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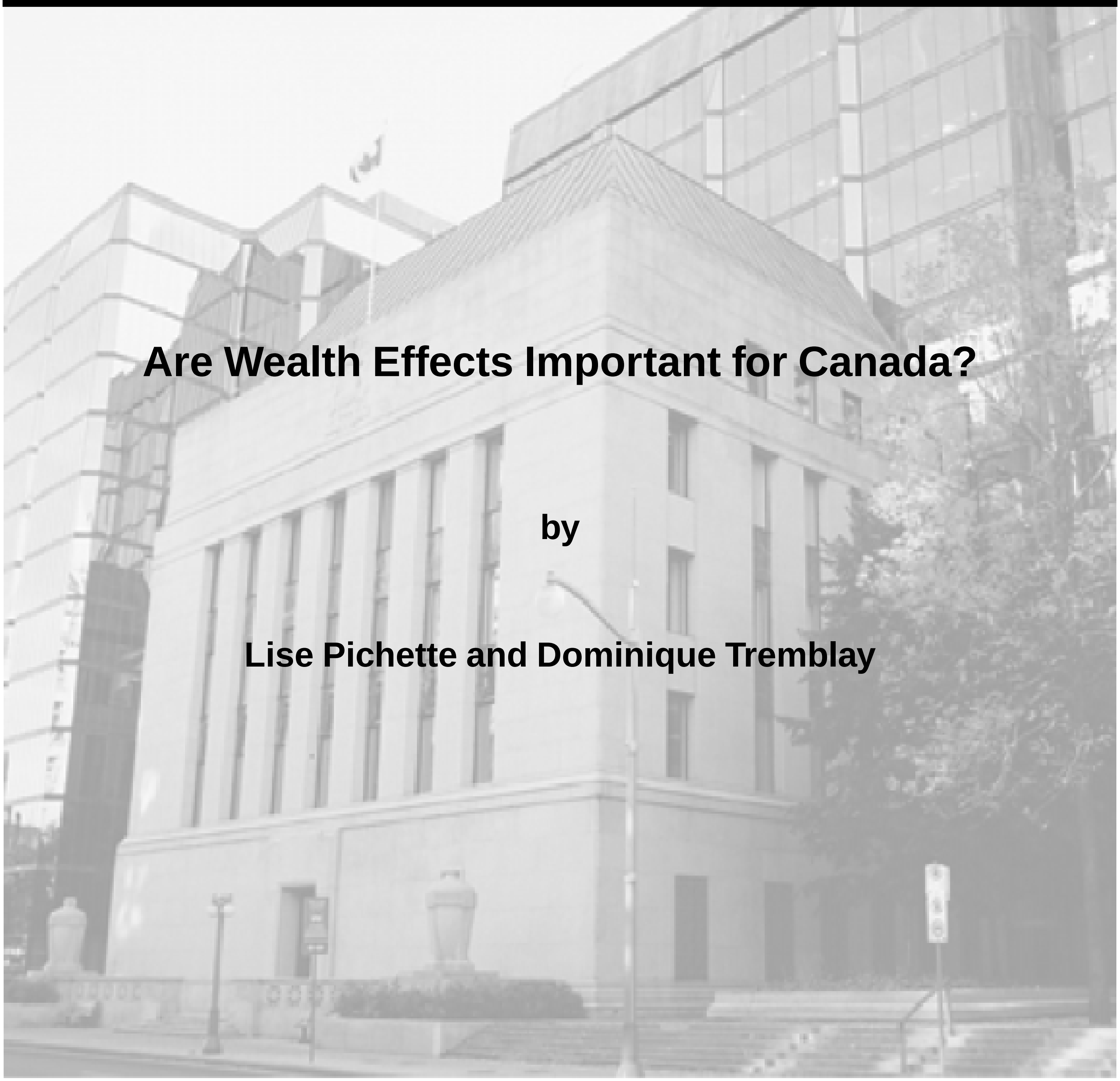

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Abstract

The authors examine the link between consumption and disaggregate wealth in Canada. They use a vector-error-correction model in which permanent and transitory shocks are identified using the restrictions implied by cointegration proposed by King, Plosser, Stock, and Watson (1991) and Gonzalo and Granger (1995). This procedure allows the authors to identify the reaction of consumption to both types of shocks and to calculate average marginal propensities to consume out of disposable income, human wealth, stock market wealth, and housing wealth. The authors find evidence of a significant housing wealth effect for Canada. Conversely, the evidence regarding the stock market wealth effect is weak. In terms of policy implications, other things being equal, the analysis of future inflationary pressures would require that more weight be put on fluctuations in housing prices than on fluctuations in stock prices.

JEL classification: E21, C32
Bank classification: Domestic demand and components

Résumé

Les auteurs étudient le lien entre la consommation et les composantes de la richesse au Canada. Pour ce faire, ils emploient un modèle vectoriel à correction d’erreurs en identifiant les chocs permanents et transitoires au moyen des restrictions de cointégration proposées par King, Plosser, Stock et Watson (1991) ainsi que par Gonzalo et Granger (1995). Cette méthode permet aux auteurs de cerner la réaction de la consommation à ces deux catégories de choc. Elle leur permet aussi de calculer les propensions marginales moyennes à consommer le revenu disponible, la richesse humaine, la richesse boursière et la richesse immobilière. Les auteurs constatent que la richesse immobilière a un effet significatif au Canada, mais qu’il n’en est pas ainsi pour la richesse boursière. Du point de vue de la politique monétaire, les autorités devraient donc tenir compte davantage de l’évolution du prix des maisons que des fluctuations des cours boursiers dans l’analyse des pressions inflationnistes à venir, toutes choses égales par ailleurs.

Classification JEL : E21, C32
Classification de la Banque : Demande intérieure et composantes

1. Introduction

Theoretically, there are good reasons to believe that greater wealth entails higher consumption. For that reason, many economists argue that the large appreciation of the stock market from 1995 through 2000 and the increase in household wealth that followed were the driving forces behind the strength of consumer spending during that time. The data for Canada, which suggest that higher wealth played a role in maintaining consumer spending over the last decade, seem to be consistent with this argument. Even though the disposable income-to-GDP ratio decreased during the last decade, the consumption-to-GDP ratio was relatively stable (Figure 1). Another way to highlight the possible influence of wealth accumulation on consumption is to plot the non-human wealth-to-disposable income ratio and the savings rate (Figure 2). While the personal savings rate has plunged over the last few years, the wealth-to-disposable income ratio has increased significantly. The usual explanation for this negative correlation is that stock market wealth, largely responsible for the rise of this ratio, has boosted consumption and reduced savings.

If equity prices really were driving consumer expenditures, then one might expect—other things being equal—a slowdown in consumption, now that they have fallen back to lower levels. However, while it is true that stock assets account for a large and increasing fraction of household wealth—it now represents more than half of Canadians' non-human wealth—almost a quarter of this wealth is also held in housing. Given this proportion and the current tight housing market in Canada, one must therefore take into consideration the effect of changing housing prices.

Although theories that analyze the role of wealth in consumption behaviour do not usually imply different effects for different types of wealth, there are many reasons to believe that the marginal propensities to consume (MPC) out of these two types of wealth—housing and stock market—should be different. First, the distribution of housing wealth is less concentrated among the richest households than the distribution of stock market wealth.[1] Since households with smaller wealth are likely to have a higher MPC than wealthier households, the effects of these two kinds of wealth on consumption are expected to be different. Second, households might consider shocks to the housing market less volatile than shocks to the financial markets. For that reason, households might be willing to modify their consumption

[1] Di (2001) finds that about two-thirds of U.S. households own their homes, while less than half own stocks. For Canada, Drolet, Morissette, and Zhang (2002) find a much higher Gini coefficient for stocks than for housing.

more rapidly following a change in house prices. Third, housing wealth is less liquid than stock market wealth, and transaction costs associated with the former are usually higher than for the latter. This argument is related to the functioning of the financial system, which can, in some cases, constrain households from using their houses as collateral, resulting in a relatively smaller wealth effect from housing. But such constraints have been remarkably reduced in Canada since the early 1960s, which should, in principle, facilitate the use of property as collateral. Boone, Girouard, and Wanner (2001), however, find that this financial liberalization of liquidity constraints has a mixed impact on Canadian households. Fourth, capital gains resulting from housing wealth are likely to have a higher MPC, since gains from that type of wealth have a fiscal advantage relative to stock maket gains.

It therefore seems reasonable to consider disaggregate wealth when empirically studying wealth effects on consumption. In fact, many recent studies have examined one aspect or other of the relationship between aggregate consumption and wealth, but few have extended their framework to include various components of wealth.

The main objective of this paper is to examine the empirical relationship between disaggregate wealth and consumption using Canadian data. We focus on the role of stock market wealth and housing wealth in explaining aggregate movements in consumption, using a vector-error-correction model (VECM) in which permanent and transitory shocks are identified using the restrictions implied by cointegration as proposed by King, Plosser, Stock, and Watson (1991) (hereafter KPSW) and Gonzalo and Granger (1995). This procedure allows us to identify the reaction of consumption to both types of shocks and to calculate average MPC out of disposable income, human wealth, stock market wealth, and housing wealth. We find evidence of a significant housing wealth effect for Canada. Conversely, the evidence regarding the stock market wealth effect is weak.

Section 2 provides a brief survey of the literature. Section 3 describes the concepts and the data used. Section 4 describes the econometric framework and the main results. Section 5 offers some conclusions.

2. Literature Review

Since the publication of Friedman's (1957) permanent-income hypothesis and Ando and Modigliani's (1963) life-cycle model, a lot of work has been done to determine the relationship between consumption, wealth, and income. With the increase in equity wealth in the second half of the 1990s and the more recent increase in house prices, the impact of stock market wealth and housing wealth on consumption has received increasing attention. In this section, we focus on recent studies done on the subject in other countries, and briefly describe some studies done in a Canadian context.

In the United States, the MPC out of wealth, estimated with traditional macroeconomic models, is generally between three and seven cents to the dollar. For example, Ludvigson and Steindel (1999) conclude that a one-dollar increase in wealth leads to a three-to-four cent increase in consumption. However, they find that the relation is rather unstable over time.

Maki and Palumbo (2001) find a similar estimate of the wealth effect for the United States. They combine macroeconomic and microeconomic data for their analysis, which allows them to investigate the stock market wealth effect for households in different quintiles of income distribution or level of education. According to their results, households that benefited the most from the exceptional performance of the stock market in the late 1990s were the richest and were the ones who lowered their savings rate the most significantly. Maki and Palumbo also report that most U.S. households owned a relatively modest share of equity in their portfolios and that their net worth did not increase much following the surge in stock prices.

The methodology commonly used to estimate the MPC is a simple error-correction model (ECM) (Davis and Palumbo 2001). Davis and Palumbo find that aggregate consumption in the United States adjusts only gradually to changes in income or wealth, and that these changes must persist over a sufficiently long period to have a significant effect on the level of consumer spending.

Lettau, Ludvigson, and Barczi (2001) highlight the limits of the ECM. They criticize Davis and Palumbo's (2001) methodology, arguing that it implies that consumption is the variable that does all the error correction when consumption, wealth, and labour income deviate from their long-run equilibrium. In fact, there is no empirical evidence that consumption does most of the adjustment. To address this problem, Lettau, Ludvigson, and Barczi (2001) suggest proceeding with a VECM. This more advanced econometric method allows one to take into account the dynamic responses of all variables in the cointegrating vector. Their results for the United States indicate that wealth does the error correction, while the adjustment parameter for consumption is about zero.

