The Price Elasticity of New Housing Supply in Canada:

Modelling the Canadian Housing Market and Estimating the Supply Price Elasticity of New Housing from 1981 to 2008

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for Economics 483

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INTRODUCTION

Given the recent economic downturn and the importance of the housing market to that downturn, the significance of the housing market to the overall health of the Canadian economy has been firmly reinforced Activity in new housing alone comprises approximately 2 percent of Canada's gross domestic product[1]. Indicators from the housing market, such as housing starts, function as leading indicators for economic recessions and recoveries. A decrease in activity in the housing market during periods of high level of output often indicates the onset of a recession , while a rise in the activity in the housing market during a period of economic downturn usually signals rising future output.

One of the most critical parameters needed to analyze housing market conditions is the price elasticity of supply; that is, the rate of response of housing market supply to changes in housing prices. If the price elasticity of the supply of housing is inelastic, then large increases in price will not have a significant effect on the quantity of housing supplied. If the price elasticity of the supply of housing is elastic, then large increases in price will significantly impact on the quantity of housing supplied. However, despite the importance of this measure towards understanding Canadian housing market conditions, however, estimates of the price elasticity of the housing supply have not been computed. As such, this paper will attempt to fill this void; it will present a model of the housing market, originally put forth by Malpezzi and Maclennan in the Journal of Housing Economics in 2001, which estimates the price elasticity of housing supply for Canada over the period from 1981 to 2008.

LITERATURE REVIEW

A substantial amount of literature on the price elasticity of housing supply exists for the United States. The primary analytical framework for the study of the housing market and obtaining estimates of

[1] Statistics Canada, Table 379-0027.

the price elasticity of housing supply was originally developed by Richard Muth in 1960. He regressed the real value of new construction, or output, on the relative price of housing and input prices for the United States from 1919 to 1934. He also estimated an inverted model with housing prices as the dependent variable and output as an explanatory variable. For both models, Muth found no statistically significant relationship between output and price, and so concluded an infinitely elastic supply of housing. Subsequently, in 1979, James Follain estimated a similar model for the United States for the period from 1947 to 1975. He examined issues of simultaneous and serial correlation; however, he also found an infinitely elastic supply of housing. In the mid 1980s, two major critiques of this work emerged. Mark Stover argued that interpreting the result that there is no statistically significant relationship between price and output as evidence of perfect elasticity was incorrect, and that these results could also be interpreted as indicative of a perfectly inelastic supply. Shortly thereafter, Edgar Olsen also argued against the results obtained by Muth and Follain, stating that both had mis-specified their models by including input prices as an explanatory variable. Because the relationship between housing supply and input prices should be independent of whether supply is elastic or inelastic, the inclusion of input prices is extraneous. While the inclusion of an irrelevant regressor would not bias the coefficient estimates, it would result in incorrect inferences. Given that both had found that the null hypothesis of an infinitely elastic supply could not be rejected, the inferences could differ if the model was regressed without the inclusion of input prices[2]. Subsequent estimations of the price elasticity of housing supply have used either variants of Muth's reduced-form estimation method, correcting for Olsen's criticism, or have taken more structural approaches, where aggregate supply is proxied by construction and estimated as a function of price and cost shifters[3]. These structural approaches tend to

[2] Dispasquale, p. 12.
[3] Dispasquale, p. 11.

have their foundations in the asset-market literature or in urban spatial theory[4]. Both approaches have found revised estimates of price elasticity for the United States to be finite, but typically elastic.

In contrast to the United States, however, only limited efforts have been made to apply these models or develop comparable models for other countries, with the exception of the United Kingdom. In particular, a paper published in 2001 by Stephen Malpezzi and Duncan Maclennan computed separate estimates of the price elasticity of the supply of new housing for the United States and the United Kingdom on data covering almost the entire 20th century. While a lack of Canadian data does not permit analysis over the same time frame, the computation of similar estimates for Canada will contribute to a greater understanding of the Canadian housing market, and, from that, the Canadian economy. Computation of these estimates will also allow for important comparisons of the new housing market in Canada with that of its largest trading partner, the United States.

