility frontier. This contrasts with the current practice where housing is not part of the coverage and spending on consumers' durables are not treated as capital formation. With these changes, the order of magnitude of GDP is increased, its structure slightly altered and its growth rate somewhat reduced.

Our estimate of current dollar GDP for the private economy in 2000 is \$978 billion, including imputations of \$90.6 billion that reflect services of consumer durables and housing along with \$113.3 billion of investment spending in these two categories of assets. In terms of nominal GDP, the business sector accounted for 79.2% of the private economy, unchanged from 1981.

Table 5 shows the structure of GDP for the business sector and the private economy. Over the 1981-2000 period, consumer expenditures and investment now account for 63.2% and 35% on average, respectively, compared to 68.2% and 29% under the official treatment. With 18%, household investment represents the largest component of aggregate investment, compared to 13.5% for business investment and 3.1% for public investment. During this period, the flow of consumers' durables accounted on average for 9.5% of consumption, compared to 8.7% for housing. This contrasts with investment in housing which accounted for 9.8% of household investment, slightly higher than the 8.2% for durables. Although the flow of consumers' durable remained the largest component of consumption, its share experienced a much modest increase from 9.1% to 9.7% between the 1980s and the 1990s. This contrasts with the share of the flow of services of housing which increased much more rapidly during these two periods from 7.8% to 9.1%.

Table 5. Structure of GDP (Percent of current prices)

	1981-2000	1981-1988	1988-2000	1988-1995	1995-2000
Business Sector					
Consumer Expenditures	68.2	66.6	69.1	70.2	67.4
Durables	10.5	10.4	10.7	10.7	10.6
Others	57.7	56.2	58.4	59.6	56.8
Investment	29.0	30.4	28.4	29.0	27.0
Public	3.9	4.2	3.8	4.1	3.3
Business	17.3	18.1	16.8	16.4	17.1
Household (renovation)	7.8	8.2	7.8	8.5	6.6
Others	2.8	3.0	2.6	0.7	5.6
Private Sector					
Consumer Expenditures	63.2	61.5	64.1	64.8	63.2
Durables	9.5	9.1	9.7	9.6	10.0
Housing	8.7	7.8	9.1	9.2	9.1
Others	45.1	44.6	45.3	46.0	44.2
Investment	34.6	36.1	33.9	34.7	32.4
Public	3.1	3.3	2.9	3.2	2.6
Business	13.5	14.4	13.0	12.7	13.3
Household	18.0	18.4	18.0	18.8	16.5
Durables	8.2	8.2	8.3	8.2	8.3
Housing	9.8	10.2	9.6	10.6	8.1
Others	2.2	2.4	2.0	0.6	4.4

Real GDP of the private economy grew at 2.7% per year for the entire 1981-2000 period, compared with 3.0% for the official GDP series employed by the CPA (see Table 6). In general, GDP growth of the private

economy has been slower than that of the business sector and more sensitive to the downturn of the economy during the early 1990s. This is largely attributable to investment and the flow of services of housing and durables which account for a significant portion of investment, tend to grow slowly, and are largely subject to the effects of the business cycle. The private economy grew 3.2% per year during the 1981-1988 period but slowed down significantly during the subsequent period at 2.4%. In comparison, the business sector has shown a more rapid growth during these two periods and a more moderate slowdown between in the early 1990s (3.3% vs. 2.9%, respectively). To a large extent, the slower GDP growth of the private economy can be understood by a more rapid growth of its price index compared to that of the business sector.

**Table 6. Growth Rates of Real GDP
(Average annual percentage rates of growth)**

	1981-2000		1981-1988		1988-2000		1988-1995		1995-2000	
	Price	Quantity	Price	Quantity	Price	Quantity	Price	Quantity	Price	Quantity
Business sector	2.8	3.0	4.3	3.3	2.0	2.9	2.1	1.5	1.8	4.9
Private economy	3.2	2.7	4.6	3.2	2.4	2.4	2.9	0.9	1.6	4.5

Table 7 shows the contribution of final demand categories to GDP growth. Over the 1981-2000 period, the contribution of consumption and investment to the business sector GDP is larger than that to the private economy (52.9% vs 49.2% for consumption and 37.5% and 31.5% for investment). Consumption contributed to the bulk of the private economy GDP growth during the 1980 and the 1990s (45.6% and 52.3%, respectively), followed by investment and other components, which include net exports. Household investment contributed close to three quarters of the 1.2% increase in total investment, but collapsed in the 1990s to the benefit of business investment.