Lettau and Ludvigson (2001) use the VECM approach to go further in their interpretation of the results. Using the methodology of KPSW and Gonzalo and Granger (1995), they identify the permanent and transitory elements of asset wealth. Interestingly, they find that most of the variation in the growth of wealth is transitory. This is attributable to fluctuations in the stock market component of wealth, and these transitory shocks do not have any significant effect on consumption. Aggregate consumption is determined only by the trend component of wealth and labour income. Based on this analysis, the wealth effect is relatively small compared with that calculated in previous studies. Because consumption responds exclusively to the permanent component of wealth, the authors estimate that consumption would rise by only 1.4 cent following a one-dollar increase in wealth.

For Canada, Macklem (1994) developed a measure of wealth that can be divided in two components: human wealth and non-human wealth. He noted that changes in non-human wealth seem to be driven by fluctuations in stock prices. Moreover, it appears that non-human wealth is the most volatile component of total wealth. Using an ECM, Macklem shows that non-human wealth is not significant in a long-run relationship. When equity wealth is excluded from the measure of non-human wealth, however, its effect becomes significantly different from zero. Macklem suggests two interpretations for these results. First, consumers consider changes in equity prices to be transitory shocks, so fluctuations fail to have any significant effect on the level of long-run consumption. Second, aggregate consumption does not respond very much to stock price variations, because only a small share of households own equities in their portfolios. The estimated wealth effect is approximately a 3.5 cent[2] increase in consumption on non-durable goods and services following a one-dollar increase in non-human wealth, excluding equities.

Using the same methodology as Macklem (1994), Pichette (2000) focuses on the effect of stock market wealth on total consumption (including durable goods) in Canada. In that case, fluctuations in equity prices have a statistically significant long-run effect on consumption of about 3 per cent of the asset price change. In terms of MPC, this means that a one-dollar increase in the value of equity leads to a 2.2 cent increase, on average, in consumption (for the sample period 1965Q1 to 1998Q4).

Also using an ECM, Girouard and Blöndal (2001) study the link between consumption and different components of wealth for OECD countries. Their results point to an MPC out of housing wealth of around 0.18 for Canada over the period 1973Q1 to 1998Q2.

Using a panel of 14 countries and a panel of U.S. states, Case, Quigley, and Shiller (2001)

[2]Wealth effects, in terms of a cents-per-dollar increase in wealth, are calculated by multiplying the reported elasticities by the latest value of C_t/W_t^i for studies that do not explicitly give such a measure and for which the original data set is available.

find, at best, weak evidence of a stock market wealth effect. However, their results show a large and robust impact of an increase in housing prices on consumption, with elasticities ranging from 0.11 to 0.17 for their international comparison.

For the U.S. economy, Desnoyers (2001) uses the KPSW methodology, but defines wealth as being composed of only two elements: stock market wealth and housing wealth. He finds that the MPC out of stock market wealth is an increase of about 5.8 cents per dollar, whereas the tendency to consume out of housing wealth could be an increase of as large as 20 cents per dollar.

3. Data Analysis

Data used in this empirical study are quarterly series that cover the period 1964Q2 to 2000Q4.[3] Appendix A gives a detailed description of the data. Sections 3.1 and 3.2 describe the construction of the wealth variables and some issues regarding the consumption series.

3.1 Wealth

The real per-capita total wealth variable (w) used in this paper is defined as in Macklem (1994) and can be written as:

$$W_t = A_t - D_t^f + (L_t - G_t) + E_t \left[\sum_{i=1}^{\infty} \prod_{j=1}^{i} \left(\frac{1}{1 + r_{t+j}} \right) (L_{t+i} - G_{t+i}) \right], \qquad (1)$$

where A is net domestic and foreign physical and financial assets, D^f is the government debt held by foreigners, L is labour income, G is real government expenditures on goods and services, r is the real interest rate, and E_t is the expectations operator conditioned on information available at time t. $(L - G)$ can be considered as a measure of labour income net of taxes, since, under the Ricardian equivalence proposition, the value of government debt held by households is offset by future tax liabilities.

Total wealth can be divided into two broad components: non-human wealth (nhw) and human wealth (hw). This latter type of wealth is computed in the following manner:

$$HW_t = X_t \left[1 + E_t \left[\sum_{i=1}^{\infty} \prod_{j=1}^{i} \left(\frac{1 + x_{t+j}}{1 + r_{t+j}} \right) \right] \right] \equiv X_t \kappa_t, \qquad (2)$$

[3] Because we wanted to use the longest sample possible, more recent data are not included in the sample, since Fisher chained GDP was not available before 1981 at the time of the estimation.

where $X = (L - G)$, x is its growth rate, and κ represents the term in the outer square brackets. Measuring human wealth is not an easy task, because the cumulative growth factor, κ, is not observable, since it depends on expectations. Lettau and Ludvigson (2001) use disposable income as a proxy for human wealth; this is the simplest way to measure it when no data are available. In Canada, Macklem (1994) developed a time-series model to calculate human wealth. This is not very different from Lettau and Ludvigson (2001), since, in their work, human wealth is equal to $k{*}Y$ (where k is a constant and Y is disposable income). Using Macklem's measure implies that k is a function of future expected income growth and future expected interest rates.[4]

Non-human wealth is the sum of all real and financial assets net of liabilities. It is measured at market value. Stock market wealth (s) and housing wealth (h), the variables of particular interest in this paper, are part of non-human wealth and are, respectively, defined as stocks held by persons as well as by unincorporated businesses and residential structures net of mortgages. Figure 3 plots non-human wealth and both its stock market and housing wealth components. As Macklem (1994) notes, developments in non-human wealth seem to have been driven mainly by stock market wealth over the last decade. During that period, the share of stocks in household portfolios increased significantly, from less than 25 per cent at the beginning of the sample to more than 50 per cent in 2000. Conversely, the share of housing declined continuously, from 34 per cent in the early sixties to less than 25 per cent in 2000. Nonetheless, housing wealth still represents an important fraction of household wealth.

3.2 Consumption

Consumer theory implies that agents' utility is derived from the service flow that goods and services provide. Yet, there exists no straightforward way of computing the service flow obtained from durable goods. This has led many researchers to use real expenditures on non-durable goods and services as a proxy for total real consumption. This approach assumes that real consumption of non-durable goods and services is a constant fraction of total real consumption. Blinder and Deaton (1985), however, note that this underlying assumption is not verified for level measures of U.S. consumption. For that reason, Lettau and Ludvigson (2001) opt for the log of non-durable goods and services as a proxy for the log of total real consumption, since, they argue, the relationship between those two

[4]For technical details on the construction of human wealth, see Macklem (1994).

components is more stable than their level counterparts. In contrast, Palumbo, Rudd, and Whelan (2002) use the relative stability of the nominal ratio to justify their use of the level of nominal expenditures on non-durable goods and services as an approximation for total consumption. We follow Lettau and Ludvigson and assume that the share of the log of non-durable goods and services in the log of total consumption is constant over time. This assumption might not be a strong one for Canada, since, as Figure 4 shows, the log ratio of total to non-durable real consumption is relatively constant over the estimation period.

4. Empirical Analysis

This section introduces the VECM and the identification strategy that we adopt to identify the permanent and transitory shocks.

4.1 The VECM

Our analysis is based on the following reduced-form VECM:

$$\Delta X_t = \mu_t + \sum_{j=1}^{l} A_j \Delta X_{t-1} + \alpha\beta' X_{t-1} + \varepsilon_t, \tag{3}$$

where X_t is a $n \times 1$ vector of cointegrated *I(1)* variables, α and β are two $n \times r$ matrices with full rank, and $0 \leq r \leq n$ is the number of cointegrating vectors. The reduced-form shocks are assumed to have the following properties: $E_t\left[\varepsilon_t \varepsilon_{t-j}\right] = 0 \; \forall \; j \neq 0$, $E_t\left[\varepsilon_t\right] = 0$ and $Var\left[\varepsilon_t\right] = \Sigma_\varepsilon$.

Since ΔX_t is assumed to be stationary, the above reduced form can be represented in moving-average form as:

$$\Delta X_t = \mu + C(L)\varepsilon_t, \tag{4}$$

where C_i are $n \times n$ matrices of estimated parameters, $C_0 = I_n$, and $C\left(1\right)$ is a reduced rank $n \times (n-r)$ matrix if there exists one or more cointegrating relationships denoted by r. Starting from this reduced-form moving-average representation, the following structural form has to be identified:

$$\Delta X_t = \mu + \Gamma(L)\eta_t, \tag{5}$$

where η_t is an $n \times 1$ vector of unknown structural innovations with $E_t[\eta_t \eta_{t-j}] = 0, \forall\, j \neq 0$, $E_t[\eta_t] = 0$, and $Var[\eta_t] = \Sigma_\eta$. The Γ_j are $n \times n$ matrices that need to be identified and where τ_{kl}, a typical element, measures the effect of the l^{th} structural shock on the k^{th} variable after j periods.

The identification problem is as follows: what are the main conditions that will permit us to recover the structural innovations, η_t, and the lag polynomial, $\Gamma(L)$, from both the reduced-form innovations, ε_t, and the lag polynomial, $C(L)$? Since the reduced and the structural innovations are related by $\varepsilon_t = \Gamma_0 \eta_t$, it follows that $\Sigma_\varepsilon = \Gamma_0 \Sigma_\eta \Gamma_0'$. The variance-covariance matrix of the structural innovations, Σ_η, has $\frac{n\times(n+1)}{2}$ distinct unknown elements, the variance-covariance matrix of the reduced-form innovations, Σ_ε, contains $\frac{n\times(n+1)}{2}$ distinct estimated elements, and Γ_0 has n^2 unknown elements. Given that the number of estimated elements is smaller than the number of unknown elements, identification restrictions will have to be imposed.

Before applying the VECM procedure, it is important to examine whether the available data are well-suited to this approach. ADF and Phillips-Perron unit root tests are hence applied to the level and the first difference of all variables. Results from these tests indicate that, for all variables in levels, it is not possible to reject, at the 5 per cent level, the null of a unit root, whereas the same hypothesis is rejected when this test is applied to their first difference (Tables 1 and 2).

To test for the presence and the number of cointegrating relationships, we use two types of cointegration tests. The first is a residual-based test designed to distinguish a system without cointegration from a system with at least one vector of cointegration. Residuals are obtained from the estimation of the following equations by ordinary least squares (OLS):

$$c_t = \beta_0 + \beta_1 y_t + \beta_2 w_t + \varepsilon_t, \tag{6}$$

$$c_t = \beta_0 + \beta_1 y_t + \beta_2 hw_t + \beta_3 nhw_t + \varepsilon_t, \tag{7}$$

$$c_t = \beta_0 + \beta_1 y_t + \beta_2 hw_t + \beta_3 nhwxsh_t + \beta_4 s_t + \beta_5 h_t + \varepsilon_t. \tag{8}$$

If there is a cointegrating relationship between these variables, the estimated residual $(\hat{\varepsilon})$ will be stationary. Hence, we apply the ADF and Phillips-Perron unit-root tests to the cointegrating residuals to determine their integration order. Results are given at the bottom of Table 3. The hypothesis of no cointegration is rejected at the 5 per cent level for all three models for both tests.

