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# Demographic Changes and Real Housing Prices in Canada

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## ABSTRACT

This paper seeks to determine how demographic and non-demographic factors have contributed to past changes in Canada's real housing prices as well as their possible impact over the next twenty years. To this goal, we estimate with annual data from 1956 to1997 a structural model of the Canadian housing market. This model possesses two important long-run properties, that is, the long-run supply curve is perfectly elastic while real housing price is cointegrated with real per-capita income. These two conditions imply that housing price shows a tendency to return to a stable long-run growth path dictated by the trend growth rate in real income. Although real income has been the dominant factor behind the fluctuations in the real asset price of housing since 1956, the growth rate of the population between 25 and 54 years of age has also played an important role. In the future, even if aging will continue to be a negative factor on housing demand, the continuation of past trends in real income is likely to be sufficient to counterbalance this negative impact. Consequently, real housing prices should continue to rise over the next twenty years, with possible exceptions in the Atlantic provinces and in Manitoba which will suffer a more substantial population decline.



## RÉSUMÉ

Ce document cherche à établir la contribution de la démographie par rapport à celle d'autres facteurs dans les mouvements passés du prix réel des logements au Canada ainsi que leur effet probable sur le prix des logements au cours des vingt prochaines années. À cette fin, nous estimons avec des données annuelles débutant en 1956 et se terminant en 1997 un modèle structurel du marché du travail canadien. Ce modèle possède deux importantes propriétés de long terme, à savoir que la courbe d'offre est parfaitement élastique et que le prix réel des logements est cointégré avec le revenu réel par habitant. Ces deux conditions impliquent que le prix réel du logement tend à retourner sur un sentier tendanciel de croissance lié à celle du revenu réel. Même si les variations du revenu réel ont été la plus importante source de fluctuations du prix des logements, la croissance de la population du groupe d'âge 25-54 ans a également joué un rôle important. Nous prévoyons que même si le vieillissement de la population créera des pressions à la baisse sur les prix au cours des vingt prochaines années, la croissance tendancielle prévisible du revenu réel devrait être suffisante pour en contrecarrer l'effet de sorte que le prix réel des logements au Canada devrait continuer de croître au cours des vingt prochaines années. Le modèle laisse cependant entrevoir la possibilité que les prix baissent légèrement dans les provinces atlantiques et au Manitoba en raison d'un déclin démographique plus accentué.



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"Demographics explain about two-thirds of everything",
David Foot and Daniel Stuffman (1996).

## 1. INTRODUCTION

More than 4.6 millions living births were recorded between 1955 and 1965 in Canada, the bulk of the baby-boom, while only 3.6 millions births occurred during the baby-bust of 1970-1985. (Figure 1) With the aging of the baby-boom generation, the number of young households is now falling in Canada. Mankiw and Weil (1989) (thereinafter MW) presented empirical estimates suggesting that, because of a similar demographic pattern, the real price of housing could fall by as much as 47% in the US between 1990 and 2010. A similar prediction was also made in a popular book by Foot and Stuffman (1996) who predicted that with this kind of population shift , residential real estate prices are bound to fall in parallel with the declining number of home buyers.

This paper's goal is to identify whether or not demographic has been the dominant force behind the changes in housing prices in Canada. In addition, this paper explores if the expected demographic changes are likely to trigger a pronounced downward trend in residential real estate prices. With the rapid aging of Canadians, this question is extremely important. Yet, this topic has remained largely outside the agendas of Canadian researchers, with the exceptions of Laycock (1978), Engelhardt and Poterba (1991) and Baxter (1997).

The paper is organized as followed. We review in the next section the MW's model and the numerous criticisms it has received. These criticisms pointed out many aspects of their empirical work, namely that their specification of housing demand is incomplete, that there is no supply equation, that the result seems specific to the US and, finally, that they did not adequately capture the impact of aging on the individual housing demand. Against the view that demographics could make real estate prices to collapse, other studies tends to conclude either that demographics will have

no effect or, instead, that any price decrease would be temporary and of little importance, or yet again that the effect of demographics will be counterbalanced by an increase in real income

We document in a third section how the real asset price of housing evolved in Canada since 1956. No quality-adjusted residential real estate price data are available in Canada over this time period. However, many data sources indicate that in 1973-75, and again in 1985-89, there was a substantial increase in real-estate prices which fell in 1981-82 and, again, in 1990-92. Because it is consistent over the entire period and for several provinces, our preferred price data is the average transaction price of the Multiple Listing Services (MLS). The real MLS price is then used in a fourth section, together with data on the number of housing units, in an empirical structural two equations model of the Canadian housing market which is estimated over the period 1956-1997. This structural model allows to decompose past price movements and to evaluate the impact on the real housing prices of expected demographic and economic conditions until 2016.

The resulting conclusions are that real housing prices are not likely to decrease in Canada over the coming years. Even if demographics will act as a negative factor on housing prices, the rise in the real per capita income is likely to be sufficient to counterbalance its impact. It is only in Atlantic provinces and in Manitoba, which regions will encounter the less favourable demographic outcome, that the model's forecast encompasses scenarios of slight price declines.

## 2. DEMOGRAPHIC CHANGES AND HOUSING PRICES IN THEORY

The first empirical results linking demography and housing prices were provided by MW (1989). In order to assess the importance of demography, they built a demographic index of housing demand. To do so, they indexed in a first step the calendar age of each person in a sample of about 200 thousands individuals drawn from the1970 US Census data and estimated how the house's value changes with age. They showed that this age-specific housing demand reaches its maximum at the age of 40 and steadily declines thereafter. They built the aggregate demographic index of housing

demand in a second stage by weighting each age-specific demand index by the number of individuals in the age group. Since MW found a strong positive association between this aggregate demographic index of housing demand and the average house price, they concluded that demography has been a major source of price fluctuations in the US. Moreover, when they combined their empirical model with the population projections of the US, they forecasted that house prices could fall by as much as 47% between 1990 and 2010.

This study has been severely criticized. Hamilton (1991) pointed out that over the same period studied by MW, their demographic index has had a negative impact on the real price of housing services. This is incompatible with the interpretation that houses' asset prices have been driven by demand shocks. Engelhardt and Poterba (1991) reproduced the MW's methodology with Canadian data. They found that even if the demographic pattern has been similar to that in the US, price movements have been substantially different in Canada and not significantly linked to the Canadian demographic index. With Japanese data, Ohtake and Shintani (1996) also concluded that demography is not a significant determinant of house prices. Hendershott (1991) and Swan (1995) both detected that the real per-capita income should be included in housing demand, a variable MW did not retain in their model. Thus, MW's results may suffer from a specification bias. Holland (1991) suggested that MW's results may be due to a spurious correlation between non-stationary variables. Indeed, he found no relationship between the first difference of housing prices and the change in the demographic index of housing demand. Moreover, he showed that this index is cointegrated with the housing stock but not with house prices, a fact that is consistent with an elastic long-run housing supply. DiPasquale and Wheaton (1994) estimated a structural (supply and demand) model of the housing market. In their model the real per-capita income has an important impact on housing demand but the price impact is progressively dissipated because the long-run supply is price elastic. When assessing the impact of demography, they concluded that: "The combination of slower household formation and an aging population will, on net, act as a negative shock to housing demand in the 1990s. The magnitude of the shock, however, is relatively small. Furthermore, the long run supply of housing is quite price elastic and this plays an important role in mitigating the effect of any

negative shocks to the demand side of the market."[1] The crucial role of real income has also been detected by Holly and Jones (1997). With data from 1939 to 1994 for UK, they showed that housing prices and real income are cointegrated.[2] They detected a positive and significant impact of demography but this impact is only transitory.

The shape of the age-specific housing demand has also been investigated more seriously by Atkin and Myers (1994). In a cross-section similar to that used by MW, cohort effects are not disentangled from age effects. Thus, the decline of housing consumption after the age of 40 may be explained by the fact the older population in the cross section have had a lower lifetime income. To establish if the problem arose with housing consumption, Atkin and Myers used a cohort-linked cross section (CLCS) who could follow the consumption pattern over a 30-years period. The crucial finding of their study is that housing consumption does not decline after the age of 40, but rather continues to rise until the age of 70. This has dramatic implications since : "A pure cross-sectional estimate for 1980, the year used by Mankiw-Weil, *overstates the 1990-2010 decline in the growth of aggregate housing demand by 45% in comparison with the three-decade average of the CLCS estimates.*"[3] A similar argument is developed by Green and Hendershott (1996) who showed that if a correction is made for the difference in education, housing consumption continues to rise after the age of 40. Consequently, the aging of the baby-boom generation will not create a fall in the aggregate housing demand. Other studies by Fair and Dominguez (1991), by Ermisch (1996) and by Ohtake and Shintani (1996) also concluded that housing consumption continues to rise well after the age of 40.

To undertake our investigation, it is clear that we must estimate a system of supply and demand equations. Moreover, we cannot use an index of housing demand based on a cross section. We review the historical data in the next section, which provide a basis for identifying the driving factors behind housing prices changes.

## 3. THE EVOLUTION OF HOUSING STOCK AND REAL PRICES IN CANADA

Various real estate price data can be found in Canada. The longest time series, gathered since 1956 by the Canadian Real Estate Association (CREA), is the average transaction price of the Multiple Listing Service (MLS price). Residential housing comprises approximately 90% of these transactions. The CREA also publishes separately since 1975 data related only to residential units. A comparison of these two series reveals no significant difference between the time behaviour of the MLS residential price and that of the MLS total price with the exception of a scale factor. This similar behaviour is without doubt due to the importance of residential data in the total index. For our goal, it means that the total price index allows to infer the time behaviour of residential housing prices.

Other price data are less convenient than the MLS. Because the Royal Lepage price index considers comparable houses over time, it makes an adjustment for quality that is absent from the MLS price. However, the Royal Lepage is available for a much shorter time span. Statistics Canada has published monthly since 1971 two different series of the New House Price Index (NHPI), and the active series are available for various metropolitan area only since 1981. These data present some problems. Although the NHPI is a quality-adjusted price index, Goy and Steele (1994) have shown that it substantially under-estimates the true quality-adjusted house price change.[4] Also, price movements of new houses do not necessarily provide an adequate measure of price movements in existing houses. Moreover, the NHPI covers only metropolitan area and the coverage has varied over time. Finally, an index number do not provide information on the absolute level of house prices. For all these reasons, the NHPI is not a first choice for house price's history. Other price data released by Statistics Canada and related to house prices are even less adequate. The Construction Cost Index (CCI), which is available monthly since 1971, provides a measure of input prices in construction. Although one can expect input prices to be closely related to the price of new houses, there is no proof whatsoever that they both always vary together. The other price measure related to house prices is the housing component of the CPI. However, the link with housing prices is highly indirect since the CPI seeks to measure the cost of housing services which is related to the asset price only

when the user cost of capital is stable. Finally, the CMHC has published from the beginning of the 50s to 1985 the price of new houses financed under the National Housing Act. Although these data are not quality-adjusted, some information related to house sizes have sometimes been published. However, these data present two important weaknesses. First, they are not available since 1985. Secondly, there was restrictions on the maximum value of the house to be admissible to a loan guaranteed under the NHA. Since this constraint was severely binding during some periods and less binding in another time span, the average quality of house included in this price measure has changed inversely with the quality-adjusted real house prices.