THEORETICAL FRAMEWORK

Prior to introducing the models used in this paper, it is crucial to note the conceptual problems associated with developing economic models that accurately describe the behaviour of the housing market. Obtaining an appropriate quantity or price dimensions for housing upon which to base a model of the housing market is extremely difficult. This problem severely constrains economic modelling in this area. First, measuring the quantity of housing, or developing a measure of what constitutes a unit of housing is quite problematic. Further, due to the durable nature of housing, the quality of housing can vary significantly across units of a comparable quantity[5]. As such, data on units of housing is generally not observed or measured. Second, price data suffers from many similar complications. It is very

[4] Dispasquale, p. 12.
[5] Harberger, p. 3.

possible for two units of housing to have the same price, while varying significantly on size and quality. Thus, given these problems and the complexity of trying to arrive at a standard unit with to measure the housing stock with, virtually no reliable, accurate price or quantity data exists on the housing stock. What little price data on the stock of housing does exist is not worth analyzing, because it fails to appropriately address the quantity issue. As a result, the models developed in the literature must usually rely on flow data on the price of new residential units, where quantity has been controlled for. This construction of new housing allows the existing stock to be increased and to be maintained against deprecation[6]. Thus, in general, the construction of new housing can function as a proxy of the demand for the stock of housing. However, changes in demand in the existing stock may not be reflected immediately in the market. Homeownership is a significant consumer decision, and is often timed to co-ordinate with significant life activities, such as the completion of children's schooling. This further implies that in any given period, the amount of new residential construction may not reflect changes in demand for housing in that period; that is, observable supply may not align with demand in that period. Despite this complication, this paper makes use of prices and price changes in comparable units of new housing as the most appropriate, available measure of the supply of housing.

MODEL 1

The primary modelling techniques used in this paper to obtain the price elasticity of the supply of new housing in Canada were developed by Malpezzi and Maclennan in 2001. Based on Muth's original specification, while accommodating for Olsen's critique, their model presents a simple demand and supply framework for estimating the price elasticity of supply. It attempts to replicate the housing market using a three-equation flow model:

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[6] Harberger, p. 4.

$$Q_D = \delta_0 + \delta_1 P_h + \delta_2 Y + \delta_3 D \quad (1)$$
$$Q_S = \beta_0 + \beta_1 P_h \quad (2)$$
$$Q_D = Q_S \quad (3)$$

The first equation models the demand side of the housing market, where P_h represents the relative price per unit of housing, Y represents income and D represents population. This implies that housing demand is dependent on the prevailing price in the market, the income level of consumers and the population level. The second equation models such that it depends only on market price. Finally, the third equation assumes that demand and supply must be equal; that is, the housing market must clear.

Because we seek the price elasticity of supply, the natural logarithm of all variables is used in the model. This permits the coefficient estimates produced (δ_1, δ_2, δ_3 & β_2) to be interpreted, approximately, as elasticities. For example, β_1, the coefficient on price in the supply equation, can be interpreted as the percentage change in the quantity of housing supplied for a one percent change in price. This is equivalent to the definition of the price elasticity of supply, and as such, β_1 is the primary coefficient estimate of interest.

However, it is not possible to estimate either equation (1) or equation (2), because the quantity of housing in the market is not an observed variable, as was previously noted. Thus, none of the coefficients in these equations are identified. However, if these two equations are placed into equation (3), and the observed variable, the price per unit of housing, is solved for, the following reduced-form equation is obtained:

$$P_h = \frac{\delta_0 - \beta_0}{\beta_1 - \delta_1} + \frac{\delta_2}{\beta_1 - \delta_1} Y + \frac{\delta_3}{\beta_1 - \delta_1} D \quad (4)$$

Again, while none of these individual coefficient estimates are identified, we can estimate this equation as:

$$P_h = \alpha_0 + \alpha_1 Y + \alpha_2 D \tag{5}$$

where

$$\alpha_0 = \frac{\delta_0 - \beta_0}{\beta_1 - \delta_1}$$

$$\alpha_1 = \frac{\delta_2}{\beta_1 - \delta_1} = \text{the total coefficient of income}$$

$$\alpha_2 = \frac{\delta_3}{\beta_1 - \delta_1} = \text{the total coefficient of population}$$

Re-arranging the total coefficient of income for the primary coefficient of interest, β_1, the price elasticity of housing supply can be estimated as the following:

$$\beta_1 = \frac{\delta_2}{\alpha_1} + \delta_1 \tag{6}$$

By estimating equation (5), we can obtain a value for α_1. We can also make parametric range assumptions for δ_1 and δ_2. δ_1, the price elasticity of housing demand, will be assumed to lie on the interval between -0.5 and -0.1, while δ_2, the long-run income elasticity of demand, will be assumed to lie on the interval between 0.5 and 1[7]. This first assumption implies that increases in the price of housing will cause housing demand to fall, while the second assumption implies that increases in income will cause housing demand to rise. This allows us to calculate a range for β_1, the price elasticity of housing supply.

[7] Malpezzi and Maclennan, p. 283. These estimates were taken from Mayo, 1981 and Wilkinson 1973, and are for the United States, as no estimates of these parameters exist for Canada.