The second type of cointegration test used in this paper is a procedure developed by Johansen (1988, 1991). It allows us to determine the number of cointegrating relationships in a multivariate system, as in (3). Two test statistics are provided by the Johansen procedure: the Trace and the L-max. In the first case, under the null hypothesis, H_0, there are exactly r cointegrating relationships, and under the alternative, H_1, there are n cointegrating relationships. The second statistic is obtained by testing the null hypothesis of r cointegrating relationships against the alternative of $r+1$ cointegrating relationships. Table 3 shows the results for these test statistics.

According to the results of the L-max and Trace tests, there is no strong evidence of a cointegrating relationship between consumption, disposable income, and total wealth. The same conclusion is reached when we allow human wealth and non-human wealth to have different effects, since both statistics establish no evidence of cointegration. This conclusion might seem counterintuitive, but we must keep in mind that such tests may not be very powerful. However, if non-human wealth is divided into its stock (s), housing (h), and remainder components ($nhwxsh$), we find evidence of a cointegrating relationship according to both the L-max test and the Trace test. We have also tested every combination of the variables and the different tests did not clearly support any other cointegrating relationships.

The least-squares estimates obtained from the static regressions (6) to (8) may, however, suffer from significant bias in small samples, and this is why we use the Stock and Watson (1993) dynamic least-squares procedure[5] to obtain consistent estimates of the long-run coefficients (Table 4). These estimates indicate the significant determinants of trend movements in consumption. In our first specification, disposable income and total wealth appear to be important determinants of consumption, given their highly significant coefficients, which are, respectively, 0.63 and 0.25. When total wealth is divided into its human and non-human components, we still find significant estimates and a coefficient for income that is relatively high.

In our third specification, which separates non-human wealth between stock, housing, and the remainder, all variables are highly significant determinants of consumption. The coefficient related to income, however, is a little lower than what was obtained for the

[5]This procedure adds leads and lags of the first difference of each regressor to equations (6) to (8) to correct for missing dynamics and the endogeneity problem. The lag structure was determined using the Schwarz Information Criterion (SIC).

previous regressions. This could be explained by the introduction of disaggregate wealth components into the regression. The stock market wealth coefficient may look very small, especially when compared with the one for housing wealth, which appears to explain a larger fraction of movements in the stochastic trend of consumption. This result is not very surprising, since, as stated earlier, housing is, among other things, a more largely held asset with a less variable return.

The preceding inferences, and the ones that follow, are valid only if the parameters of the long-run specifications used above are stable over time. To test for possible instability in these coefficients, we use the $SupF$ test, the $MeanF$ test, and the L_c test. These tests, which can be applied to regressions with $I(1)$ processes, have been proposed by Hansen (1992), and all share the same null hypothesis of no parameter instability. These tests, however, differ in their choice of alternative hypothesis. The first test tries to identify a structural break with unknown timing. Hence, Hansen recommends that it be used to investigate a possible swift shift in regime. The second and third tests model the cointegrating vector as a martingal process, and should be used primarily to test whether the specification under study captures a stable relationship, as opposed to one that is slowly changing over time. As Hansen notes, since the lack of cointegration is a special case of the alternative hypothesis considered, the $SupF$ test, the $MeanF$ test, and the L_c test can also be viewed as cointegration tests, with the null being the presence of cointegration. The results for these three tests are reported in Table 5. According to these statistics, it is not possible to reject the null of stability against a number of alternatives that represent one form or another of instability. The results of the $MeanF$ test for the third specification might weakly suggest a gradual change in the parameters of this equation, an evidence of instability that is, however, not confirmed by the other two tests. Hence, there are good reasons to believe that the cointegrating relationships under study are stable ones. These results also support the view that consumption, income, and either wealth or some of its components are cointegrated.

Because the main objective of this study is to examine the various wealth effects, we focus on $X_t = (y, hw, s, h, nhwxsh, c)$ and assume that there is only one cointegrating relationship between these variables. This single relationship is given by $\alpha = (-\beta_1, -\beta_2, -\beta_3, -\beta_4, -\beta_5, 1)$, where the cointegrating coefficient on consumption has been normalized to one. We can then estimate the VECM defined in (3) where β is equal to $\hat{\beta}$, the vector of estimated parameters obtained from the Stock and Watson (1993) dynamic least-squares procedure for the third model. The results of the estimated VECM are shown in Table 6.[6] The fact that at least one adjustment coefficient, $\hat{\alpha}$, is significantly different from zero supports the existence of a cointegrating relationship between the variables at hand. Although Pichette (2000) assumes that all of the adjustment to the long-run equilibrium was done by consumption, we find that this adjustment is more likely to be done by human and stock market wealth, since their adjustment coefficients are economically large and highly significant. Results from equations that test the ability of the error-correction term to predict changes in human and stock market wealth over various horizons are as expected: deviations from the common trend are good predictors of future movements in human and stock market wealth (Tables 7 and 8), because these variables make most of the adjustment following a disequilibrium. This conclusion holds for up to 8 quarters.

4.2 Permanent component

Because the model used to examine the different wealth effects includes six variables and one cointegrating relationship, we know from Stock and Watson (1988) that this cointegrated system will be driven by five common trends. This means that we will have five permanent shocks and one transitory shock.

To identify informative permanent shocks, we follow a procedure proposed by KPSW (1991), which relies on two sets of restrictions. First, the cointegrating vector is used to constrain the matrix of long-run multipliers. Second, permanent shocks are assumed to be uncorrelated with each other and with the transitory shock. In our model, these restrictions affect the matrix of long-run multipliers in the following manner:

$$\Gamma(1) = \tilde{A}\Pi = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ \beta_1 & \beta_2 & \beta_3 & \beta_4 & \beta_5 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ \pi_{21} & 1 & 0 & 0 & 0 \\ \pi_{31} & \pi_{32} & 1 & 0 & 0 \\ \pi_{41} & \pi_{42} & \pi_{43} & 1 & 0 \\ \pi_{51} & \pi_{52} & \pi_{53} & \pi_{54} & 1 \end{bmatrix}.$$

The matrix $\tilde{A}$ gives the impact of each permanent shock on consumption. For instance, the first column states that a one per cent increase in disposable income will eventually increase consumption by β_1 per cent. The second column says that a one per cent increase

[6] The lag structure of the VECM was chosen using the SIC, which Ivanov and Kilian (2000) find to be the most accurate criterion for quarterly VECM. However, additional lags were added to remove serial correlation left in the error terms.

in human wealth will increase consumption by β_2 per cent in the long run, etc. Except for the zero constraints, the matrix Π lets each permanent shock have a long-run impact on each variable. Its π_{ij} elements are also determined to ensure that the permanent innovations are uncorrelated with each other.

An intuitive way to examine the effects of these permanent shocks is to simply plot the related impulse-response functions that give the magnitude of consumption's response to a shock over a certain horizon. These response functions are of interest because it is usually assumed that consumers will modify their consumption patterns only after experiencing permanent changes to their income or wealth. Figures 5 to 9 display these responses along with their 90 per cent bootstrap-after-bootstrap confidence intervals.[7]

Following a permanent shock to disposable income that will eventually lead to a one per cent increase in income, consumption gradually rises to more than 0.6 per cent. The response of consumption to a permanent human wealth shock is around 0.04 per cent during the first 5 quarters and, thereafter, it reaches its long-term value at a little more than 0.2 per cent. Such a response means that human wealth has some significant explanatory power for consumption over and above the disposable income's informational content. However, the fact that disposable income is still an important determinant of consumption might suggest the existence of habit formation, or that some households are liquidity-constrained.

The importance of a shock to stock market wealth for consumption is not very clear. After such a shock, consumption rapidly increases to 0.04 per cent in 3 quarters, only to fall to around 0.01 per cent after 20 quarters. It is, however, important to note that this positive response is insignificant for all horizons. Consumption's reaction to a permanent shock to housing wealth is, on the contrary, relatively strong and significant. Following a housing shock, consumption rapidly goes up to 0.1 per cent and gradually stabilizes to its long-run value at 0.08 per cent. The discrepancy between the effects of these two types of wealth on consumption is consistent with the fact that housing is more largely held than equity. The same argument can be used to justify the explanatory power of non-human wealth excluding stock and housing, which includes, among other things, currency and deposits.

4.3 Transitory component

To this point, we have concentrated on the impact of permanent changes in wealth on consumption. However, it is probable that movements in wealth are not exclusively permanent

[7] Appendix C gives more details on the bootstrap-after-bootstrap procedure.

and, for that reason, it might be instructive to also investigate the transitory component of each variable and their interrelations. The methodology used so far has not permitted the explicit study of such a question. Hence, in this section, we introduce a procedure proposed by Gonzalo and Ng (2001) that will enable us to address this matter.

Defining a structural model as in KPSW and following the methodology initially described by Gonzalo and Granger (1995), the estimated parameters α and β are used to identify the permanent and transitory innovations.[8] Again, the reduced-form Wold representation of the system can be written as follows:

$$\Delta X_t = \mu + C(L)\varepsilon_t. \tag{9}$$

A new distributed lag operator, $D(L)$, is defined as being equal to $C(L)G^{-1}$, where

$$G = \begin{pmatrix} \alpha'_{\perp} \\ \beta' \end{pmatrix}$$

and $\alpha'_{\perp}\alpha = 0$. Following Gonzalo and Ng (2001), $\alpha_{\perp}$ is calculated using the eigenvectors associated with the $n-r$ smallest eigenvalues of the matrix $\alpha\alpha'$. A structural form of the type of equation (5) is obtained with η_t being set equal to $G\varepsilon_t$. Each variable is then expressed in terms of a set of permanent and transitory innovations.

Intuitively, this transformation implies that variables that do much of the adjustment to restore the long-run equilibrium, and thus have a large α, will have a large weight on transitory innovations. In other words, variables that participate in the error correction deviate from trend, which means that they contain a transitory component. In contrast, variables for which the associated adjustment coefficient is small and insignificant will have a small weight on transitory innovations.

As we have shown, the adjustment coefficients associated with human and stock market wealth are both significant and economically large, which means that these two variables are mainly responsible for the restoration of the equilibrium following a shock. Human and stock market wealth components are therefore expected to have a large weight in the transitory innovation. Although the adjustment coefficient in the consumption growth equation has the expected negative sign, it is relatively small and insignificant. This suggests that consumption plays a very small role in the adjustment towards equilibrium following

[8]Gonzalo and Granger (1995) define a shock, i, as being permanent if $\lim_{h\to\infty} \frac{\partial E(x_{t+h})}{\partial \eta_t^i} \neq 0$ and transitory if $\lim_{h\to\infty} \frac{\partial E(x_{t+h})}{\partial \eta_t^i} = 0$.

a shock. Hence, following a permanent innovation in wealth or income, consumption would have to adjust very rapidly to its new level. But, as Figures 5 to 9 show, consumption adjusts more or less rapidly to restore the equilibrium. This could be due to the presence of habit formation, or it could result from the fact that some households are borrowing-constrained and indicate the presence of a transitory component in consumption.