Figure 2 shows the real MLS total price in dollar of 1986, that is the MLS total price divided by the CPI, and an index of the real value of the NHPI and the CCI, these two last indexes arbitrarily normalized to 100 in 1986. All these series reveal that the real price increased substantially between 1971 and 1974 and, again, between 1985 and 1989. There were also two episodes of falling prices which coincide with the recessions of 1981-82 and 1990-92. The similarity in the short-term movements of these prices measures is better confirmed by the high degree of correlation in their logarithmic differences, which correlation varies from 0.82 (SIA and NHPI) to 0.93 (NHPI and CCI). However, the figure also shows a huge difference in the trend. Although the average annual growth rate of the real MLS price was 1.49% between 1971 and 1998, those of the CCI and of the NHPI were respectively -0.16% and -0.40%. Clearly, the adjustment for quality is very important in assessing the long-run evolution of house prices. Obviously, the real MLS price captures the trend rise in house quality, with the real house value increasing from 54 909 $ in 1956 to 77 116 $ in 1971 and to 113 593 $ in 1998. The trend decline in the NHPI is, in our interpretation, a consequence of the bias identified by Goy and Steele (1994). Our belief is that the CCI provides an unbiased measure of the trend increase in a quality-adjusted house. If we are right, this implies that the average annual bias of the NHPI and the MLS price have been -0.24% and 1.65% respectively between 1971 and 1998.

The Canadian average of house prices conceals wide provincial discrepancies. Figure 3 shows

the Provincial averages of house prices (dotted lines) since 1960 for 6 provinces and the Regional average for the Atlantic provinces, together with the change in the stock of housing (solid lines), this stock being measured by Statistics Canada's estimation of the number of units at the end of each year. Some basic facts stand out from this provincial comparisons. First, with the sole exception of Quebec, the rise in housing prices during the period 1971-74 was widespread. The rise was particularly strong in Alberta and Saskatchewan, and prices continued to rise in these two provinces even during the second half of the 70s. Although these data are silent as to the source to these provincial discrepancies, the likely interpretation it that it is a reaction to the energy price shocks and the provincial migration that followed. It is also easy to observe the close link between the change in real prices and the change in the number of houses built. Those provinces which recorded the highest price also registered the most rapid increase in the housing stock.

Prices fell in all provinces in 1981-82, although the reduction was less significant in Ontario. This fall in prices was accompanied by a generalized reduction in the construction of new housing units. The most persistent reversals of fortune were recorded in the same provinces that had enjoyed the most important housing boom in the 70s, that is, Alberta and Saskatchewan. In both cases, prices and construction never returned close to the level observed in the second part of the 70s. The most significant price increase in the second part of the 80s was in Ontario. House prices continued to rise in BC in the first years of the 90s, the only province which avoided a real-estate bust. This province also stands out because of the huge year-to-year swings in construction observed in the 90s.[5]

## 4. THE THEORETICAL MODEL OF PRICE DETERMINATION

To better understand the dynamic adjustment of housing prices and stock that take place following a demand shock, we need to define a structural supply and demand model of the housing market. If the housing demand raises in reaction to demographic changes, the long run price adjustment can be completely different than its instantaneous reaction. Indeed, current housing supply is mainly the stock inherited from previous periods, so that house prices rise significantly in the short

run. On the other hand, the long run housing supply reflects the minimum of the average cost and is almost completely elastic so that price changes cannot last indefinitely. Moreover, non-demographics factors such that the user cost of housing and the real per-capita income influence the asset demand for using. To measure adequately all sources of demand shocks and the dynamic of market adjustment, we use a model of the housing market similar to that of DiPasquale and Wheaton (1994).

Let the households be separated into various age groups identified by *i*. The demand for housing for a household of group *i* at time *t* can be written as $d_{it}(X_t, P_t, U_t)$, were $P_t$ is the real asset price of housing units, $U_t$ is the user cost of housing capital and $X_t$ is a vector of exogenous variables which capture the impact of non-demographic elements on housing demand.[6] The number of households in the age group *i* can itself be written as the product of the number of individuals in this age group $N_{it}$ multiplied by the household's headship rate $m_{it}(X_t, P_t, U_{it})$. This general specification allows the headship rate to vary with age, income, many individual characteristics and the cost of maintaining an independent housing unit. The headship rate is then a function of the same variables that determine the housing demand (Skaburskis, 1997), so that housing demand for group *i* at time *t* is a convolution of the per-capita demand and the headship rate function, that is, $h_{it}(X_t, P_t, U_{it}) = m_{it}(X_t, P_t, U_{it}) \times d_{it}(X_t, P_t, U_t)$. The aggregate demand for housing at time t $D_{it}$ is then:

$$D_{it} = N_{it} \times h_{it}(X_t, P_t, U_t) = H_{it}(X_t, P_t, U_t) \quad (1)$$

Housing supply is a simple function of last period's (depreciated) stock and of the construction of new houses $C_t$. It is assumed that construction reacts positively to the actual real purchasing price and to a vector of variables $W_t$. Amongst the variables included in $W_t$ is the cost of inputs used to build new houses (labour, materials and land) and real interest rates which both have a negative impact on construction.[7] If housing stock $S_t$ decays at the constant rate $\boldsymbol{\delta}$, the aggregate housing supply can be written :

$$S_t = C_t(W_t, P_t) + (1- \boldsymbol{\delta})S_{t-1} \quad (2)$$

If price adjustment is instantaneous, the real price of housing is determined by the following market clearing condition:

$$H_{it}(X_t, P_t, U_t) = C_t(W_t, P_t) + (1- \delta)S_{t-1} \quad (3)$$

To show how the real price reacts to the exogeneous variables, we differentiate totally equation (3) and isolate $dP_t$:

$$dP_t = [\Sigma H_{Ni}dN_{it} + H_x dX_t + H_u dU_t - C_w dW_t -(1-\delta)dS_{t-1}]/(C_P - H_P) \quad (4)$$

Since $C_P > 0$ while $H_P < 0$, the instantaneous price reaction of a change in the size of the demographic group *i* is non-ambiguous. Indeed:

$$dP_t/dN_{it} = H_{Ni}/(C_P - H_P) > 0 \quad (5)$$

However, the price reaction is bound to decrease in subsequent periods. Because of the change in price, equation (2) implies that the current period stock adjusts to the demographic shock. By the chain's rule:

$$dS_t/dN_{it} = (dS_t/dP_t)\times(dP_t/dN_{it}) = C_P \times H_{Ni}/(C_P - H_P) > 0 \quad (6)$$

Thus, the price reaction at period t+1 is mitigated by the fact that the stock of housing at the beginning of period $t$+1 is larger than the stock at the beginning of period $t$. Equation (7) shows more precisely how $P_{t+1}$ reacts to the demographic shock.

$$dP_{t+1}/dN_{it} = (dP_{t+1}/dN_{it+1})\times(dN_{it+1}/dN_{it}) + (dP_{t+1}/dS_t)\times(dS_t/dN_{it}) \quad (7)$$

Equation 7 has two terms. The first term shows the direct price impact of the part of the

demographic shock which persists at the second period while the second term captures the price reaction to the stock adjustment. Let us suppose for the goal of simplicity that the demographic shift is permanent, that is, $dN_{it+1}/dN_{it} = 1$. Then $dP_{t+1}/dN_{it}$ becomes:

$$dP_{t+1}/dN_{it} = [H_{Ni}/(C_P - H_P)]\times[1 - (1-\delta)C_P/(C_P - H_P)] \quad (8)$$

which is smaller than $dP_t/dN_{it}$. Obviously, because the price is still abnormally high at $t$+1, construction is still more intense than usual. Thus, the real price of housing will continue to decline in the subsequent periods to eventually returns to its long run stable value in which construction no longer allows abnormal returns. If the industry uses no specific resources, the long run supply curve is perfectly elastic and the real price returns to its pre-shock value at a speed determined by $C_P$, the stock reaction to price changes.

This standard model supposes that price adjusts instantaneously to clear the housing market. DiPasquale and Wheaton (1994) showed that empirically, housing prices seem to adjust gradually. Indeed, they found that the price of housing, lagged once, substantially improves the explanatory power of aggregate prices. We will verify in the empirical section if a similar observation can be made in Canada.[8]

## 4. THE EMPIRICAL MODEL OF PRICE DETERMINATION

Based on equation (1) and (2), we estimate a system of supply and demand equations. As in DiPasquale and Wheaton, equation (1) is written so that $P_t$ is on the left hand side. The main questions we have to solve are measurement issues. The real price of houses is the average MLS price divided by the CPI while the stock is the number of housing units as estimated by Statistics Canada. [9] The most crucial question is how to measure demographic pressures. The basic unit in housing demand is the household, so that a natural choice would be to use the number of households. However, because the household headship rate is negatively related to the cost of maintaining an

independent household, the number of household is endogenous in the house price equation. To avoid a possible estimation bias, we need to rely on an independent measure of demographic. One possible solution would be to use the age-specific headship rate observed on a base year (say on the 1991 Census) to calculate, from population data, an adjusted number of households in which the age-specific headship rate is constant. This approach presents two pitfalls. First, the choice of the base year is arbitrary. Second, the weight given to the age would then be directly proportional to the age-specific headship rate, which imposes that all other age-specific variables are unimportant.

In order to capture the effect of age on housing demand, we preferred to follow a more general approach in which the population growth for the age group 15-24, 25-34, 35-44, 45-54, 55-64 and 65 and over are directly used as independent variables in the price equation.[10] This approach allows the price impact of population growth to vary with age without imposing any *a priori* structure based on other estimation of the impact of age. We will use this general specification to conduct some tests that will allow to identify a simplified model in which the impact of age is more precisely defined.

Following many studies, and namely the specification of Laycock (1978), we use as a measure of income the real GDP divided by the adult population (15 and over). The nominal interest rate on 5-year residential mortgage loans is used to capture the current payments constraint that limits housing demand in some situations. Our expectation is that the former variable has a positive impact on house prices while the later has a negative influence. The user cost is a crude calculation based on four assumptions. First, current non-interest expenditures represent 6% of the house value each year. Second, mortgage debt represents 50% of the house value for the average home-buyer. Third, the opportunity cost of non-borrowed funds is half that of the mortgage rate, an hypothesis consistent with a 50% tax rate on a rate of return equals to the mortgage rate. Finally, we suppose that the expected house price increase equals the previous year's percentage change in the CPI.[11] The resulting user cost is a time series which abruptly fell between 1972 and 1975, thanks to an increase in interest rate more gradual than the rapidly accelerating inflation rate. On the contrary, the user cost

rose abruptly in 1983 and remained high for more than a decade, as the Canadian economy entered into a prolonged period of moderate or low inflation combined with high real interest rates. As another measure of price pressures, we add the housing vacancy rate in the price equation. Finally, following DiPasquale and Wheaton, we include in the specification the lagged price of house in the specification. As to the stock equation, it includes only the stock of the previous period, the house vacancy rate, the real price of housing and, as a measure of possible bottlenecks, the capacity utilization rate in construction.