We now discuss the estimates of the capital stock and the flow of capital services and corresponding price indexes. We employ a broad definition of capital, including tangible assets such as equipment and structures, as well as owner occupied housing, consumers' durables, land, and inventories. We estimate a service flow from the installed stock of these assets.

Table 7. Contribution of Final demand Categories to Real GDP Growth (Average annual percentage points)

	1981-2000	1981-1988	1988-2000	1988-1995	1995-2000
	Business Sector				
GDP	3.0	3.2	2.9	1.5	4.9
Consumer Expenditures	1.6	1.7	1.5	0.8	2.5
Durables	0.5	0.6	0.3	0.0	0.8
Others	1.1	1.1	1.2	0.8	1.7
Investment	0.7	0.8	0.7	-0.1	2.0
Public	0.1	0.1	0.1	-0.1	0.0
Business	0.4	0.3	0.4	0.0	1.3
Household (renovation)	0.3	0.4	0.2	0.0	0.6
Others	0.7	0.7	0.7	0.8	0.4
	Private Economy				
GDP	2.7	3.2	2.4	0.9	4.5
Consumer Expenditures	1.3	1.5	1.2	0.8	1.8
Durables	0.1	0.3	0.0	0.0	0.2
Housing	0.3	0.3	0.3	0.3	0.3
Others	0.9	0.9	0.9	0.6	1.3
Investment	0.8	1.2	0.6	-0.5	2.3
Public	0.1	0.1	0.1	0.1	0.0
Business	0.4	0.2	0.5	0.1	1.3
Household	0.4	0.9	0.0	-0.7	1.0
Durables	0.2	0.4	0.0	0.0	0.6
Housing	0.1	0.4	0.0	-0.7	0.4
Others	0.5	0.5	0.5	0.6	0.3

Table 8. Structure of Capital (Percent of current prices)

	1981-2000	1981-1988	1988-2000	1988-1995	1995-2000
	Capital Services				
Private Economy	100.0	100.0	100.0	100.0	100.0
Business sector	62.6	64.8	61.3	60.6	62.1
Consumers' durables	19.5	18.9	19.9	20.1	19.8
Housing	17.9	16.2	18.8	19.3	18.2
	Capital Stock				
Private Economy	100.0	100.0	100.0	100.0	100.0
Business sector	61.4	64.7	59.3	59.6	58.7
Consumers' durables	13.3	12.3	14.0	13.9	14.1
Housing	25.3	22.9	26.7	26.5	27.2

Our estimate of capital stock is \$2.3 trillion in 2000, substantially larger than the \$1.4 trillion in fixed tangible capital estimated by the Canadian

productivity accounts. This difference reflects our inclusion of owner occupied housing and consumer's durables, estimated at \$624 and \$322 billion, respectively. In terms of capital stock, the share of business sector was 59.4% of the private economy in 2000, down from 66.7% in 1981.

Table 8 shows the structure of capital stock and capital services for the business sector and the private economy. Over the 1981-2000, the business sector accounted for close to 63% of the private economy in terms of nominal domestic capital income, compared to 61.4% for nominal capital stock. Consumers' durable assets accounted for only 19.5% of the total capital service flow, but a much larger share than the corresponding capital stock shares. This reflects the rapid price declines and high depreciation rates that enter into the rental price of some of the assets of the business sector and consumers' durables. In contrast, high capital gains and small depreciation rates have significantly reduced the share of owner-occupied dwellings in gross domestic capital income.

Table 9 shows that capital stock of the private economy grew at 2.5% on average during the 1981-2000 period, compared to 2.2% for the business sector. After a relatively rapid 2.7% increase during the 1980s, the private economy capital stock slowed down at 2.3% during the 1990s, a sharp contrast with the business sector which saw its capital stock grow more rapidly during the latter period (2.3% compared to 1.9%). This is due primarily to consumers' durables capital stock which slowed down from 3.6% to 0.4% between the early 1980s and the late 1990s. After a modest increase during the early 1990s, the growth of the private economy capital stock almost doubled during the late 1990s to reach slightly more than 3% on average.

The aggregate capital services of the private economy increased at an average growth rate of 3.1% during the 1981-2000 period, slightly lower than the 3.3% for the business sector. Capital services have generally grown more rapidly than capital stock across the different subperiods, a reflection of the shift in the composition of capital towards assets with higher marginal products such as information technology.