4.4 Variance decomposition

One easy way to determine the permanent and transitory components of each variable is to compute its forecast variance decomposition. Table 9 depicts the fraction of the total forecast-error variance that is attributable to permanent (P) and transitory (T) shocks. Results from this table indicate that, for all horizons, most of the variability in consumption, disposable income, and housing wealth is explainable by permanent shocks, with little variation being due to the transitory shock. In the case of non-human wealth, excluding stock and housing, virtually all changes are attributable to permanent shocks. The result is somewhat different for movements in human and stock market wealth, since they contain a larger transitory component. If consumption responds essentially to permanent changes in wealth, this could mean that the MPC out of equity wealth could be lower than what has been commonly estimated. We will come back to this point in the next section.

As we argued earlier, consumption seems to adapt with a lag to transitory deviations from the common trend. The variance decomposition described above, however, is not very explicit regarding the possible links or covariances between permanent and transitory innovations, since orthogonality between the various shocks is assumed. Table 10 shows the variance-covariance decomposition of the unorthogonalized shocks. As for the variance decomposition of the orthogonalized innovations, stock market and human wealth growth still have an important transitory component; consumption, income, and housing wealth changes are mainly permanent, but have a small transitory component; the remainder wealth movements are almost all attributable to permanent shocks. The results shown in Table 10 also indicate the covariance between the permanent and the transitory component of a variable ($\widetilde{\epsilon}^P$,$\widetilde{\epsilon}^T$). One of the covariances of interest here is for consumption growth. The permanent component of consumption is slightly correlated with its transitory counterpart, which confirms our previous finding that consumption adjusts rapidly, but not instantaneously, to permanent shocks.

4.5 Marginal propensities to consume

In most papers in this field, the coefficients of the wealth variables in the cointegrating equation are interpreted as the MPC applying to every movement in wealth. As Lettau and Ludvigson (2001) show, however, this MPC does not take into account the possible influence of transitory changes. For instance, how should the stock market wealth effect be interpreted if not all fluctuations in equity are permanent changes? To answer this question could significantly modify the estimated MPC out of this wealth component.

We have shown, using the variance decomposition, that changes in some wealth components can be partly explained by transitory shocks. We have not discussed the possible influence of these transitory fluctuations on consumer spending. Figure 10 shows the response of consumption to the transitory shock. Even though consumption increases immediately at the time of the shock, it immediately falls down in the following periods. This response, however, is never statistically significant. Given this fact, transitory fluctuations do not seem to explain much consumer spending at any horizon.

Now that we have information on the permanent and transitory components of wealth and their respective impacts on consumption have been studied, we can calculate MPC that incorporate these elements. Hence, following Lettau and Ludvigson (2001), we can obtain the MPC out of an average movement in wealth using the following formula:

$$MPC_i = \pi_i \cdot \Phi_i^T + (1 - \pi_i) \cdot \Phi_i^P, \tag{10}$$

where i is a wealth component (for instance, stock or housing), π is the percentage of the wealth variation that is transitory, $(1 - \pi)$ is the percentage of the wealth variation that is permanent, Φ^T is the MPC out of a transitory movement in wealth, and Φ^P is the MPC out of a permanent movement in wealth.

We have shown that consumption does not significantly adjust following a transitory shock. This means that the MPC out of such a movement in wealth, or Φ^T, is null, or at best very weak. Figures 5 to 9 show the response of consumption to a one per cent change in income and in each measure of disaggregate wealth. Multiplying these responses by the latest value of C_t/W_t^i gives us the MPC out of a permanent movement in wealth component i, Φ^T. Because our variance decomposition gives us the share of each shock in the variability of a variable in squared changes, the percentage in wealth fluctuations that is transitory is given by $\pi_i = \frac{\sqrt{\epsilon_i^T}}{\sqrt{\epsilon_i^T}+\sqrt{\epsilon_i^P}}$. For instance, given that 22 per cent of the variability in stock market wealth growth is attributable to the transitory shock at an infinite horizon, we will have $\pi_s = 0.35$.

We have calculated the MPC out of average movements in disposable income and in our various measures of wealth using the above equation. Four conclusions can be drawn from these numbers.

First, the MPC associated with disposable income is relatively high; it reaches around a 65 cents per dollar increase in disposable income, whereas its human wealth counterpart is much lower, at a little more than 0.1 cent per dollar increase in human wealth. Because human wealth represents the actual value of all future labour incomes, this MPC out of human wealth indicates that households not only base their current consumption decisions on present income, but also on the future flow of revenues.

Second, the MPC out of stock market wealth is weak, with less than a 0.5 cent per dollar increase in stock market wealth. This result is not that surprising, since, as we argued earlier, direct holding of equities is essentially concentrated in the hands of wealthier households that probably do not have an MPC as large as that of median households. In addition, wealthier households surely have other assets to use as collateral when the time arrives to borrow at a cheap rate and, hence, their consumption patterns do not depend on stock market movements. The exclusion of durable goods from our analysis, however, might bias this MPC downward, since stock market gains are often redirected toward the purchase of this type of goods.

Third, with a significant MPC of 5.7 cents per dollar, housing wealth is without doubt a variable to examine when studying the future evolution of consumption. Again, the fact that this type of wealth has a stronger link with consumption than stock market wealth can be explained by its more equal distribution among households and its larger permanent component.

Fourth, as shown by the impulse responses, it takes a certain time for consumption to completely adjust to the various shocks. Hence, the full effects of a movement in wealth on consumption are not going to be felt immediately, but gradually. Even if the MPC out of stock market wealth is very weak, large permanent movements in equity prices might still have a non-negligible impact on consumption. The MPC is surely not high enough, however, to explain sustained consumer expenditures or the observed drop in savings.

5. Conclusion

The main objective of this paper has been to examine the empirical relationship between various components of wealth on consumer spending. We have focused on housing and stock market wealth. Using a methodology developed by KPSW (1991) and Gonzalo and Ng (2001), and following Lettau and Ludvigson (2001), we calculated average MPC out of movements in these wealth variables by taking into consideration their permanent and transitory components. As expected, we found that the effect of stock market wealth on consumption is significantly different from the housing wealth effect. This finding is in line with the results of previous studies for the United States, such as those by Case, Quigley, and Shiller (2001) and Desnoyers (2001). Using Canadian data, we found an average MPC out of housing wealth that is, at an increase of 5.7 cents per dollar, much greater than the MPC out of stock market wealth, which is very small, less than a cent, and insignificant.

At first appearances, the stock market wealth effect may seem very small when compared with its housing counterpart, but we think that these results can be easily explained by the higher concentration of stocks among wealthier households, the difference in fiscal treatment between the two types of wealth, and the more transitory nature of stock market fluctuations. Other factors, such as mortgage refinancing and the more frequent use of housing wealth as collateral, are likely to widen this gap even more in the future. A recent Canadian Imperial Bank of Commerce study indicates that, since 2001, Canadians have obtained an additional $22 billion from the refinancing of their houses and the use of such an asset as collateral.

These results are important from a monetary policy viewpoint, in that movements in wealth, and especially in housing wealth, directly affect consumption, which in turn has an impact on aggregate demand and inflation. It is also important to remember that the link between asset prices and aggregate demand does not sum up to the wealth effects. There exist other connections, such as a possible direct causal link from stock prices to business investment or a cost-of-capital effect, that one may want to take into account when studying the full impact of asset prices on inflation. And while it is clear that movements in asset prices that have a direct influence on future inflation forecasts should be taken into account in the conduct of monetary policy, the question of whether movements above this effect should, or, perhaps more importantly, could, be taken into consideration by central bankers is still open to debate.

Bibliography

Ando, A. and F. Modigliani. 1963. "The Life Cycle Hypothesis of Savings: Aggregate Implications and Tests." *American Economic Review* 53: 55-84.

Blinder, A. and A. Deaton. 1985. "The Time-Series Consumption Function Revisited." *Brookings Papers in Economic Activity* 2: 465-521.

Boone, L., N. Girouard, and I. Wanner. 2001. "Financial Market Liberalisation, Wealth and Consumption." OECD Economic Department Working Paper No. 308.

Case, K.E., J.M. Quigley, and R.J. Shiller. 2001. "Comparing Wealth Effects: The Stock Market Versus the Housing Market." National Bureau of Economic Research. NBER Working Paper Series No. 8606.

Davidson, R. and J.G. Mackinnon. 1993. *Estimation and Inference in Econometrics.* New York: Oxford University Press.

Davis, M.A. and M.G. Palumbo. 2001. "A Primer on the Economics and Time Series Econometrics of Wealth Effects." Federal Reserve Board. Finance and Economics Discussion Paper No. 2001-09.

Desnoyers, Y. 2001. "L'effet de la richesse sur la consommation aux États-Unis." Bank of Canada Working Paper No. 2001-14.

Di, Z.X. 2001. "The Role of Housing as a Component of Household Wealth." Harvard University. Joint Center for Housing Studies. W01-6.

Drolet, M., R. Morissette, and X. Zhang. 2002. "The Evolution of Wealth Inequality in Canada, 1984-1999." Statistics Canada. Analytical Studies Branch Research Paper Series No. 187.

Dupuis, D., J. Rossiter, C. St-Arnaud, and G. Wright. 2002. "International House Price Comparisons." Bank of Canada. Unpublished manuscript.

Engle, R.F. and C.W.J. Granger. 1987. "Co-integration and Error Correction: Representation, Estimation and Testing." *Econometrica* 55(2): 251-76.

Faust, J. and E.M. Leeper. 1997. "When Do Long-Run Identifying Restrictions Give Reliable Results?" *Journal of Business and Economic Statistics* 15(3): 345-53.

Friedman, M. 1957. "A Theory of the Consumption Function." Princeton University Press, Princeton.

Girouard, N. and S. Blöndal. 2001. "House Prices and Economic Activity." OECD Working Paper No. 279.

Gonzalo, J. and C.W.J. Granger. 1995. "Estimation of Common Long-Memory Components in Cointegrated Systems." *Journal of Business and Economic Statistics* 13: 24-35.

Gonzalo, J. and S. Ng. 2001. "A Systematic Framework for Analyzing the Dynamic Effects of Permanent and Transitory Shocks." *Journal of Economic Dynamics and Control* 25: 1527-46.

Hansen, B.E. 1992. "Test for Parameter Instability in Regressions with $I(1)$ Processes." *Journal of Economic Business and Statistics* 10(3): 45-59.

Ivanov, V. and L. Kilian. 2000. "A Practitioner's Guide to Lag-Order for Vector Autoregressions." Manuscript.

Johansen, S. 1988. "Statistical Analysis of Cointegrating Vectors." *Journal of Economic Dynamics and Control* 12: 231-54.

———. 1991. "Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models." *Econometrica* 56: 1551-80.

Karakoulas, G. and B. Tal. 2003. "Banking on the House." CIBC World Markets.

Kilian, L. 1998. "Small-Sample Confidence Intervals for Impulse Response Functions." *The Review of Economics and Statistics* 80: 218-30.

King, R.G., J.C. Plosser, J. Stock, and M. Watson. 1991. "Stochastic Trends and Economic Fluctuations." *American Economic Review* 81(4): 819-40.

Lettau, M. and S. Ludvigson. 2001. "Understanding Trend and Cycle in Asset Values: Bulls, Bears and the Wealth Effect on Consumption." CEPR Discussion Paper No. 3104.