Thus, the basic specification of the model is :

$$\Delta S_t = \beta_0 + \beta_1 P_t + \beta_2 S_{t-1} + \beta_3 \Delta Y_t + \beta_4 V_t + \beta_5 CUR_t + u_t \quad (9)$$

$$P_t = \gamma_0 + \gamma_1 P_{t-1} + \gamma_2 R_t + \gamma_3 Y_t + \gamma_{41} \Delta N(15,24)_t + \gamma_{42} \Delta N(25,34)_t + \gamma_{43} \Delta N(35,44)_t + \gamma_{44} \Delta N(45,54)_t + \gamma_{45} \Delta N(55,64)_t + \gamma_{46} \Delta N65_t + \gamma_5 S_{t-1} + \gamma_6 V_t + \gamma_7 U_t + \nu_t \quad (10)$$

where :

$P_t$ is the logarithm of the real MLS price,

$S_t$ is the logarithm of housing stock,

$Y_t$ is the logarithm of the real GDP (1986 price) divided by the population15 years and over,

$V_t$ is the vacancy rate,

$CUR_t$ is the capacity utilization rate in construction,

$R_t$ is the 5-years residential mortgage rate,

$\Delta N(\mathrm{A,B})_t$ is the rate of change in the number of persons between the age A and B,

$\Delta N65_t$ is the rate of change in the number of persons of 65 and over.

All series are available for Canada from 1956 to 1997, with the sole exception of the capacity utilization rate which is available only since 1962. We submitted both $\Delta S_t$ and $P_t$ to stationarity tests and we concluded that they are non-stationary variables. This raises the question of whether or not the estimation in level will produce a problem of spurious correlation. In the case of the price

equation, the problem is avoided because the lagged dependent variable is included in the right hand side, and also because $P_t$ and $Y_t$ are cointegrated variables. Although the statistical test is silent as to the causality link, the logic suggests that it is the trend increase in the real per-capita income which drives up house prices in the long run. As to the $\Delta S_t$ equation, the spurious correlation is avoided because $\Delta S_t$ is cointegrated with $\Delta Y_t$.[12] Thus, the system has been estimated in the level of $\Delta S_t$ and $P_t$ from 1962 to 1997.

## 5. ESTIMATION RESULTS

In order to correct for the presence of endogenous variables as explanatory variables, and also to improve the efficiency of the estimator by taking account of the correlation between the error terms of each equation, the system has been estimated by 3SLS. The list of instruments includes all exogenous variables. Moreover, a first pass having revealed a first order positive autocorrelation of the residual in equation 9, we estimated a first-order autocorrelation process of the error term which requires to add to the instrument list all lagged variables of equation 9 as well as $P_{t-1}$.[13]

The model was in a first step estimated on 35 annual data from 1963 to 1997 and, with these results, we could simplify the model. The joint test $\beta_4=0$, $\beta_5=0$, $\gamma_{41}=0$, $\gamma_{42}=\gamma_{43}$, $\gamma_{42}=\gamma_{44,}$ $\gamma_{45}=0$, $\gamma_{46}=0$, $\gamma_6=0$ and $\gamma_7=0$ has a calculated $\chi^2$ = 15,56 and a marginal level of 0,07. That means that three variables can be omitted from the specification, that is, the vacancy rate, the capacity utilization rate and the user cost. Interestingly, nominal interest rate if more important than the real interest rate to correctly specify the housing demand. Moreover, the growth rate of the population in the age group15-24 and 55 and over do not impact on house prices while, at the same time, the impact of the population growth rate is identical for the age groups 25-34, 35-44 and 45-54. Consequently, the model can be simplified as in equations 11 and 12 and be estimated from 1958 to 1997.[14]

$$\Delta S_t = \beta_0 + \beta_1 P_t + \beta_2 S_{t-1} + \beta_3 \Delta Y_t + u_t \quad (11)$$

$$P_t = \gamma_0 + \gamma_1 P_{t-1} + \gamma_2 R_t + \gamma_3 Y_t + \gamma_4 N(25,54)_t + \gamma_5 S_{t-1} + v_t \quad (12)$$

where $N(25,54)$ is the growth rate of the population in the age group 25-54. The estimation results from 1958 to 1997 are presented in Table 1. The coefficient $\rho$ is the estimated first order autocorrelation of the error term.[15]

**TABLE 1**

**ESTIMATION RESULTS OF THE 3SLS**

| **ESTIMATED EQUATION : $\Delta S_t = \beta_0 + \beta_1 P_t + \beta_2 S_{t-1} + \beta_3 \Delta Y_t + u_t$** | | | |
|---|---|---|---|
| | **Coefficient** | **S. E.** | **t-stat** |
| $\beta_0$ | 0.283697 | 0.050321 | 5.637729 |
| $\beta_1$ | 0.041919 | 0.007662 | 5.4708 |
| $\beta_2$ | -0.046651 | 0.006487 | -7.191881 |
| $\beta_3$ | 0.058849 | 0.016036 | 3.66968 |
| $\rho$ | 0.587959 | 0.121218 | 4.850422 |
| $R^2$ = 0.864, | | **S. E.** = 0.0025 | |
| **ESTIMATED EQUATION : $P_t = \gamma_0 + \gamma_1 P_{t-1} + \gamma_2 R_t + \gamma_3 Y_t + \gamma_4 N(25,54)_t + \gamma_5 S_{t-1} + v_t$** | | | |
| | **Coefficient** | **S. E.** | **t-stat** |
| $\gamma_0$ | 6.308495 | 1.236329 | 5.102602 |
| $\gamma_1$ | 0.76472 | 0.062205 | 12.29352 |
| $\gamma_2$ | -1.19058 | 0.284833 | -4.179916 |
| $\gamma_3$ | 0.841898 | 0.167641 | 5.022045 |
| $\gamma_4$ | 4.741296 | 1.516625 | 3.126215 |
| $\gamma_5$ | -0.389039 | 0.118534 | -3.282077 |
| $R^2$ = 0.976 | | **S. E.** = 0.0417 | |

All coefficients have the expected sign. In the $\Delta S_t$ equation, the real price of housing has a positive and significant impact, with a price elasticity of $\Delta S_t$ estimated to 0.042, while the elasticity with respect to the growth rate of per-adult income is 0.059, which is also highly significant. There is also a significant negative impact of $S_{t-1}$ on $\Delta S_t$ : there is less construction if there is already more available houses. There is also an important first-order autocorrelation process, with a root estimated to 0.59. As to the real price, it declines of 1.19% for each percentage point increase in the mortgage interest rate while the income elasticity of the real price is 0.84. The model also detects an important

and significant impact of the growth rate of the population in the age group 25-54 since a one percentage point increase raises the real price by 4.74%. As expected, the stock has a significant impact on price. Finally, as DiPasquale and Wheaton, we detect a very strong impact of $P_{t-1}$ on $P_t$.

We first used these estimates to identify the contribution of demographic and economic changes to the price movements observed over the last forty years. The simplest way to measure the impact of demographic shifts is to remove any fluctuation in the population's growth rate and to calculate what would have been the time path of real housing prices followed if the annual growth rate of the population in the age group 25-54 had been constant to its sample average of 1.95%. Figure 5 compares this experiment with the model's predicted value. It shows that in the 60s, because of the slow demographic growth, the real price was lower. However, the rapid transition towards a faster population growth rate at the beginning of the 70s maintained the real price higher by approximately 10% in average between 1972 and 1990, and by 12.3% in 1989. Once again, a transition occurred at the beginning of the 90s so that by 1997, the real price was 8% lower than the price that would have been observed if the population growth had maintained its previous momentum. Thus, between 1989 and 1997, the demographic shift pushed down real housing prices by approximately 20%. Without this effect, the real price would have almost stagnated between 1989 and 1995.

Although substantial, the impact of demographic pales in comparison to the effect of economic fluctuations. Figure 6 shows the forecasted price if the real per-adult real income had been growing at the constant annual rate of 1.58%, its sample average. This shows that the actual acceleration of economic growth in the 60s and the 70s pushed up real price. The figure shows also that the fall in price in 1981-82 is mainly the result of the decline in real income, although the rise in the interest rate also played a significant role. The striking aspect of the figure is however that the economic slowdown has been an important source to the falling price of the 90s. Indeed, if economic growth had continued during the last decade, real price would have been growing by almost 15% between 1989 and 1997 rather than the actual decline of 20%.

Interestingly, these simulations shows that demographic and economic factors can easily be mislead. Indeed, we compare in figure 7 the deviation in percentage between the model's actual forecasted price with the price the model would forecast if there has been a constant demographic or if there has been a constant economic growth. Although the impact of economic growth is much larger, the general shape of both factors is similar. Indeed, they contributed to the price increase of the 70s and of the last half of the 80s. They also both contributed to the price decline of the 90s, with a fall of 35% caused by the economic slowdown and 20% by demographic changes. Thus, although it is easy to conclude that demographic has been the dominant factor behind the falling price of the 90s, the model suggests that two-third of the decline was not demographic.

## 6. EXPLORING THE FUTURE

Over the last few years, there has been a revival of the housing market. This revival is out of our sample but its roots lies obviously into the solid economic recovery since 1997. It is of course hard to predict how long a recovery lasts and we make no prediction on this matter. Rather, we explore the future of Canadian house prices by combining various demographic forecasts with two simple assumption regarding the trend increase in real income. The future of Canada's natural growth of its adult population is already partly written. It is possible to forecast with great accuracy the population growth of older age groups. As to group between 25 and 54, which is identified as the crucial group for housing price, the uncertainty that surrounds its evolution stems from the fact that the number of immigrants for the next twenty years is unknown.

We used three demographic scenarios Statistics Canada has published for the future of the Canadian population, the low, medium and high forecasts. In these scenarios, the synthetic fertility rate is 1.5, 1.7 and 1.9 while the annual number of immigrants is 150 000, 250 000 and 330 000 respectively.[16] The growth rate of the actual population 25-54 until 1997 and the forecasts until 2016 are shown in figure 8. It is clear that even with an optimistic forecast, the growth rate of this population is bound to decrease, first at a rapid pace between 2000 and 2002, and then more slowly.

In the low-growth scenario, the population starts to fall in 2010 while the growth remains positive for the entire interval with the medium and high growth forecasts. In any situation however, the growth rate will be lower than it is today, so that demographic changes will add negative pressures on housing prices. However, these pressures will be less severe than the one encountered since 1990 because the rate at which the growth diminishes is slowing.

To see how this impact on house prices, we combined these three demographic scenarios with two different time path of real income. In the medium growth time path, the growth rate of real per-adult income continues the trend observed between 1956 and 1997, that is, 1.58% per annum. In the low growth time path, it is rather the trend of the last twenty years of the sample which is prolonged until 2016, that is, an annual growth rate of 1%. Thus, we envision six scenarios for the future of house prices, which are described in Table 2.