Table 10 presents estimates of multifactor productivity measures. The private economy has shown virtually no multifactor productivity gain over the 1981-2000 period, compared to a lacklustre 0.3% for the business sector. This is due to a slower growth in GDP of the private economy compared to that of the business sector while capital input grew almost at the same pace, reflecting differences in the share of housing and durables in GDP and gross domestic income. In general, multifactor productivity growth of the private economy grew at a smaller pace than that of the business sector, particularly during the early

**Table 9. Growth Rates of Real Capital Services
(Average annual percentage rates of growth)**

	1981-2000		1981-1988		1988-2000		1988-1995		1995-2000	
	Price	Quantity	Price	Quantity	Price	Quantity	Price	Quantity	Price	Quantity
	Capital Service									
Private sector	2.9	3.1	4.3	3.7	2.2	2.7	2.4	2.2	1.9	3.5
Business sector	2.7	3.4	4.2	3.6	1.8	3.3	1.4	2.6	2.4	4.3
Consumer durable	3.4	1.6	3.6	3.6	3.4	0.4	4.9	-0.5	1.2	1.8
Housing	3.2	3.6	5.5	4.1	1.9	3.3	3.2	3.4	0.0	3.1
	Capital Stock									
Private sector	2.3	2.5	3.6	2.7	1.6	2.3	2.7	1.7	0.2	3.2
Business sector	2.0	2.2	3.1	1.9	1.3	2.3	2.1	1.5	0.3	3.4
Consumer durable	4.3	1.5	5.6	3.3	3.6	0.5	5.5	-0.5	0.9	1.8
Housing	2.3	3.6	3.9	4.1	1.3	3.3	2.5	3.4	-0.3	3.1

**Table 10. Multifactor Productivity Growth Rates
(Average annual percentage rates of growth)**

	1981-2000	1981-1988	1988-2000	1988-1995	1995-2000
Private Economy	0.0	0.1	-0.1	-0.8	0.9
Business Sector	0.3	0.3	0.3	-0.2	1.0

1990s, a period of slow growth of the Canadian economy. The late 1990s, however, stand in contrast to the other sub-periods, as the private sector's multifactor productivity grew at almost a similar pace as that of the business sector. This is primarily due to the more rapid growth of the business sector's capital services which outweigh the less rapid increase of the private economy GDP growth.

IV. Conclusion

In this paper, we have extended the coverage of the CPA from the notion of the business sector to that of the private economy. The difference between these notions stems from the inclusion of owner-occupied dwellings as durables assets on both sides of the aggregate production possibility frontier. Since that consumers' durable goods share many similarities with owner-occupied dwellings, they were treated symmetrically. The account of owner-occupied dwelling and consumers' durable goods in the aggregate framework requires two adjustments. One is to add to conventional gross fixed capital formation capital spending on owner-occupied dwellings and household expenditures on consumer durables (treated as consumption in the Income and Expenditures Accounts). The second is to add to consumption and capital services a measure of the flow of services yielded by the installed capital stocks of consumer durables and owner-occupied dwellings. The imputations for services of consumer durables are based on the cost of capital for consumer durable. The cost of capital is multiplied by the real value of the consumer durable stock to obtain the imputed service flow from consumer durables. The rental value of owner-occupied housing is imputed to households, based on Statistics Canada estimates.

This approach has proved to be useful in many important respects:

First, it helped quantifying the impact of the extension in the CPA coverage from the business sector to the private economy. Current dollar GDP of the private economy is \$978 billion in 2000, and real GDP growth averaged 2.7% over the 1981-2000 period. These magnitudes can be compared to the current dollar value of \$775 and the average real growth of 3.0% for the business sector GDP. The difference reflects investment and the flow of services of consumers' durables and owner-occupied dwelling assets. Gross domestic capital income for the private economy is \$481 billion in 2000 and real capital services advanced at an average of 3.1% over the last two decades. In comparison, the business sector gross domestic capital income is \$313 billion and its capital services increased at a 3.4% on average. The difference here stems from the services flow of durables and owner-occupied dwellings. Whether at the business sector or the private economy, productivity of capital services remained unchanged at -0.4% over the 1981-2000 period.

Second, it has been exploited to capture the important impact of information technology not only on businesses but also on households (see Harchaoui *et al.* 2004). Following the relative price declines of information technology, businesses and households have made huge commitments to spending in terms of computers, software and communication equipments. In response, the growth contribution of these assets to GDP and capital input increased more than two-fold in the late 1990s compared to the 1980s.

Third, the estimates of gross household capital income derived from this approach can be added to the value of unpaid work estimated by Statistics Canada to arrive at the notion of gross household product. This notion recognizes households as producers, and not merely as consumers, using their own labour and capital. A natural extension of this paper is, therefore, to derive the estimates of gross household product for Canada.

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