Lettau, M., S. Ludvigson, and N. Barczi. 2001. "A Primer on the Economics and Time Series Econometrics of Wealth Effects: A Comment." Federal Reserve Bank of New York.

Ludvigson, S. and C. Steindel. 1999. "How Important is the Stock Market Effect on Consumption?" *FRBNY Economic Policy Review* July: 29-51.

Macklem, T. 1994. *Wealth, Disposable Income and Consumption: Some Evidence for Canada.* Technical Report No. 74. Ottawa: Bank of Canada.

Maki, D.M. and M.G. Palumbo. 2001. "Disentangling the Wealth Effect: A Cohort Analysis of Household Saving in the 1990s." Federal Reserve Board.

Newey, W.K. and K.D. West. 1987. "A Simple Positive, Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix." *Econometrica* 55(3): 703-8.

Palumbo, M., J. Rudd, and K. Whelan. 2002. "On the Relationship between Real Consumption, Income, and Wealth." Federal Reserve Board and Central Bank of Ireland.

Pichette, L. 2000. "Les effets réels du cours des actions sur la consommation." Bank of Canada Working Paper No. 2000-21.

Poterba, J.M. and A.A. Samwick. 1995. "Stock Ownership Patterns, Stock Market Fluctuations, and Consumption." Brookings Papers on Economic Activity, No. 2, 295-357.

Runkle, R. 1987. "Vector Autoregressions and Reality." Federal Reserve Bank of Minneapolis. Research Department Staff Report No. 107.

Stock, J. and M. Watson. 1988. "Testing for Common Trends." *Journal of the American Statistical Association* 83: 1097-1107.

———. 1993. "A Simple Estimator of Cointegrating Vectors in Higher Order Integrated Systems." *Econometrica* 61: 783-820.

Table 1: Augmented Dickey-Fuller Test

Variables	c	y	w	hw	nhw	$nhwxsh$	s	h
x	-2.108	-1.045	-1.488	-1.692	-2.767	-1.880	-1.760	-1.547
	(0.54)	(0.93)	(0.83)	(0.75)	(0.21)	(0.66)	(0.72)	(0.81)
Δx	-3.470	-5.254	-4.089	-4.177	-5.823	-3.169	-6.651	-3.220
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.02)

Notes: p-values associated with the corresponding statistics are in parentheses. The lag structures for the ADF equations are chosen using the Modified Akaike Information Criterion (MAIC).

Table 2: Phillips-Perron Test

Variables	c	y	w	hw	nhw	$nhwxsh$	s	h
x	-2.353	-1.208	-1.807	-1.897	-2.910	-1.756	-1.962	-1.959
	(0.40)	(0.91)	(0.70)	(0.65)	(0.16)	(0.72)	(0.62)	(0.62)
Δx	-12.421	-14.097	-14.793	-15.198	-10.934	-9.767	-1.962	-1.959
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Note: p-values associated with the corresponding statistics are in parentheses.

Table 3: Cointegration Tests

Test	H_0	c,y,a	c,y,hw,nhw	$c,y,hw,nhwxsh,s,h$
L-max	$r=0$	18.656	11.998	40.640*
	$r=1$	7.586	5.766	23.565
	$r=2$	0.055	4.133	15.274
Trace	$r=0$	26.296	21.964	99.056*
	$r=1$	7.641	9.966	58.416
	$r=2$	0.055	4.199	34.851
ADF-stat	$\epsilon \sim I(1)$	-5.415*	-5.096*	-5.254*
PP-stat	$\epsilon \sim I(1)$	-5.496*	-5.113*	-5.235*

Notes: * indicates the rejection of the null hypothesis of no cointegration at the 5 per cent level. Critical values for the residual-based tests of no cointegration are taken from Davidson and Mackinnon (1993).

Table 4: Estimation of Long-Run Equations

	Dependent variable: *consumption (c)*		
Variables	Model 1	Model 2	Model 3
y	0.625	0.523	0.360
	(0.00)	(0.00)	(0.00)
w	0.251	–	–
	(0.00)		
hw	–	0.168	0.154
		(0.00)	(0.00)
nhw	–	0.098	–
		(0.00)	
$nhwxsh$	–	–	0.084
			(0.00)
s	–	–	0.021
			(0.00)
h	–	–	0.089
			(0.00)
cst	0.275	1.280	2.208
	(0.09)	(0.00)	(0.00)

Notes: p-values are in parentheses and are based on the Newey and West (1987) procedure, since there is evidence of serially correlated and heteroscedastic residuals. The SIC suggested using one lead and lag of the first difference of each variable in each regression. However, coefficients of these regressions are relatively robust to changes in the lag structure.

Table 5: Tests of Parameter Stability

Test	Cointegrating vector		
	c,y,w	c,y,hw,nhw	$c,y,hw,nhwxsh,s,h$
$SupF$	2.223	7.598	13.755
	($\geq$ 0.20)	($\geq$ 0.20)	(0.18)
$MeanF$	0.780	2.748	9.799
	($\geq$ 0.20)	($\geq$ 0.20)	(0.08)
L_c	0.111	0.241	0.727
	($\geq$ 0.20)	($\geq$ 0.20)	($\geq$ 0.20)

Note: p-values associated with the test statistics are in parentheses.

Table 6: VECM Estimates

	Dependent variable					
	Δc_t	Δy_t	Δhw_t	Δs_t	Δh_t	$\Delta nhwxsh_t$
Regressors						
$\sum \Delta c_{t-i}$	0.508	0.831	-2.847	**-8.127**	3.720	1.020
	(0.23)	(0.24)	(0.20)	(0.03)	(0.06)	(0.31)
$\sum \Delta y_{t-1}$	0.039	-0.402	**2.096**	3.030	0.154	0.089
	(0.85)	(0.24)	(0.05)	(0.07)	(0.89)	(0.85)
$\sum \Delta hw_{t-1}$	0.060	-0.111	0.434	0.947	0.586	0.081
	(0.36)	(0.31)	(0.21)	(0.08)	(0.08)	(0.60)
$\sum \Delta s_{t-1}$	0.052	-0.017	-0.159	0.052	0.026	**0.106**
	(0.78)	(0.63)	(0.15)	(0.79)	(0.81)	(0.04)
$\sum \Delta h_{t-1}$	-0.010	0.031	0.303	0.513	-0.312	0.118
	(0.88)	(0.77)	(0.37)	(0.37)	(0.33)	(0.44)
$\sum \Delta nhwxsh_{t-1}$	-0.123	0.082	-0.829	-0.726	-0.184	0.079
	(0.19)	(0.60)	(0.09)	(0.36)	(0.74)	(0.72)
EC_{t-1}	-0.047	0.176	**1.346**	**2.236**	-0.606	0.094
	(0.61)	(0.25)	(0.01)	(0.00)	(0.19)	(0.66)
$\bar{R}^2$	0.125	0.092	0.162	0.252	0.155	0.129
$LM(1) = 0.96$ $LM(2) = 0.35$ $LM(3) = 0.74$ $LM(4) = 0.18$ $HTS = 0.74$						

Notes: For $i = 1, ..., 6$. Bold numbers indicate significance at the 5 per cent level. p-values are in parentheses. The lag structure of the VECM was chosen using the SIC, which Ivanov and Kilian (2000) find to be the most accurate criterion for quarterly VECMs. However, additional lags were added to remove serial correlation left in the error terms.

Table 7: Predictive Power for Growth in Stock Market Wealth

Δs_{t+h} regressed on	Horizon h 1	2	4	8	16
Δc_t	-0.810	-2.052	**-4.011**	**-6.357**	-6.599
	(-1.012)	(-1.639)	(-2.353)	(-2.679)	(-1.748)
Δy_t	0.359	0.405	-0.100	1.586	1.392
	(0.717)	(0.468)	(-0.086)	(1.145)	(0.719)
Δhw_t	0.050	0.0416	0.660	0.0600	-0.571
	(0.263)	(0.153)	(1.433)	(0.120)	(-0.750)
$\Delta nhwxsh_t$	-0.628	-1.008	-0.389	**-2.677**	**-4.605**
	(-1.835)	(-1.572)	(-0.379)	(-2.589)	(-2.807)
Δs_t	**0.252**	**0.464**	0.225	-0.076	0.121
	(2.223)	(2.616)	(1.160)	(-0.295)	(0.356)
Δh_t	0.064	0.0278	-0.121	-0.171	-0.954
	(0.575)	(0.146)	(-0.339)	(-0.458)	(-1.766)
EC	**1.096**	**2.449**	**5.056**	**9.756**	6.573
	(2.406)	(2.758)	(3.145)	(4.245)	(1.581)
cst	0.016	0.035	0.071	0.142	0.263
	(2.540)	(2.819)	(2.913)	(4.622)	(5.291)
R^2	0.073	0.131	0.110	0.282	0.157

Notes: Bold numbers indicate significance at the 5 per cent level. t-statistics are in parentheses. Δs_{t+h} is defined as $s_{t+h} - s_t$ and EC represents the cointegrating residual.

Table 8: Predictive Power for Growth in Human Wealth

Δhw_{t+h} regressed on	Horizon h 1	2	4	8	16
Δc_t	-0.830	-0.537	-0.100	-0.720	-0.578
	(-1.699)	(-1.060)	(-1.634)	(-0.681)	(-0.317)
Δy_t	0.250	0.191	0.391	0.523	-0.033
	(0.984)	(0.559)	(0.879)	(0.868)	(-0.037)
Δhw_t	-0.181	-0.104	-0.153	-0.018	-0.329
	(-1.722)	(-0.847)	(-1.020)	(-0.108)	(-1.057)
$\Delta nhwxsh_t$	-0.236	0.174	-0.188	-0.109	-1.215
	(-1.288)	(0.741)	(-0.876)	(-0.227)	(-1.589)
Δs_t	-0.010	-0.007	-0.090	0.028	-0.064
	(-0.228)	(-0.136)	(-1.325)	(0.221)	(-0.265)
Δh_t	**0.152**	0.101	0.128	0.033	-0.182
	(2.311)	(1.492)	(1.319)	(0.288)	(-0.871)
EC	**0.973**	**1.513**	**2.577**	**3.347**	2.499
	(4.109)	(3.692)	(3.264)	(3.033)	(1.187)
cst	0.006	0.006	0.017	0.025	0.054
	(2.217)	(1.217)	(2.264)	(1.858)	(2.194)
R^2	0.096	0.113	0.203	0.150	0.045

Notes: Bold numbers indicate significance at the 5 per cent level. t-statistics are in parentheses. Δhw_{t+h} is defined as $hw_{t+h} - hw_t$ and EC represents the cointegrating residual.