**TABLE 2**

**DESCRIPTION OF THE SCENARIOS**

| Δ%GDP/Adult | Demographic growth | Scenario name | Scenario number |
|---|---|---|---|
| 1.00% | Low | Low-Low | 1 |
| 1.00% | Medium | Low-Medium | 2 |
| 1.00% | High | Low-High | 3 |
| 1.58% | Low | Medium-Low | 4 |
| 1.58% | Medium | Medium-Medium | 5 |
| 1.58% | High | Medium-High | 6 |

Two major facts stand out from these forecasts. First, economic growth easily counterbalances the negative impact of demography. It is only in the worst case, with low fertility and immigration and slow economic growth (Case 1), that prices fall until 2004. After that, real prices would start to rise again. In effect, however, the recent favourable economic conditions almost rule out this worst-case scenario. Second, the future of housing prices will clearly be determined by the evolution of per-capita income. Our general conclusion are then similar to the findings of Baxter (1997) in a comparison of Canadian metropolitan area.

## 7. PROVINCIAL ESTIMATES

We have also investigated the regional differences in price forecasts by estimating similar models for six provinces and for the Atlantic provinces. These provincial estimates are important because not all regions will have the same population growth. Moreover, despite the fact that all provincial models share the same basic structures, they don't have an equal responsiveness to the shocks. As can be seen in Table 3, while Ontario's model show a price reaction to the real income twice as high as the national average, BC's model stands out because of the high price's sensitivity to demographic growth.

As with the Canadian model, we combined the three demographic scenarios with two real income time paths. In Statistics Canada's population forecasts, Ontario and BC and, to a lesser extent, Alberta are the provinces which benefit most from immigration. They also have a younger population. Because of these two phenomena, these provinces will have a higher than average population growth. At the other extremes, Atlantic provinces, Saskatchewan, Quebec, and Manitoba will be the provinces with the most sluggish population growth. It would be too long to present all six scenarios for all provincial models. Rather, we will concentrate on the medium-medium case.

Figure 10 shows the medium case of Statistics Canada's population forecasts. In the Atlantic provinces, the population 25-54 will start declining as soon as 2002, with the demographic implosion continually accelerating so that by 2012, this population will fall by more than 1% a year. The next province to be touched by such a decline will be Saskatchewan in 2007 with Quebec next on the road one year later and Manitoba in 2009. BC will have the fastest growing population until 2004, followed by Ontario and Alberta, and these three provinces will continue to have a positive population growth until 2016. However, Ontario will succeed to BC as the province with the fastest growing population in 2005, thanks to a decline less pronounced than in BC.

**TABLE 3**

**Provincial Estimates**

| | Atlan. | Québec | Ontario | Manitoba | Sask. | Alberta | BC |
|---|---|---|---|---|---|---|---|
| **ESTIMATED EQUATION :** $\Delta S_t = \beta_0 + \beta_1 P_t + \beta_2 S_{t-1} + \beta_3 \Delta Y_t + u_t$ | | | | | | | |
| $\beta_0$ | -0.2969 (0.3266) | 0.1445 (0.3226) | 0.3342 (0.0534) | 0.2444 (0.1892) | -0.1002 (0.0780) | -0.1246 (0.0810) | 0.3636 (0.0582) |
| $\beta_1$ | 0.0526 (0.0208) | 0.0324 (0.0158) | 0.0410 (0.0196) | 0.0348 (0.0116) | 0.0443 (0.0047) | 0.0607 (0.0068) | 0.0377 (0.0086) |
| $\beta_2$ | -0.0202 (0.0112) | -0.0333 (0.0156) | -0.0526 (0.0054) | -0.0481 (0.0137) | -0.0295 (0.0059) | -0.0401 (0.0054) | -0.0558 (0.0096) |
| $\beta_3$ | 0.0371 (0.0179) | 0.0788 (0.0216) | 0.0489 (0.0196) | 0.0306* (0.0205) | -0.0142* (0.0101) | 0.0209* (0.0269) | 0.0117 (0.0405) |
| $\rho$ | 0.7330 (0.1906) | 0.7847 (0.1043) | 0.3982 (0.1506) | 0.6933 (0.1212) | 0.1226 (0.1282) | 0.4451 (0.1297) | 0.0213 (0.1617) |
| $R^2$ | 0.7695 | 0.868 | 0.8738 | 0.7393 | 0.7514 | 0.8886 | 0.5211 |
| **S. E.** | 0 | 0.003 | 0.0033 | 0.0038 | 0.005 | 0.006 | 0.007 |
| **ESTIMATED EQUATION :** $P_t = \gamma_0 + \gamma_1 P_{t-1} + \gamma_2 R_t + \gamma_3 Y_t + \gamma_4 N(25,54)_t + \gamma_5 S_{t-1} + v_t$ | | | | | | | |
| $\gamma_0$ | 5.5806 (0.9398) | 2.2499 (0.9896) | -3.7997 (0.8091) | 2.4831 (0.6981) | 7.0095 (1.3499) | -0.7773 (0.0802) | -5.2561 (2.3218) |
| $\gamma_1$ | 0.4878 (0.0848) | 0.6715 (0.0684) | 0.7017 (0.0469) | 0.9496 (0.0645) | 0.7342 (0.0735) | 0.7719 (0.0802) | 0.7910 (0.0985) |
| $\gamma_2$ | -0.0075 (0.0025) | -0.0117 (0.0027) | -0.0077 (0.0024) | -0.0122 (0.0033) | -0.0076 (0.0040) | -0.0105 (0.0042) | -0.0094 (0.0059) |
| $\gamma_3$ | 0.3541 (0.1853) | 0.7095 (0.2231) | 1.4945 (0.2152) | 0.6074 (0.1954) | 0.4482 (0.1348) | 0.8998 (0.1718) | 1.0416 (0.4743) |
| $\gamma_4$ | 4.1358 (1.1028) | 2.7772* (1.5544) | 1.6018* (1.2035) | 2.9344 (1.0933) | 4.3532 (0.7944) | 2.3806* (1.2710) | 5.5448 (2.0027) |
| $\gamma_5$ | -0.2431 (0.1232) | -0.3697 (0.1303) | -0.5100 (0.0977) | -0.6072 (0.1576) | -0.6640 (0.1647) | -0.4298 (0.1023) | -0.1951 (0.2284) |
| $R^2$ | 0.816 | 0.8503 | 9778 | 0.9362 | 0.9287 | 0.9698 | 0.9609 |
| **S. E.** | 0.038 | 0.0382 | 0.0397 | 0.0406 | 0.0564 | 0.0514 | 0.0816 |

* : Not significant at the 5% level. Standard errors are between brackets.

Figure 11 compares the provincial price forecasts. There is a wide discrepancies between provincial prices. Atlantic provinces and Saskatchewan should continue to have the lowest prices, while Ontario will become the province with the most expensive houses in Canada. This outcome is not just due to the demographic profile. It is also influenced by the fact that the estimated impact of income on housing prices is higher in Ontario than in BC. As to Manitoba, the time profile of the forecast is strongly affected by the combination of a high autocorrelation of price, which amplifies

the dynamic impact of exogenous shocks, and two years of rapid income growth at the end of the sample, which continue to have an impact in the first part of the forecast. Given the income and demographic profiles for this province, we believe that a much more modest increase, intermediate between Saskatchewan and Quebec scenarios, is a more likely outcome.

## 8. CONCLUSION

We have started this research with the goal of identifying the contribution of demographic changes to house price movements. This task required in a first step to identify a consistent measure of housing prices. Because no quality-adjusted housing prices data are available for a long period of time, we relied to the average MLS price as a consistent measure of price movements over the period 1956-1997. This price makes no correction for the quality of houses, and we suggested that it may have an average bias of 1.65% a year. We identified two periods of substantial price increase, that is, in the 70s and between 1984 and 1989, and two periods of important price decline in 1981-83 and in 1990-92. Then, we needed to identify in a second step what kind of changes in the structure of the population have an impact on housing demand. As a third step, we must estimate what is the price reaction to these changes in demand. Economic theory predicts that with a gradual stock adjustment towards a perfectly elastic supply curve, demand shocks will have only temporary impacts on the real price of housing. If we conclude that it is the case, there remains to evaluate the speed of adjustment towards the long run.

A structural model of the housing market was needed. The estimated model has a perfectly elastic long run supply curve with the real price cointegrated with real income. Thus, the real price converges in the long run towards a value dictated by the evolution of the real per-adult income. In the model, the only demographic component that significantly alters the time path of housing prices is the growth rate of the population between 25 and 54 years of age. The slowing in the rate of growth of this population after 1989 contributed to a price decline of 20% between 1989 and 1997. Over the same period however, the economic slowdown has had an impact almost twice as important,

with a price reduction of 35%. This followed a 20-years period over which prices were pulled up by both demographic and economic growth.

The future of housing prices has been explored by combining three different Statistics Canada's demographic forecasts with two hypotheses regarding the trend growth rate of real income. The worst case scenario, which combines a slow income growth with a low population growth, is the only case in which real prices continue to fall, but only for a few years before the trend increase in real income finally overcomes the downward demographic pressures. In all other scenarios, real price will rise over the next 15 years. At the provincial levels however, the Atlantic provinces, Saskatchewan and, to a lesser extent, Quebec will suffer more because their population in the age group 25-54 will soon start to decline.

The main uncertainties on these forecasts are related to the trend growth rate of real income. Obviously however, macroeconomic fluctuations will continue to have a strong impact on housing prices in the future, as they have had in the past. The worst case for housing prices would be to have a recession with a substantial rise in interest rates. This is the recipe for a temporary fall in prices.

## REFERENCE


Baxter, D. (1997), *Demographics and The Future of Housing Demand in Canada : The Myth of the Vanishing Purchaser*, The Urban Futures Institute, Vancouver, B. C.

Canada, Statistique Canada (1973), *Population 1921-1971. Révision des estimations annuelles de la population par sexe et par groupe d'âge, Canada et provinces*, 91-512, MIC, Ottawa.

Canada, Statistique Canada (1994), *Projections démographiques pour le Canada, les provinces et les territoires : 1993-2016*, 91-520, MIST, Ottawa.

DiPasquale, D. and W. C. Wheaton (1992), The cost of capital, tax reform, and the future of the rental housing market, *Journal of Urban Economics*, 31(3), 337-59.

DiPasquale, D. and W. C. Wheaton (1994), Housing market dynamics and the future of housing prices, *Journal of Urban Economics* 35, 1-27.

Engelhardt, G. V. and J. M. Poterba (1991), House prices and demographic change, *Journal of Regional Science and Urban Economics* 21, 539-546.

Ermisch, J. (1996), «The demand for housing in Britain and population ageing: microeconometric evidence», *Economica* 63, 383-404.

Fair, R. C. and K. M. Dominguez (1991), «Effects of the changing U.S. age distribution on macroeconomics equations», *American Economic Review* 81(5), note 13, p. 1286.

Filardo, Andrew J. (1996), The Outlook of Housing: The Role of Demographic and Cyclical Factors, *Economic Review, Federal Reserve Bank of Kansas City*, troisième trimestre, 39-61.