Table 9: Forecast-Error Variance Decomposition

	Δc_t		Δy_t	
Horizon h	ϵ^T	ϵ^P	ϵ^T	ϵ^P
1	0.04	0.96	0.06	0.94
	(0.00,0.20)	(0.80,1.00)	(0.00,0.27)	(0.73,1.00)
2	0.05	0.95	0.07	0.93
	(0.00,0.21)	(0.79,1.00)	(0.00,0.28)	(0.72,1.00)
4	0.07	0.93	0.09	0.91
	(0.01,0.20)	(0.80,0.99)	(0.01,0.27)	(0.73,0.99)
8	0.08	0.92	0.09	0.91
	(0.02,0.19)	(0.81,0.98)	(0.02,0.25)	(0.75,0.98)
∞	0.09	0.91	0.10	0.90
	(0.03,0.19)	(0.81,0.97)	(0.03,0.24)	(0.76,0.97)
	Δhw_t		$\Delta nhwxsh_t$	
Horizon h	ϵ^T	ϵ^P	ϵ^T	ϵ^P
1	0.26	0.74	0.04	0.96
	(0.02,0.63)	(0.37,0.98)	(0.00,0.19)	(0.81,1.00)
2	0.27	0.73	0.04	0.96
	(0.02,0.62)	(0.38,0.98)	(0.00,0.18)	(0.82,1.00)
4	0.24	0.76	0.06	0.94
	(0.03,0.52)	(0.48,0.97)	(0.01,0.18)	(0.82,0.99)
8	0.24	0.76	0.08	0.92
	(0.06,0.47)	(0.53,0.94)	(0.02,0.18)	(0.82,0.98)
∞	0.22	0.77	0.09	0.91
	(0.07,0.43)	(0.56,0.93)	(0.03,0.18)	(0.82,0.97)
	Δs_t		Δh_t	
Horizon h	ϵ^T	ϵ^P	ϵ^T	ϵ^P
1	0.31	0.69	0.09	0.91
	(0.04,0.66)	(0.34,0.96)	(0.00,0.33)	(0.66,1.00)
2	0.28	0.72	0.09	0.91
	(0.04,0.61)	(0.39,0.96)	(0.00,0.32)	(0.68,1.00)
4	0.26	0.74	0.09	0.91
	(0.06,0.52)	(0.48,0.94)	(0.01,0.28)	(0.71,0.99)
8	0.25	0.75	0.10	0.90
	(0.09,0.46)	(0.54,0.91)	(0.02,0.25)	(0.75,0.98)
∞	0.22	0.78	0.10	0.90
	(0.09,0.38)	(0.62,0.91)	(0.03,0.23)	(0.77,0.97)

Notes: This table reports the forecast-error variance decomposition over various horizons for all the variables included in the system. ϵ^P represents the permanent shocks component and ϵ^T the transitory shock component. The numbers indicate the percentage of the total variance of the variable that is due to each shock. The 90 per cent confidence intervals are in parentheses.

Table 10: Forecast-Error Variance-Covariance Decomposition

	Δc_t			Δy_t		
Horizon h	$\widetilde{\epsilon}^P$	$\widetilde{\epsilon}^T$	$\widetilde{\epsilon}^P,\widetilde{\epsilon}^T$	$\widetilde{\epsilon}^P$	$\widetilde{\epsilon}^T$	$\widetilde{\epsilon}^P,\widetilde{\epsilon}^T$
1	0.79	0.03	0.18	0.99	0.16	-0.15
2	0.78	0.07	0.15	0.91	0.20	-0.11
4	0.94	0.13	-0.06	0.95	0.24	-0.19
8	0.94	0.17	-0.12	1.00	0.25	-0.26
∞	0.94	0.19	-0.14	1.01	0.27	-0.27
	Δhw_t			$\Delta nhwxsh_t$		
Horizon h	$\widetilde{\epsilon}^P$	$\widetilde{\epsilon}^T$	$\widetilde{\epsilon}^P,\widetilde{\epsilon}^T$	$\widetilde{\epsilon}^P$	$\widetilde{\epsilon}^T$	$\widetilde{\epsilon}^P,\widetilde{\epsilon}^T$
1	1.26	0.94	-1.20	1.07	0.02	-0.09
2	1.36	0.96	-1.32	1.07	0.03	-0.10
4	1.34	0.84	-1.19	1.03	0.05	-0.08
8	1.32	0.89	-1.21	1.19	0.13	-0.32
∞	1.32	0.87	-1.19	1.14	0.19	-0.33
	Δs_t			Δh_t		
Horizon h	$\widetilde{\epsilon}^P$	$\widetilde{\epsilon}^T$	$\widetilde{\epsilon}^P,\widetilde{\epsilon}^T$	$\widetilde{\epsilon}^P$	$\widetilde{\epsilon}^T$	$\widetilde{\epsilon}^P,\widetilde{\epsilon}^T$
1	1.83	0.92	-1.75	2.10	0.21	-1.31
2	1.78	0.88	-1.67	2.03	0.20	-1.23
4	1.84	0.82	-1.66	1.93	0.19	-1.12
8	1.61	0.86	-1.47	1.80	0.27	-1.07
∞	1.57	0.80	-1.37	1.75	0.28	-1.03

Note: This table reports the forecast-error variance-covariance decomposition over various horizons for all the variables included in the system.