Foot, David K., en collaboration avec Daniel Stoffman (1996). *Entre le boom et l'écho. Comment mettre à profit la réalité démographique*, Montréal : Boréal, 307 pages. (Collection Info Presse)

Foot, David K., en collaboration avec Daniel Stoffman (1999). *Entre le boom et l'écho. Comment mettre à profit la réalité démographique à l'aube du prochain millénaire*, Montréal : Boréal, 387 pages. (Collection Info Presse)

Goy, R. and M. Steele (1994) *Alternative constant - quality price indexes for modest houses and condominiums in Kitchener Waterloo*, Richard Goy Consulting, Guelph and department of economics, University of Guelph.

Granger, C. and P. Newbold (1974), Spurious regressions in econometrics, *Journal of Econometrics* 2, 111-120.

Green and Hendershott (1996), Age, housing demand and real house prices,.*Journal of Regional Science and Urban Economics* 26, 465-480.

Greene, W. H. (1990), *Econometric Analysis.* MacMillan Publishing Company, N. Y.

Hamilton, B. W. (1991), The baby-boom, the baby bust, and the housing market : A second look, *Journal of Regional Science and Urban Economics* 21, 547-552.

Hendershott, P. H. (1991), Are real house prices likely to decline by 47 percent?, *Journal of Regional Science and Urban Economics* 21, 553-563.

Hill, John K. and Petersen, D'Ann M. (1994), Demographics and the Long-Term Outlook for Housing Investment », *Economic Review, Federal Reserve Bank of Dallas*, premier trimestre, 13-25.

Holland, A. S. (1991), The Baby Boom and the housing market : Another look at the evidence, *Journal of Regional Science and Urban Economics* 21, 565-571.

Holly, S. and N. Jones (1997), House prices since the 1940s: cointegration, demography and asymmetries, *Economic Modeling*, 14, 549-65.

Laycock, W., *Housing Prices of the Seventies: Perspectives and Analysis*, Étude No 78.05, Direction de la recherche économique, Commission de lutte à l'inflation, Ottawa, 1978.

Levin, E. J. and R. E. Wright (1997), The impact of speculation on house prices in the United Kingdom, Economic Modelling 14, 567-585.

Lewis, R. (1997), *Perspectives à long terme du logement : augmentation des ménages au Canada et dans les provinces, 1991-2016*, Société canadienne d'hypothèques et de logement, Ottawa.

Mankiw, N. G. and D. N. Weil (1989), The Baby Boom, the Baby Bust and the housing market, *Journal of Regional Science and Urban Economics* 19, 235-258.

Mankiw, N. G. and D. N. Weil (1991), The Baby Boom, the Baby Bust, and the Housing Market:A Reply to Our Critics. *Regional Science and Urban Economics*, 21(4), 573-79.

Miller, Glenn H. Jr. (1988), Demographic Influences on Household Growth and Housing Activity, *Economic Review, Federal Reserve Bank of Kansas City*, septembre/octobre, 34-48.

Ohtake, F. and M. Shintani (1996), The effect of demographics on the Japanese housing market, *Journal of Regional Science and Urban Economics* 26, 189-201.

Pitkin, J. R. and W. Myers (1994), «The Specification of Demographic Effects on Housing Demand : Avoiding the Age-Cohort Fallacy», *Journal of Housing Economics* 3, 240-250.

Poterba, J. M. (1991), House price dynamics: the role of tax policy and demography, *Brookings Papers on Economic Activity*, 143-203.

Skaburskis, A. (1997), Gender Differences in Housing Demand. *Urban Studies*, 34(2), 275-320.

Swan, C. (1995), Demography and the demand for housing : A reinterpretation of the Mankiw-Weil demand variable, *Journal of Regional Science and Urban Economics* 25(1), 41-58.

Steele, M. (1979), *La demande de logements au Canada*, Catalogue 99-763F, Ministère de approvisionnements et services, Canada, 223 p.

Woodward, S. (1991), Economists' prejudices: why the Mankiw-Weil story is not credible, *Regional science and Urban Economics* 21, 531-537.

## APPENDIX 1 : FIGURES

Figure 1
The demographic wave

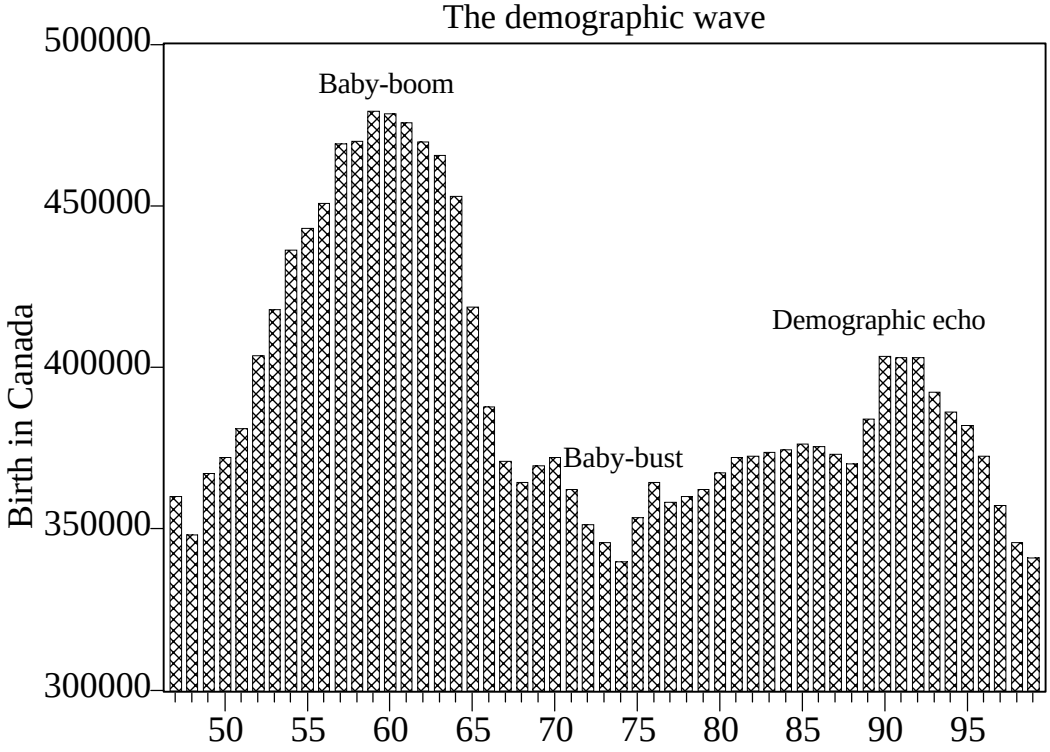
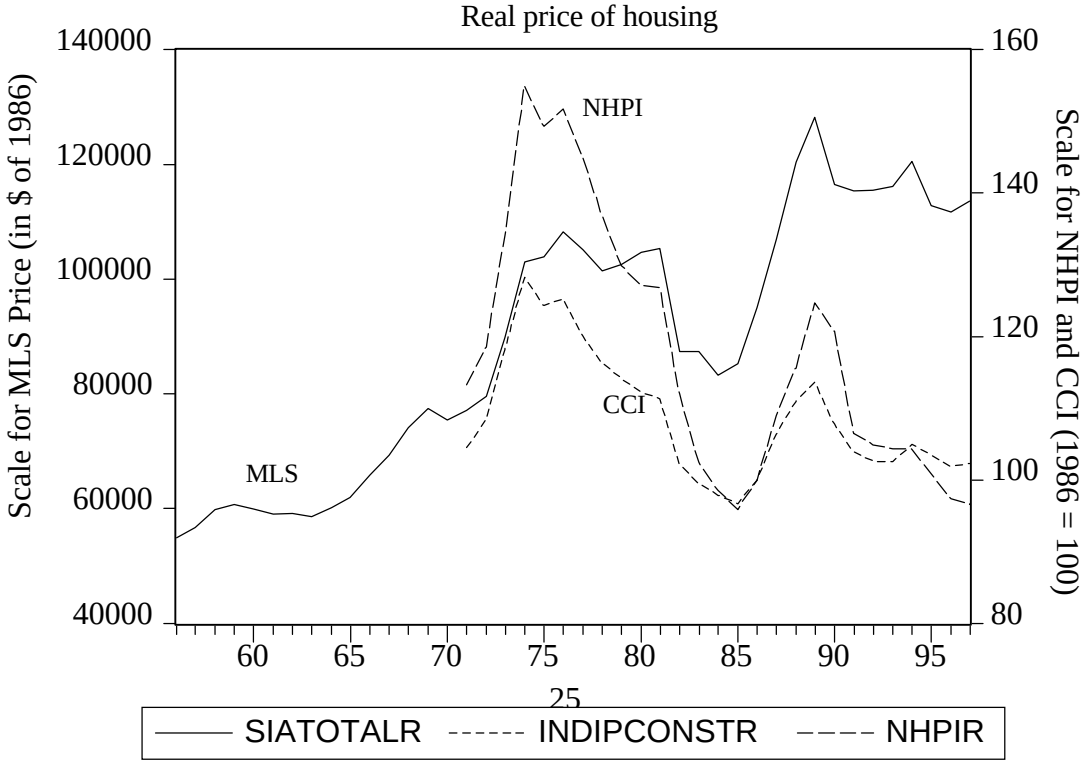