Figure 1: Disposable Income, Wealth, and Consumption

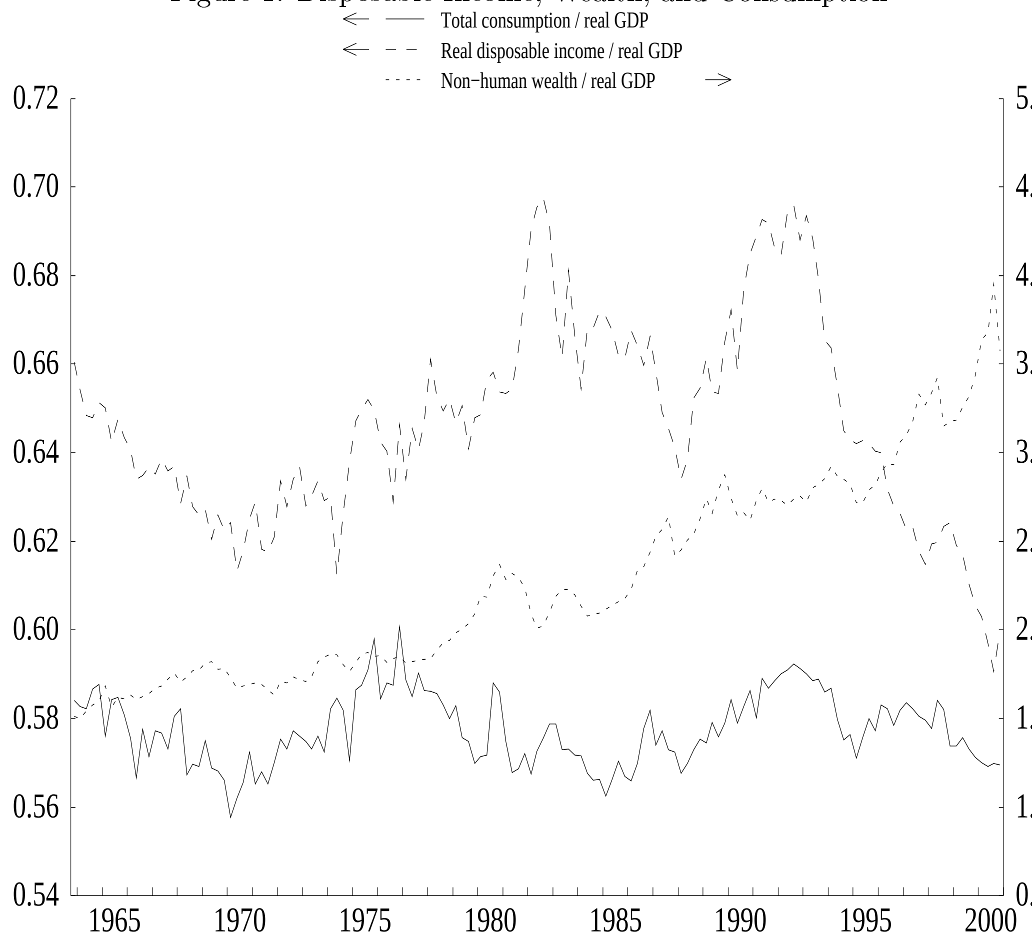


Figure 2: Wealth-to-Disposable-Income Ratio and Personal Savings Rate

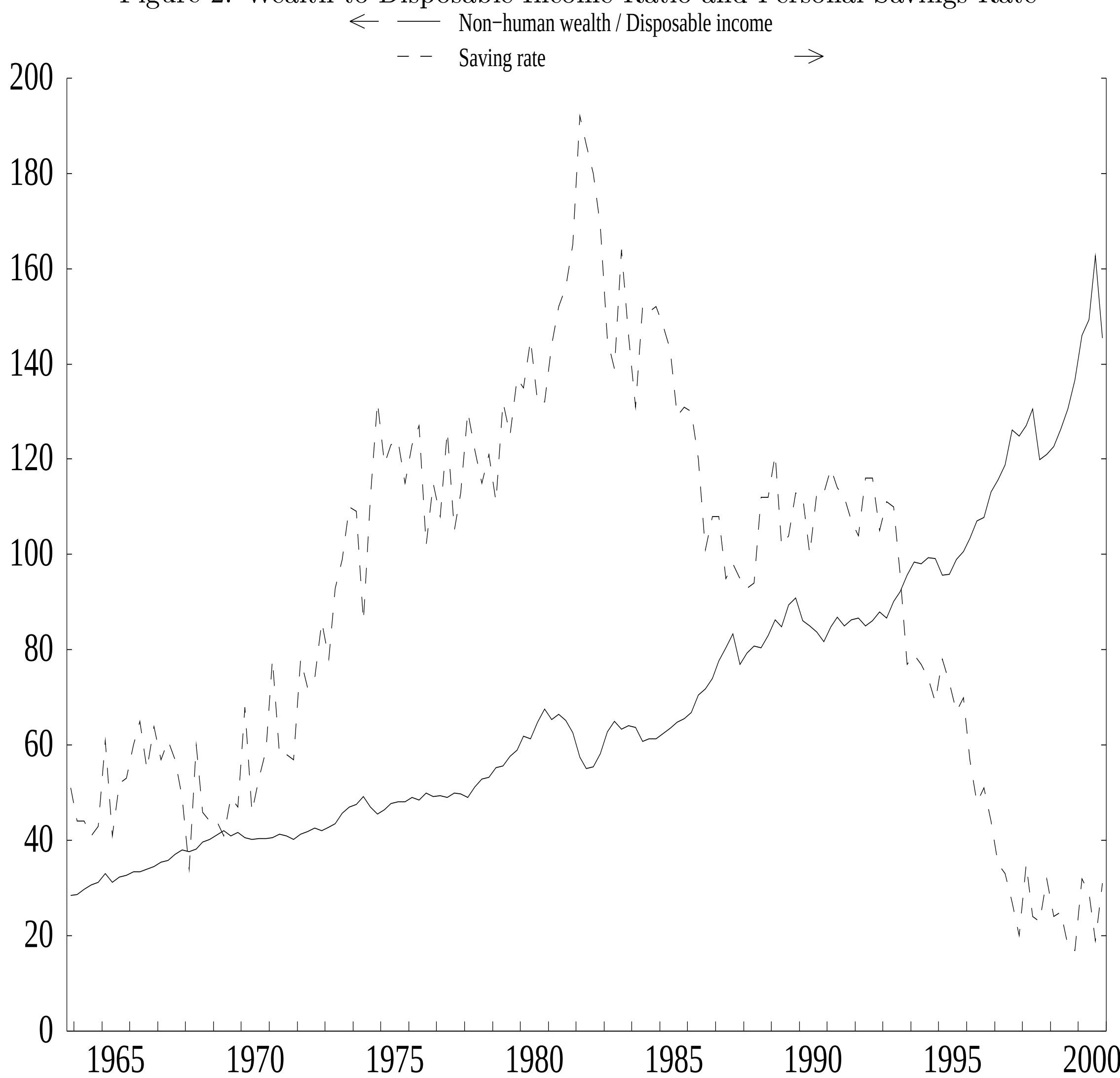


Figure 3: Non-Human Wealth and its Stock and Housing Components

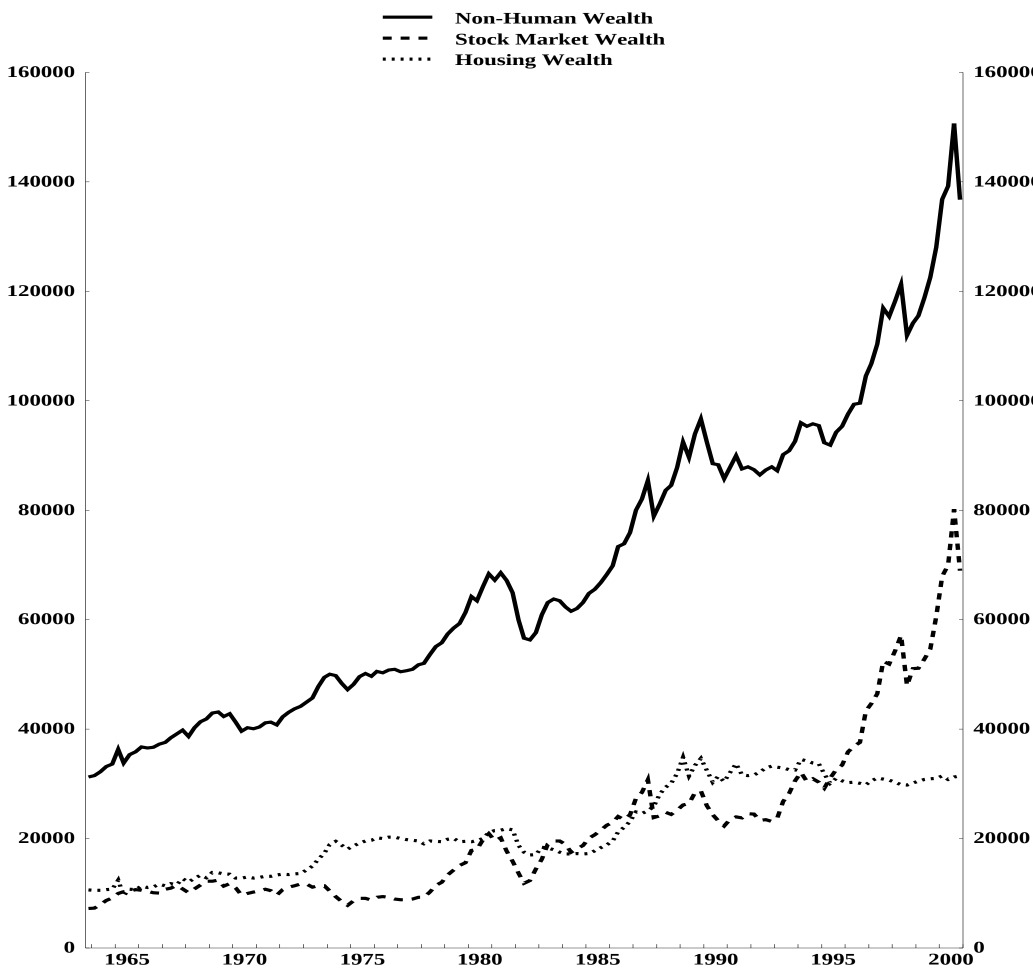


Figure 4: Ratio of Log Total to Log Non-Durable Consumption

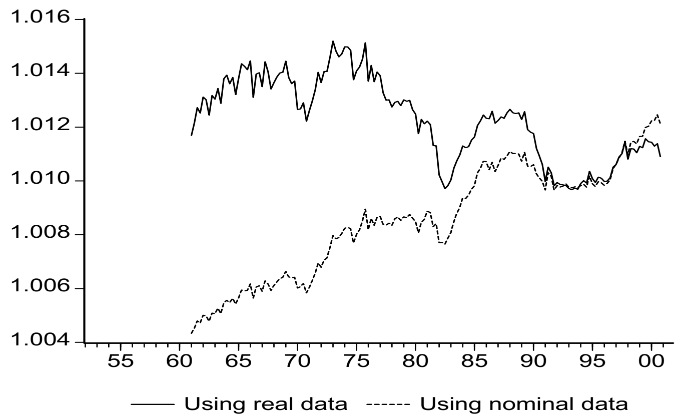


Figure 5: Response of Consumption to a Disposable Income Permanent Shock

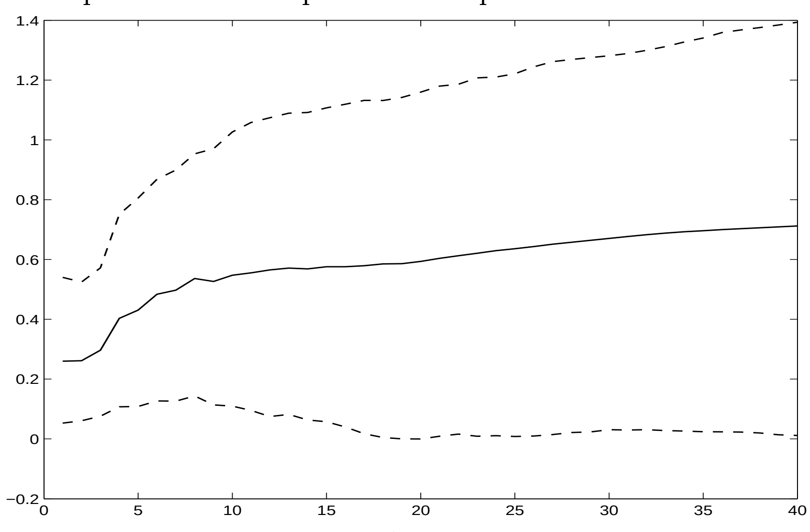


Figure 6: Response of Consumption to a Human Wealth Permanent Shock

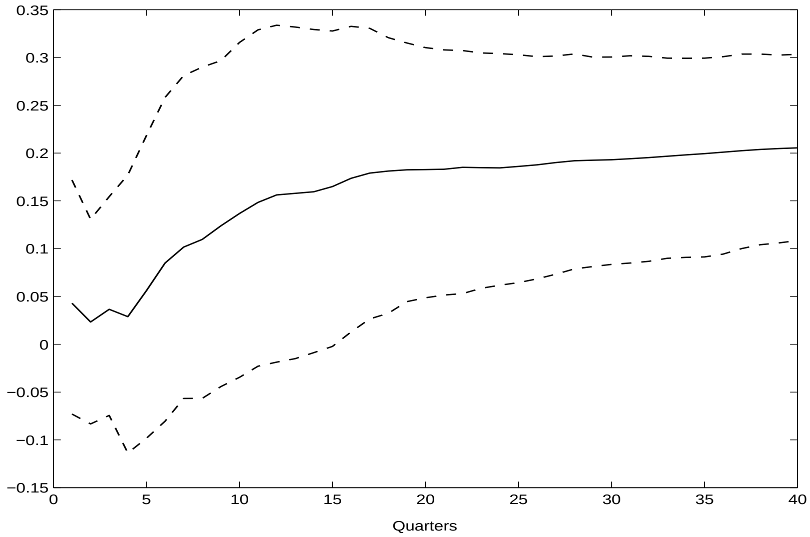


Figure 7: Response of Consumption to a Stock Market Wealth Permanent Shock

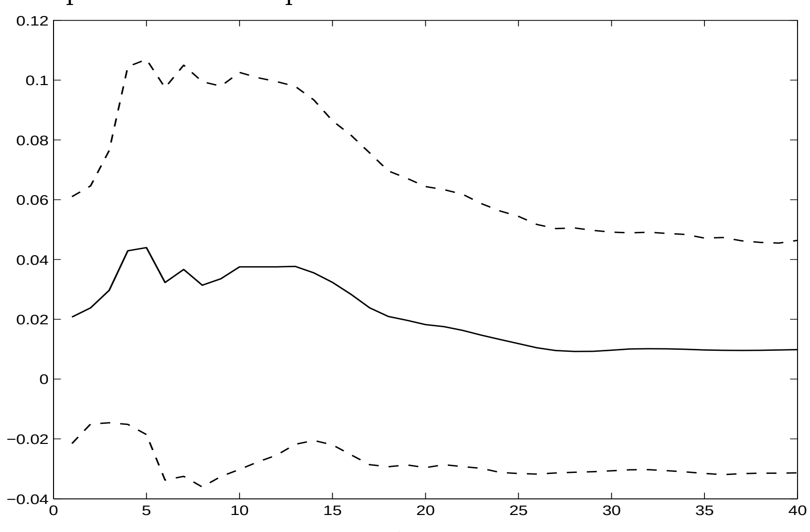


Figure 8: Response of Consumption to a Housing Wealth Permanent Shock

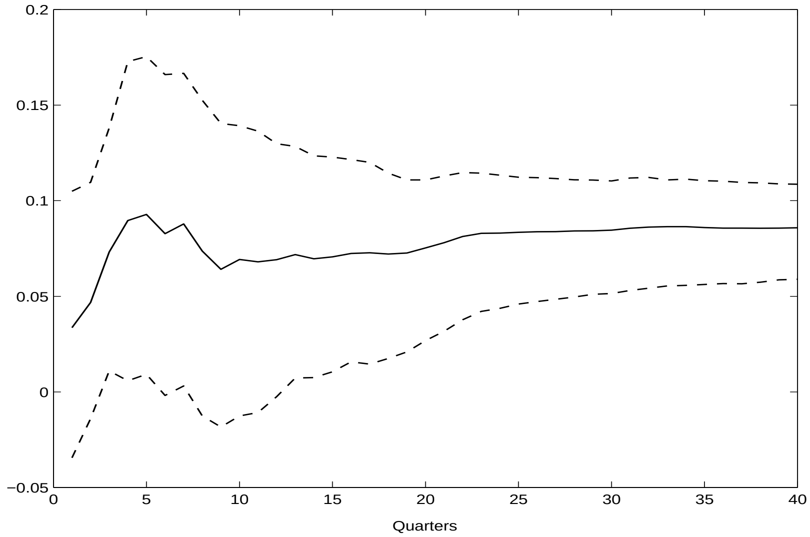


Figure 9: Response of Consumption to a Non-Human Wealth, Excluding Stock and Housing, Permanent Shock