Figure 2
Real price of housing



## FIGURE 3

## Provincial housing price and stock data

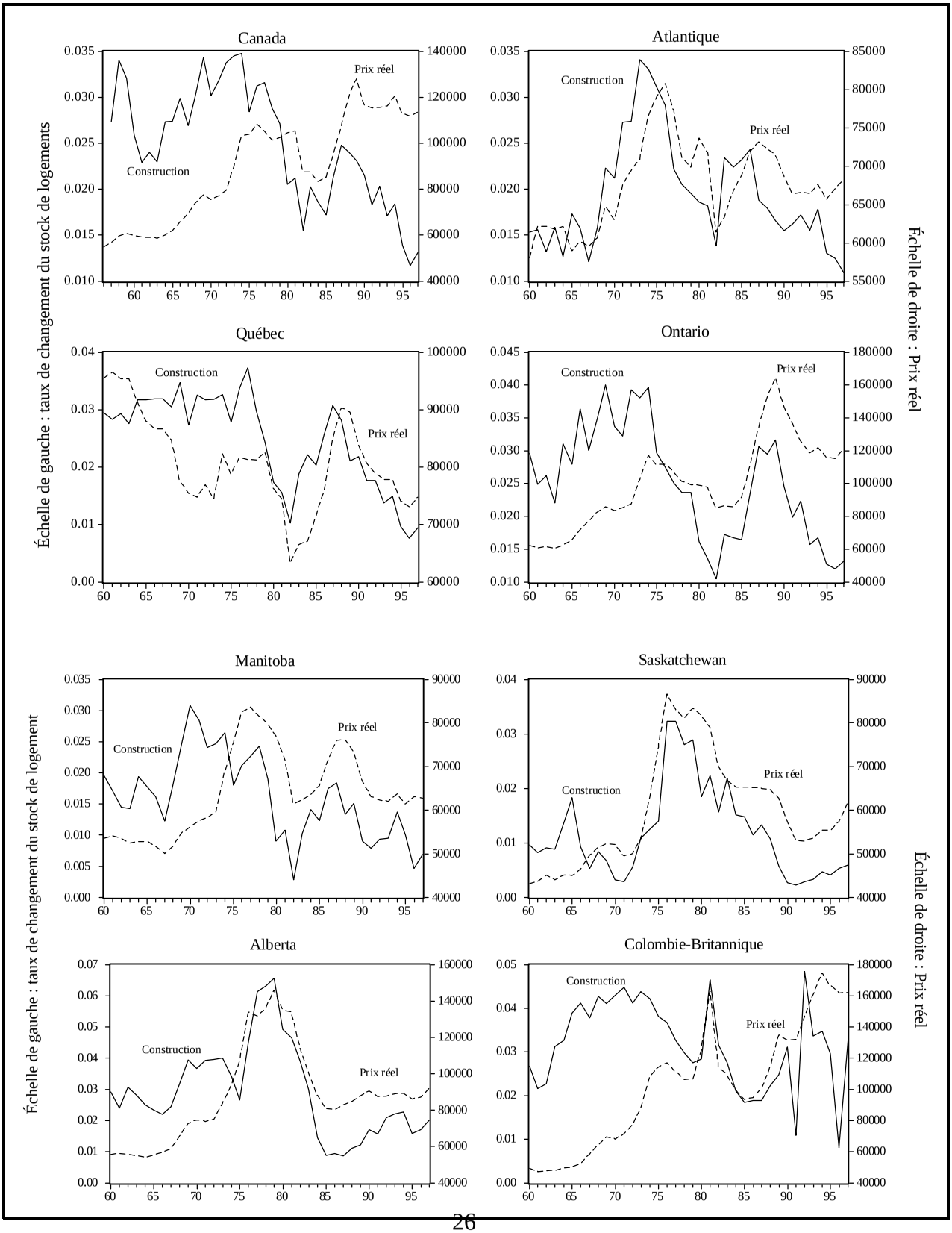


**FIGURE 4**
**Actual and predicted value of endogenous variables**

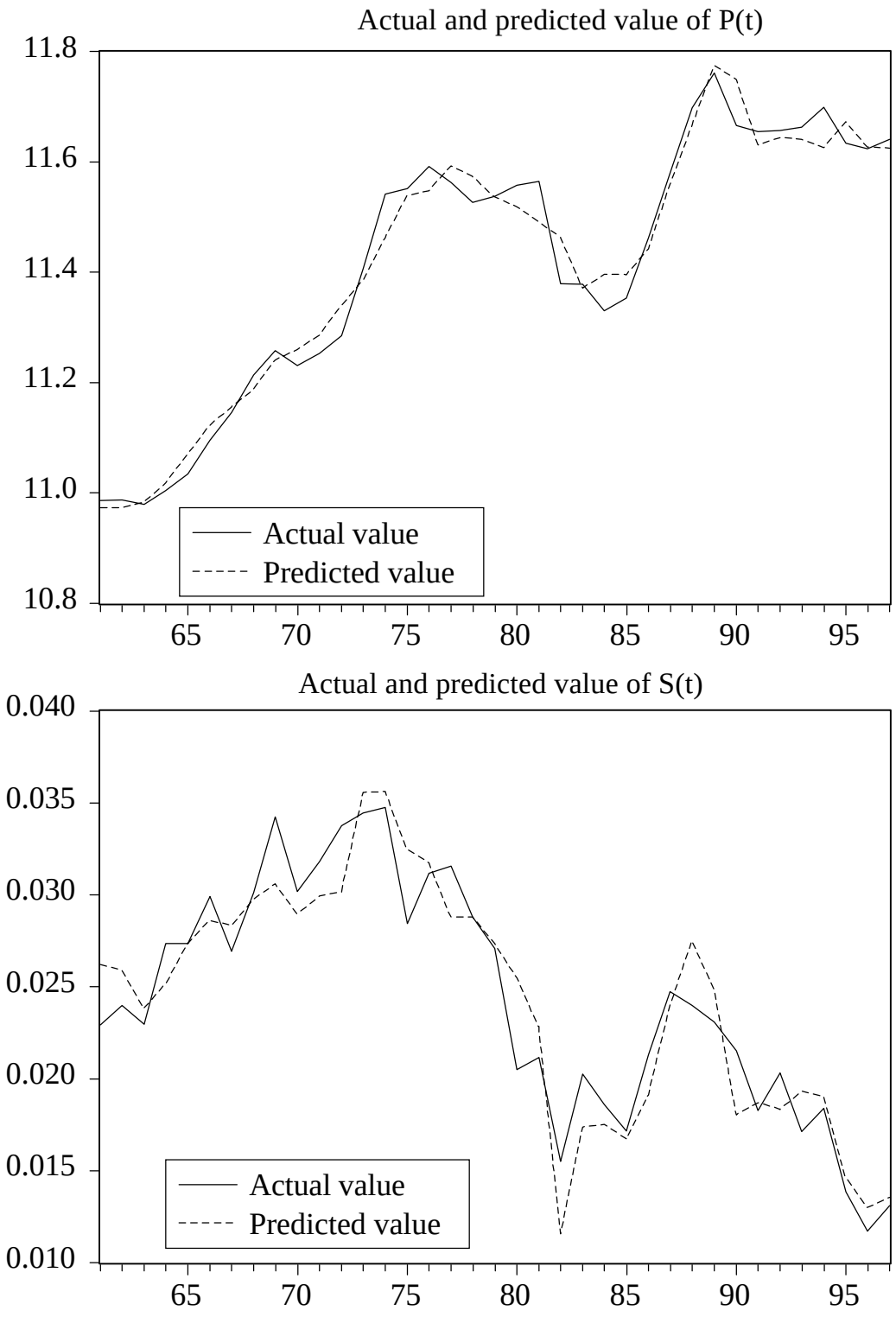


FIGURE 5

Real price with constant demographic growth

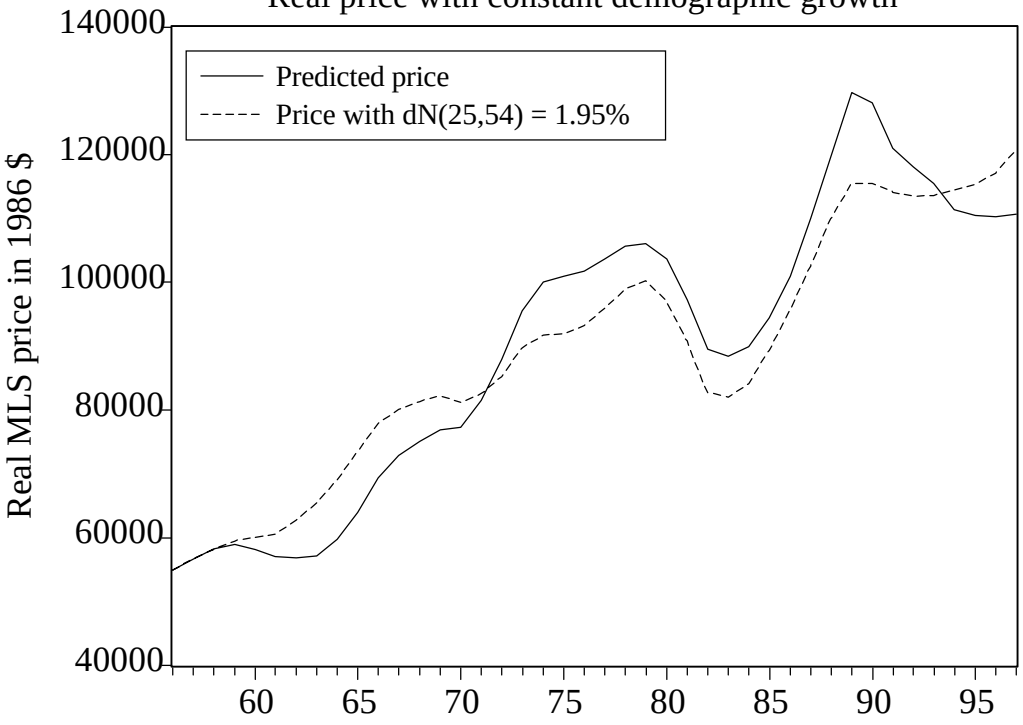



FIGURE 6

Real price with constant economic growth

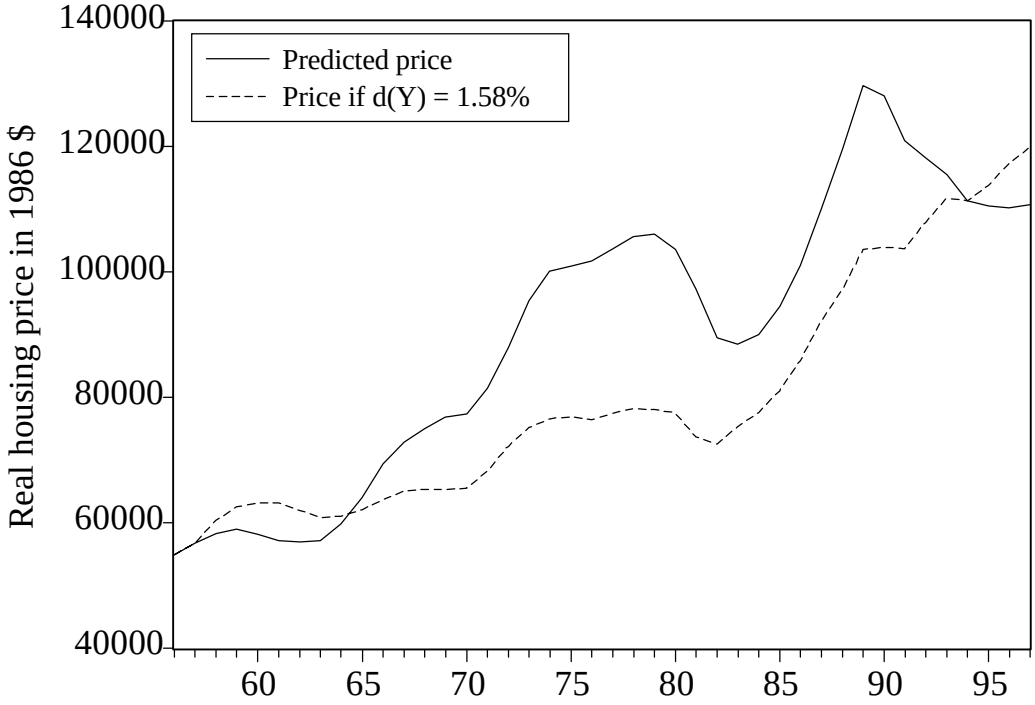


FIGURE 7

Price deviation from the predicted value

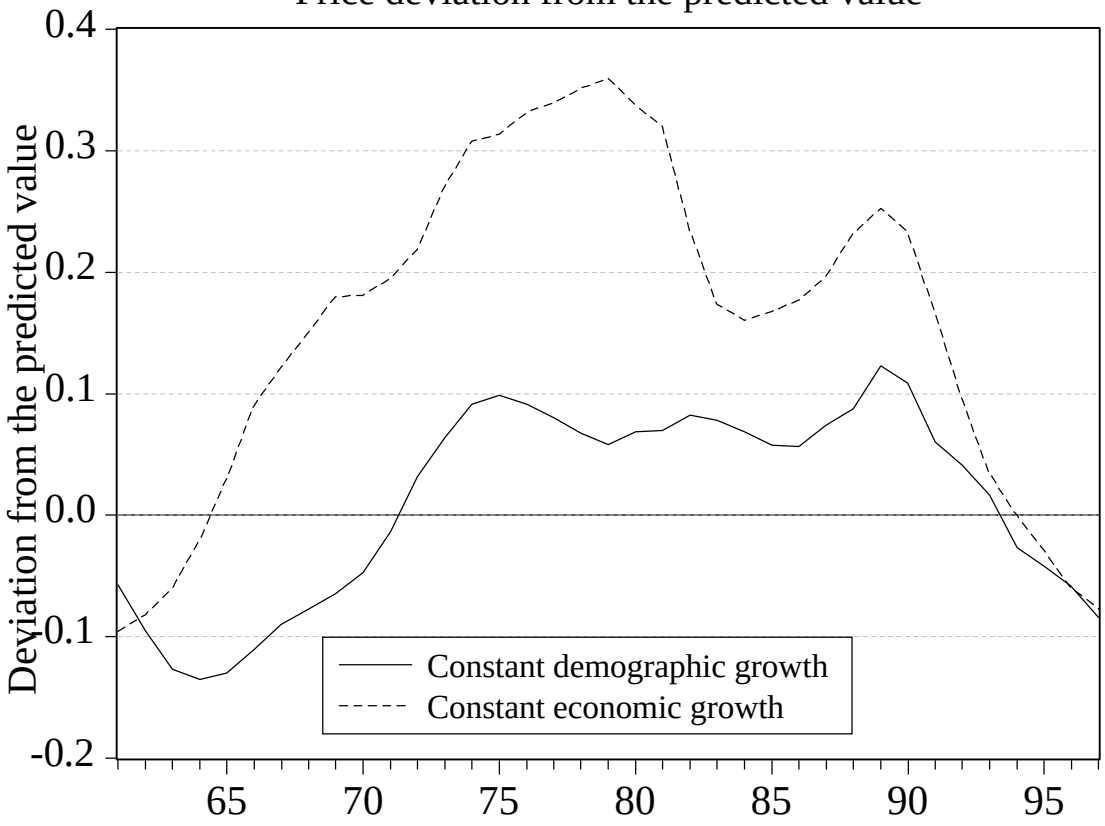


FIGURE 8
Forecast of the population growth (25-54)