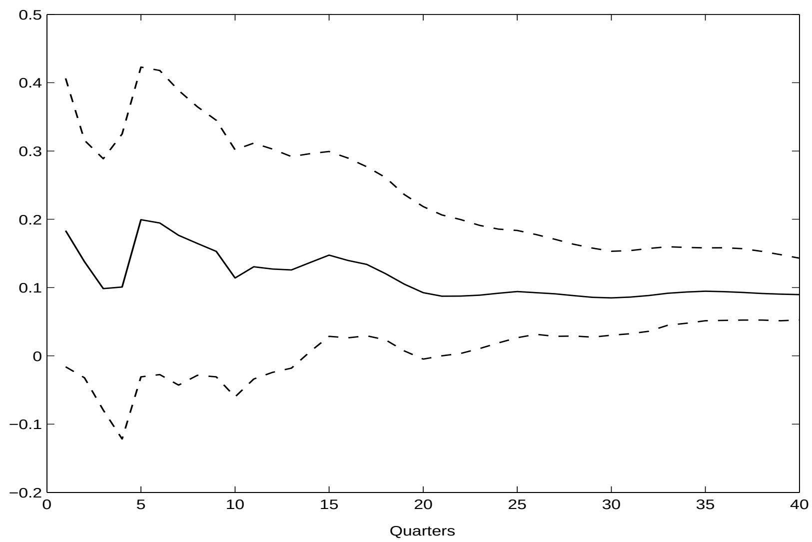
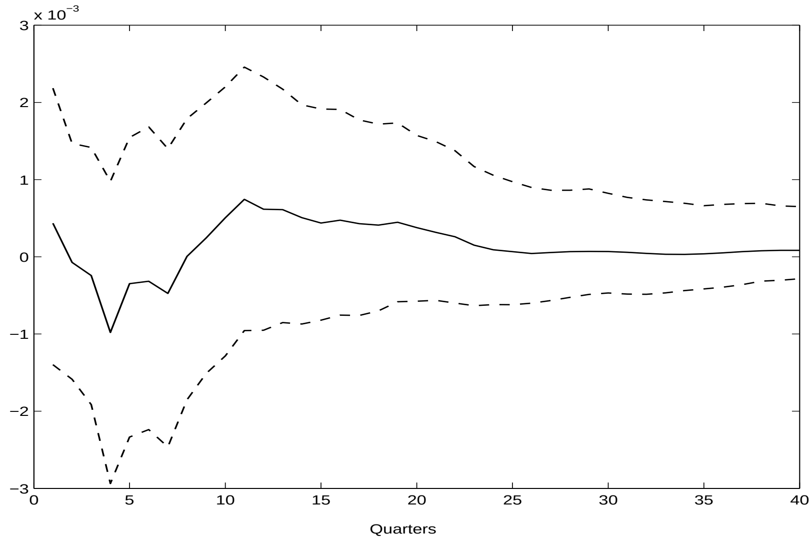


Figure 10: Response of Consumption to the Transitory Shock



Appendix A: Data Description

Data used in this study are mainly drawn from CANSIM and cover the period 1964Q2 to 2000Q4. Variables included in the system are in logarithms.

Real per-capita consumption of non-durables and services (in 1992 dollars) [C]= (D15372-D15373)/NPOP.

Population (15 years and over) ($NPOP$) = D980000/1000. Data before 1976 are from the Bank of Canada.

Real per-capita disposable income [Y] = D14914/PGDP/NPOP.

GDP price deflator (PGDP) = D14840/D14872.

Real interest rate [r] = RR90+2.3/400

$RR90 = R90/400 - EINF$

$R90$ = nominal interest rate on 90-day prime corporate paper. B14017

$EINF$ = expected inflation estimated with a fourth-order autoregressive process.

Total wealth [W] = Human wealth [HW] + Non-human wealth [NHW]. These variables were constructed by Macklem (1994) and, since then, data have been revised by Statistics Canada using 1992 as the base year.

Human wealth [HW]

L = real per-capita labour income.

G = real per-capita government expenditures on goods and services to be paid for by households.

Non-human wealth [NHW]

A = net and domestic foreign assets = the sum of non-financial and financial assets held by persons and unincorporated businesses, less the liabilities of this sector, plus the value of the Canada and Quebec Pension Plans, and less the value of domestically held outstanding government debt.

D^f = government debt held by foreigners = the sum of treasury bills and federal, provincial, and municipal government bonds held by non-residents.

S = stock market wealth = market value of equity held by persons and unincorporated businesses = $(EQUITYQ_{t-1} * (TSE_t/TSE_{t-1})) + (BEQUITY_t - BEQUITY_{t-1})$.

TSE = TSE300 composite stock price index. B4237

$BEQUITY$ = book value of equity held by persons and unincorporated businesses = $EQUITQ - (YCR/4) * (EQUITQ/TEQUITQ)$.

$EQUITQ$ = current value of shares held by persons and unincorporated businesses. Current value is measured as the sum of book value and cumulated retained earnings. D160027, D150067

$TEQUITQ$ = total outstanding stock of equity. D162906

YCR = retained earnings. D20068

H = housing wealth = $RSTRUC - MORTQ$.

$RSTRUC$ = residential structures = $(PMLS/100) * KRC$.

$PMLS$ = multiple homes listing price index.

KRC = stock of housing in constant 1992 dollars.

$MORTG$ = mortgages. D160017, D150128

Appendix B: KPSW Identification Strategy

The first set of restrictions is given by $\Gamma(1) = \left[A\tilde{\Pi}, 0\right]$, where Γ_0^{-1} exists and where $\tilde{A}$ is a known $n \times (n-r)$ full-column rank selection matrix, the columns of which are orthogonal to the cointegrating vectors. Π is a $(n-r) \times (n-r)$ lower triangle matrix, the diagonal elements of which have been normalized to unity. This matrix permits certain shocks to have a long-term impact on more than one variable. 0 is a $n \times (n-(n-r))$ matrix of zeros.

Given the fact that permanent and temporary shocks are assumed to be uncorrelated, the second set of restrictions implies a variance-covariance matrix of the form $\Sigma_\eta = E_t\left[\eta_t \eta_t'\right] = \begin{bmatrix} \Sigma_{\eta^1} & 0 \\ 0 & \Sigma_{\eta^2} \end{bmatrix}$ with $\eta_t = \left(\eta_t^{1\prime}, \eta_t^{2\prime}\right)$, where η_t^1 is a $k \times 1$ vector of permanent shocks, η_t^2 is a $(n-k) \times 1$ vector of temporary shocks, and Σ_{η^1} is a block-diagonal matrix. This constraint is essential, since it allows us to recuperate the first columns of $\Gamma(L)$, which represent the impact of permanent shocks on the different variables.

Starting with the reduced form, a structural model can be obtained using the following relationships:

$$\Gamma(L)^{-1}(\Delta X_t - \mu) = \eta_t, \tag{11}$$

$$\Gamma_0 \Gamma(L)^{-1}(\Delta X_t - \mu) = \Gamma_0 \eta_t, \tag{12}$$

$$\Delta X_t = \mu + C(L)\varepsilon_t. \tag{13}$$

We have $C(L) = \Gamma(L)\Gamma_0^{-1}$ and $\varepsilon_t = \Gamma_0 \eta_t$. From the first expression, we can deduce that $C(1) = \Gamma(1)\Gamma_0^{-1}$. Let D be a solution of $C(1) = \tilde{A}D$. For instance, we could have $D = (\tilde{A}'\tilde{A})^{-1}\tilde{A}'C(1)$, where $(\tilde{A}'\tilde{A})^{-1}\tilde{A}'$ is in fact the generalized inverse, which is not directly invertible, since its rank is not full. It is possible to show that $C(1)\varepsilon_t = \Gamma(1)\eta_t = \tilde{A}\Pi\eta_t^1$. Since $C(1) = \tilde{A}D$, we have $\tilde{A}D = \Gamma(1)\Gamma_0^{-1}$. By using the fact that $\varepsilon_t = \Gamma_0\eta_t$ and that $\Gamma(1) = \left[\tilde{A}\Pi, 0\right]$, we obtain:

$$\tilde{A}D\varepsilon_t = \tilde{A}\Pi\eta_t^1. \tag{14}$$

Because $E_t\left[\eta_t^1 \eta_t^{1\prime}\right] = \Sigma_{\eta_t^1}$, $\tilde{A}DE(\varepsilon_t\varepsilon_t')D'\tilde{A}' = \tilde{A}\Pi E(\eta_t^1\eta_t^{1\prime})\Pi'\tilde{A}'$ and, consequently,

$$D\Sigma_\varepsilon D' = \Pi\Sigma_{\eta^1}\Pi'. \tag{15}$$

Let Π^{*} be the unique lower triangle root square of $D\Sigma_{\varepsilon}D'$ and let Π and $\Sigma_{\eta^1}^{\frac{1}{2}}$ be the unique solutions of $\Pi\Sigma_{\eta^1}^{\frac{1}{2}} = \Pi^{*}$. If k is the number of permanent shocks, then the first k rows of Γ_0^{-1} are given by $G = \Pi^{-1}D$. Since D is unique up to premultiplication by a non-singular matrix, G will also be unique. Given that $\tilde{A}D\varepsilon_t = \tilde{A}\Pi\eta_t^1$, we have $\eta_t^1 = G\varepsilon_t$. The dynamic multipliers of η_t^1 can be obtained by partitioning the Γ_0 matrix into two distinct matrices: one, matrix H, of dimensions $n \times k$ and the other, matrix J, of dimensions $n \times (n-k)$. Since $\Gamma(L) = C(L)\Gamma_0$, the first k columns of $\Gamma(L)$ are given by $C(L)H$. Because $\varepsilon_t = \Gamma_0\eta_t$, we have $E(\varepsilon_t\varepsilon_t') = \Gamma_0 E(\eta_t\eta_t')\Gamma_0'$. It follows from this relationship that:

$$\Gamma_0^{-1}\Sigma_{\varepsilon} = \Sigma_{\eta}\Gamma_0', \tag{16}$$

in a way to ensure that $H' = \Sigma_{\eta^1}^{-1}G\Sigma_{\varepsilon}$. Finally, the dynamic multipliers of η_t^1 can be identified by:

$$A(L) = C(L)\Sigma_{\varepsilon}G'\Sigma_{\eta^1}^{-1}. \tag{17}$$

Appendix C: Bias-Corrected Confidence Intervals

Given the uncertainty surrounding the coefficient estimates of the VECM, and taking into account that these estimates are used to compute the impulse-response functions and variance decompositions in a non-linear way, the choice of an appropriate method for the construction of confidence intervals is not trivial. Even though the delta method intervals, the standard bootstrap intervals, and the Monte Carlo integration intervals could be used, these asymptotic-based approaches might bring unreliable results in small samples. In particular, Kilian (1998) shows that, in VAR models, the distribution of the impulse-response estimator is biased and skewed in small samples and can lead to very inaccurate confidence intervals. In fact, since OLS estimates of autoregressive coefficients are systematically biased in small samples, distributions of impulse-response functions and variance decompositions, which are highly non-linear functions of these coefficients, are likely to be even more biased. Simply correcting for median bias in the bootstrap distributions of these statistics ignores the fact that they are not scale-invariant. To address these problems, Kilian proposes a new approach to bootstrapping that indirectly removes the bias in non-linear statistics before simulating.

Kilian's bootstrap-after-bootstrap procedure suggests two modifications to Runkle's (1987) non-parametric bootstrap procedure. First, to preserve the bootstrap analogy, the VAR coefficient estimates have to be corrected for the OLS small-sample bias. This ensures that the bias-corrected coefficients are good approximations of the population coefficients and that they can be correctly used to generate artificial series. Second, the bootstrap-simulated VAR coefficient estimates are replaced by bias-corrected estimates before the impulse-response functions and variance decompositions are computed.[9] Again, this guarantees that the bias-corrected simulated coefficients are related to the bias-corrected VAR coefficients, because the latter coefficients are related to the true population parameters.

[9]Kilian (1998) gives a detailed description of the bootstrap-after-bootstrap algorithm.

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