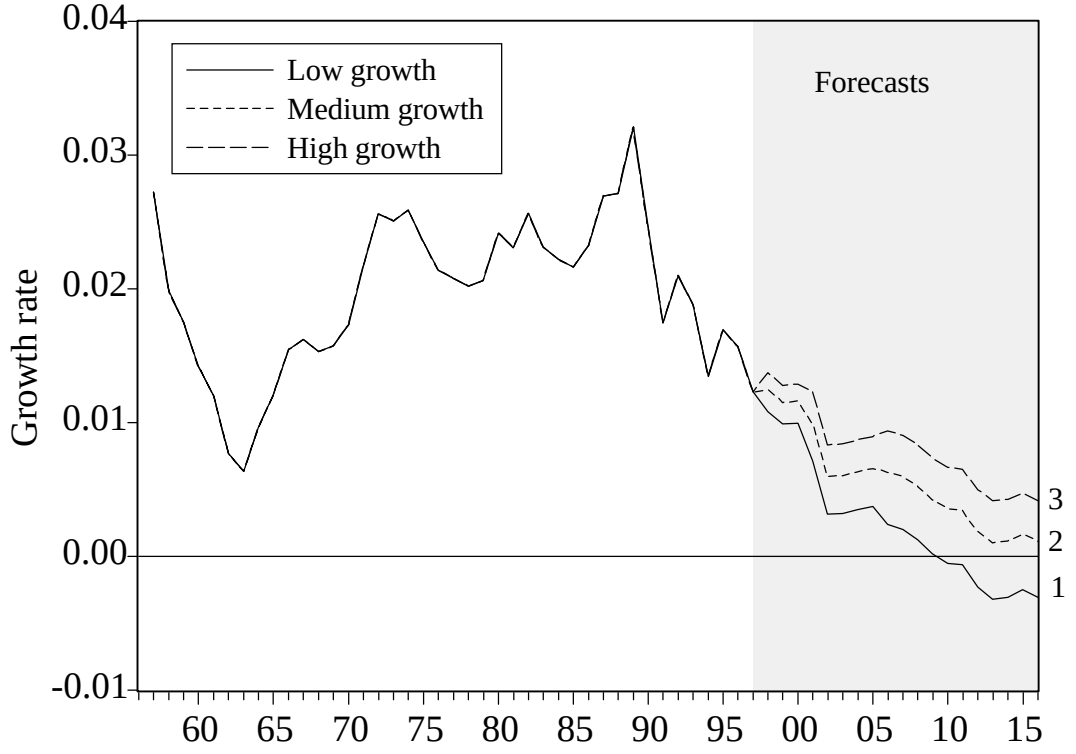



FIGURE 9
Price forecasts until 2016

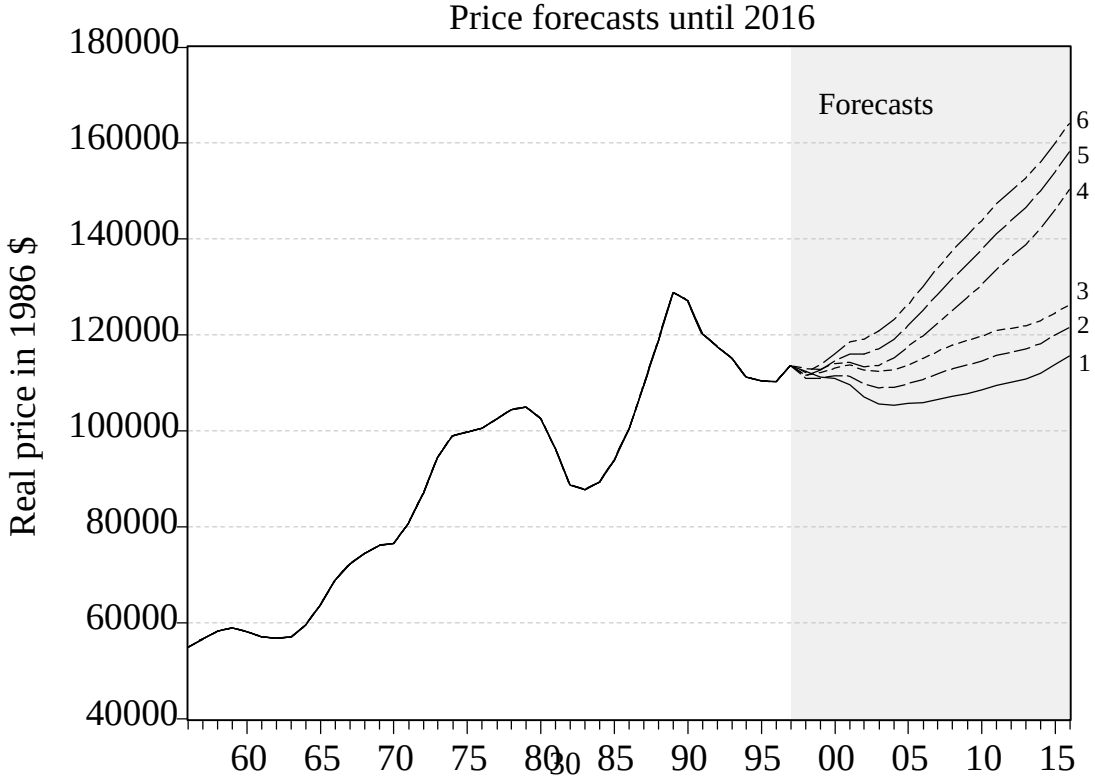


FIGURE 10
Provincial population growth rates

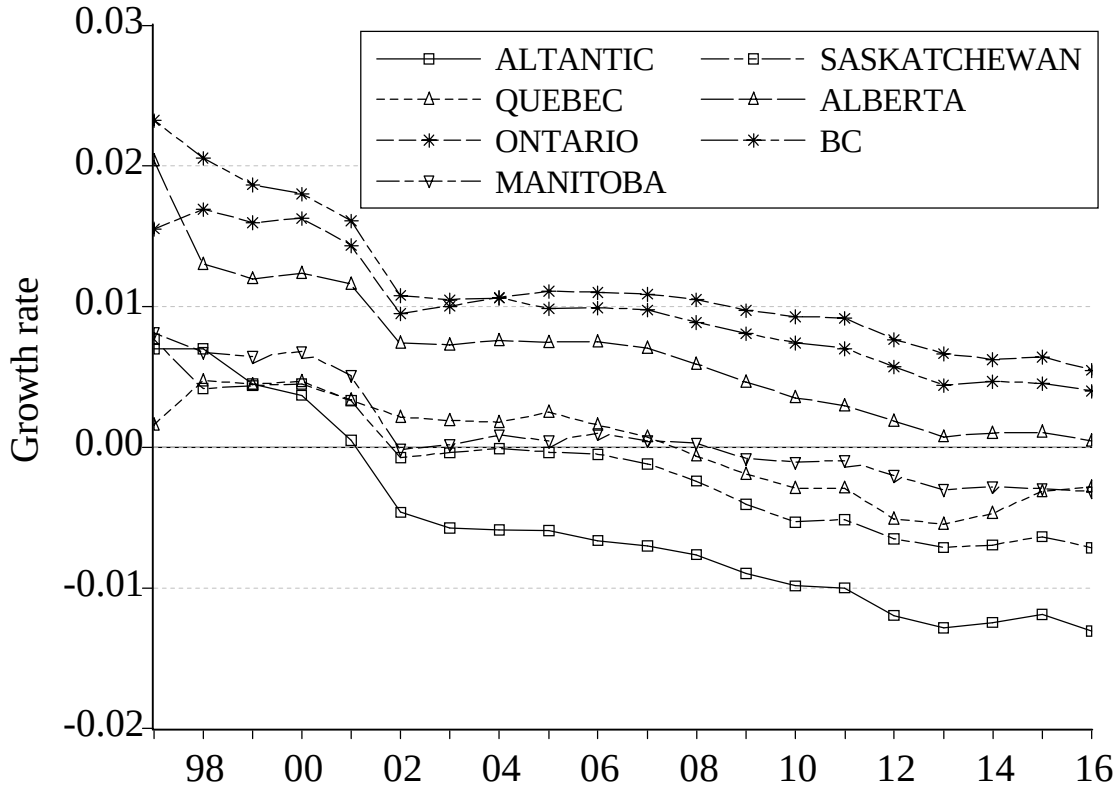
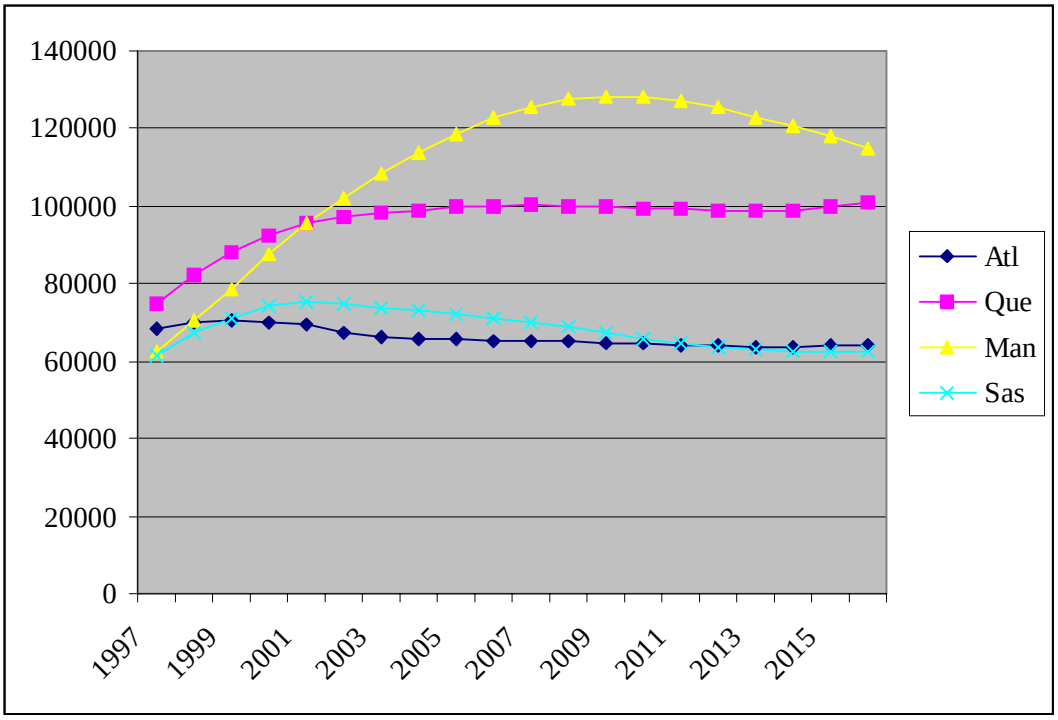
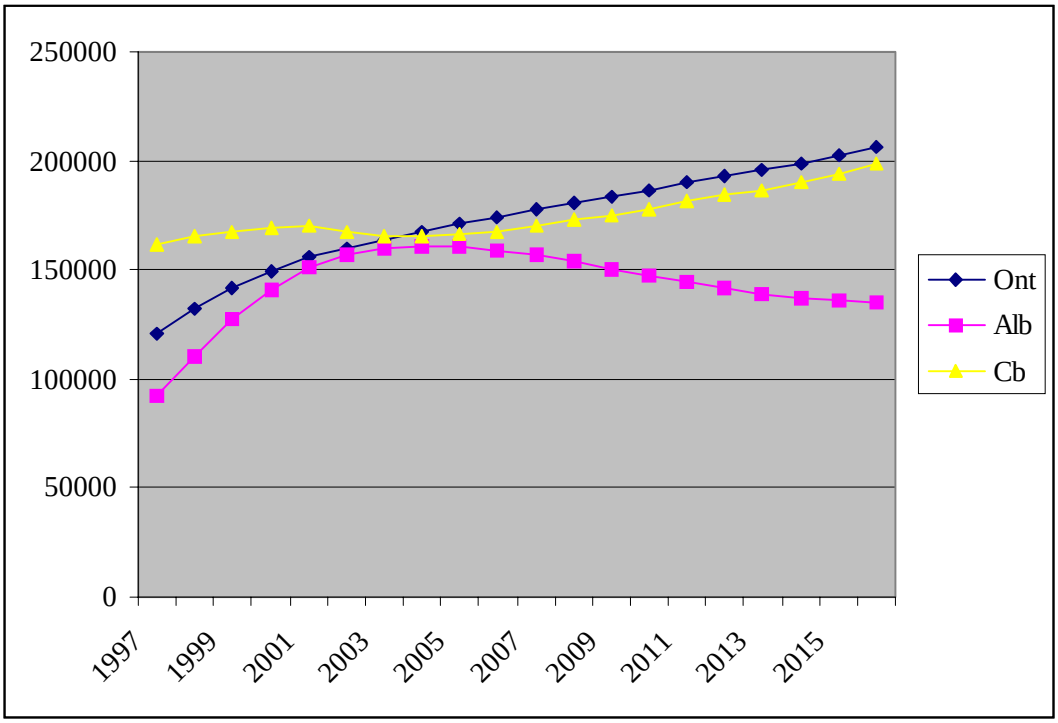


FIGURE 11
Provincial Forecasts of Real Price



## SOURCES OF DATA

Housing prices and number of housing sold based on Multiple Listing Services (MLS) : *Canadian Real Estate Association*, special compilation.

New housing price index : Cansim, series P10248 for the period 1981-1997. This series has been coupled with previous data available from Statistics Canada for the years 1971-1981.

Price index of new residential units : CANSIM, series D20588

NHA price series : *Canadian Housing Statistics*, Central Mortgage and Housing Corporation, several issues.

Housing stock : Estimated number of single and multiple housing units at year end, CANSIM, series D845803 (Canada), D845804 (NF), D845807 (PEI), D845810 (NS), D845813 (NB), D845816 (QC), D845819 (ON), D845822 (MN), D845825 (SK), D845828 (AB), D845831 (BC)

Housing prices based on national account series : estimated value of residential buildings, CANSIM series D18882, divided by the estimated number of housing, D845803.

Real canadian GDP : annual average of CANSIM series D20463.

Real provincial GDP : for the years 1961-1995, Conference Board of Canada. For the years 1996-1997, these series has been coupled with GDP at factor costs estimates by Statistics Canada : CANSIM series I340415 (NF), I340530 (PEI), I340585 (NS), I340640 (NB), I340695 (QC), I340750 (ON), I345475 (MN), I345530 (SK), I345585 (AB), I345640 (BC).

Consumer price index : CANSIM, series P700000.

Five years mortgage interest rate : CANSIM, series B14051.

Population by age group, Canada and the provinces, 1956-1971: Canada, Statistics Canada (1973), *Population 1921-1971. Revised annual estimates of population, by sex and age group, Canada and the provinces*, 91-512, MITC, Ottawa.

Population by age group, Canada and the provinces, 1971-1997 : CANSIM, matrix 6367 to 6377. (The 1971 population have been estimated by applying to the 1970 population a growth rate equal to the average rate of 1970 and 1972.)

Population projections for Canada and the provinces by age group for different scenarios : Canada, Statistics Canada (1994), *Population projections of Canada, Provinces and Territories, 1993-2016,* 91-520, MIST, Ottawa.

## NOTES

1.DiPasquale, D. et et W. C. Wheaton (1994), « Housing Market Dynamics and the Future of Housing Prices », *Journal of Urban Economics* 35, p. 24.

2. The cointegration between the real per-capita income and the real price of houses implies that, in the long run, both series share a common stochastic trend by which both series are growing with time. The fact that the real price of housing grows in the long-run is explained by the fact that no quality adjustment have been made to price of houses. So, the cointegration means that as the real income increases, people use up some of it to improve the quality of their houses.

3.Pitkin, J. R. et W. Myers (1994), «The Specification of Demographic Effects on Housing Demand : Avoiding the Age-Cohort Fallacy», *Journal of Housing Economics* 3, p.248. The emphasis in italic is in the original text.

4. The NHPI is constructed in measuring the change in the price of the same model of house on a given market. Goy and Steele explained the bias by the fact that end-of-line model must be sent at a discount with respect to the price it was sold out when is was brand new. Although the bias is barely noticeable on a month-to-month basis, is may become significant over a one-year interval.

5. The peaks and trough in the construction in the 90s made us suspect that there could be some problems in the data. However, a thorough examination did not reveal any evidence of such problems.

6.With perfect markets, the demand for housing can be written as a function of the user cost of housing services $P_t \times U_t$. The user cost of owner-occupied housing is a complicated function of the nominal interest rate, the inflation rate, the marginal tax rate on interest income nd and the loan-to-value ratio. For a discussion of the determinants of this user cost and a comparison between owner-occupied housing and rental housing, see Fortin (1991).

7. DiPasquale and Wheaton (1994) have also included in their model an index of the expected selling time of new houses. Since home builders must finance housing construction until the final sale, the time-to-sale variable as well as the interest rate have an expected negative impact on construction.

8.A gradual price adjustment does not necessarily contradict that the housing market is inefficient market, Indeed, because of high transaction costs, a not too large expected price changes can subsist.

9.Canadian stock price data are contained in the CANSIM matrix 4079 while provincial estimates are in matrices 4080 to 4089.

10. Although the theoretical model relates demographic pressures to size of the population, we use in the empirical model the population growth. This choice is justified on empirical ground since we have not find a single result in which the population is statistically related with house prices while we consistently found, as it will become evident soon, that the price reacts to the growth rate of the middle age population.

11. Many criticisms may be addressed to these unrealistic assumptions. We are perfectly aware that the marginal tax rate on interest income has varied over time, that is considerably varies with income, that the indebtedness rate of houses also greatly differs amongst households, and that the expected price appreciation can be much different from the last year inflation rate. However, there is no satisfactory solutions to these criticisms. To protect our conclusions, we have tried many different measures of user costs. One important conclusion of our result is that the user cost is not significant in the housing price equation, and this remains true for all the various forms we could imagine to define the user cost.

12. The details of the tests are not provided in this text but are available upon request.

13. The stock equation is over-identified while the price equation is exactly identified. See Greene (1990), p. 629 for a discussion of the instrumental variables estimator with autocorrelation process.

14. The marginal value of the test is close to the 5% level. It is legitimate to express concerns as to a possible biased introduced in the model if we inadvertently reject some variables that have their place in the model. So, we have checked more carefully and it is the vacancy rate in the $\Delta S$ equation which makes the rejection of the null hypothesis more difficult. Indeed, if we do not impose the hypothesis $\beta_4 = 0$ together with the other hypotheses, the calculated $\chi^2$ is only 9.046 and the marginal value is only 0.34. On the contrary, if we keep the vacancy rate in the equation but we exclude the other variables, the estimation period now can begin in 1958. With this longer sample, $\beta_4$ has a marginal value of only 0.25. It is then possible to remove it from the final specification.

15. These two equations have been submitted to many specification tests. The LM test, applied with 1 to 4 lags, do dot allow to reject that succesive residuals are independent. The stability of the parameters has also been checked and is rejected only with the Chow-Fisher with a structural break in 1977. However, the problem does not seem serious since it disappears if we vary the date of the break. Moreover, both the CUSUM test and the CUSUM of squares do not detect a significant instability at this date, which gives indication that the model is well specified. The Jarque-Bera test on the residuals of equations 11 and 12 has a calculated value of 0.68 and the former equation and 0.24 on the later, with marginal value of 0,71 and 0,88 respectively. Since, residuals are normally distributed, the 3SLS estimator is asymptotically efficient.

16. Since we completed this study, last summer, Statistics Canada has produced a new set of demographic forecasts until 2026. These are based on slightly different hypotheses with a higher life expectancy but with a lower fertility rate.

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