MODEL 2

This second model is an extension of the preceding model. Model 1 is a flow model, and so it does not allow for the possibility that changes in the explanatory variables may have delayed effects on the housing market. In fact, there is frequently a lag between changes in the explanatory variables and resulting changes in housing. In particular, on the supply side of the market, the construction of new housing often taken takes several months to complete, especially in Canada, due to our more extreme climate[8]. Meanwhile, on the demand side of the market, changes in income are not necessarily immediately translated to in changes in housing consumption, due to the significant transaction costs associated with moving residences. Thus, this second model attempts to provide a more accurate estimate of the price elasticity of housing supply by accounting for some of these lags by introducing of a stock adjustment parameter. This adjusted model is as follows:

$$Q_D = \gamma(S^* - S_{-1}) \quad (7)$$
$$S^* = \delta_0 + \delta_1 P_h + \delta_2 Y + \delta_3 D \quad (8)$$
$$Q_S = \beta_0 + \beta_1 P_h \quad (9)$$
$$Q_D = Q_S \quad (10)$$

In this model, S^* is the desired housing stock in the current period, S_{-1} is the stock of housing in the previous period, and γ is the adjustment in the housing stock per period. Putting equation (7) into equation (8) yields

$$Q_D = \gamma(\delta_0 + \delta_1 P_h + \delta_2 Y + \delta_3 D - S_{-1}) \quad (11)$$

Substituting this equation and equation (9) into equation (10), and solving for P_h gives the reduced form of the adjusted model:

$$P_h = \frac{\gamma\delta_0 - \beta_0}{\beta_1 - \gamma\delta_1} + \frac{\gamma\delta_2}{\beta_1 - \gamma\delta_1} Y + \frac{\gamma\,\delta_3}{\beta_1 - \gamma\delta_1} D - \frac{\gamma}{\beta_1 - \gamma\delta_1} S_{-1} \quad (12a)$$

[8] Rosenthal 1999, p. 6.

To conclude, while estimations yielded results which were comparable with what has been shown in the literature for the United States, a longer, more-detailed time series would certainly enable a more thorough, accurate examination and comparison of these estimates. The data series, while covering approximately thirty years, may not be long enough to uncover long-run trends in the housing market. Because housing is a durable good and considered a major investment by many consumers, there is an expectation that the individual will retain the house for a lengthy period of time, or at least the amount of time it takes for the consumer to pay off loans. In many ways, this model does not accurately describe or depict the unique nature of durable goods, and more so attempts to model housing as a typical, disposable consumer good. Despite these shortcomings of the modelling strategy used, this point implies that cycles in the housing market are long. As a result, it can take many years for the housing market to reach its long-run equilibrium, if it ever does, and a longer time series of data would certainly enable a more accurate estimation of the housing market. Further, the data is aggregated nationally over 21 metropolitan regions. Housing markets are local, and this aggregate data may not reflect important local economic conditions[15]. Certain Canadian cities, like Calgary, have faced greater demand pressures in recent years, which has given rise to far different housing market conditions than seen in other major Canadian cities, such as Montreal or Halifax. Given this local nature of the housing market, the outcomes of the Calgary market would not have a significant impact on these other housing markets. In utilizing aggregate data, this local nature of the housing market may be eliminated. Thus, it is possible that no individual metropolitan housing market in Canada is consistent with the national average. As such, a more detailed, lengthier time series would add further credibility and greater certainty to these results.

[15] Malpezzi and Maclennan 2001, p.301.

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DATA APPENDIX

All data are Statistics Canada figures.

Population	All ages, both sexes, all persons, July 1st, annual v466668
GDP	Gross domestic product, expenditure-based, Canada, Chained 2002 dollars, annual v3860085
Personal Income	Personal income per person, dollars, annual v691802
Personal Disposable Income	Personal disposable income, dollars, quarterly v44182035
Implicit GDP Deflator	Gross domestic product (GDP) indexes, Canada, Implicit chain price index 2002=100, annual v3860248
CPI	Consumer price index, 2005 basket, Canada, all-items, 2002=100, annual v41693271
NHPI	New housing price indexes, Canada, 1997=100, monthly v21148161 (House only); v21148160 (Total House and Land) Annualized by averaging yearly index values and converted to 2002 base year
Housing Starts & Completions	CMHC, housing starts, and completions, all areas, Canada, annual v730524 (Single-detached starts); v732398 (Single-detached completions); v730579 (Total starts); v732453 (Total completions)
Net Stock of Housing	Flows and stocks of fixed residential capital, Canada, Total, single and multiple dwellings end-year net stock, Chained 2002 dollars, annual v28368488
Residential Investment	Investment in residential structures, Canada, Chained 2002 dollars, annual v3860139 (New Only); v3860140 (Renovations Only); v386014 (Total Investment)

FIGURE 1: Housing Starts and Completions of Single-Detached Units in Canada 1955-2008

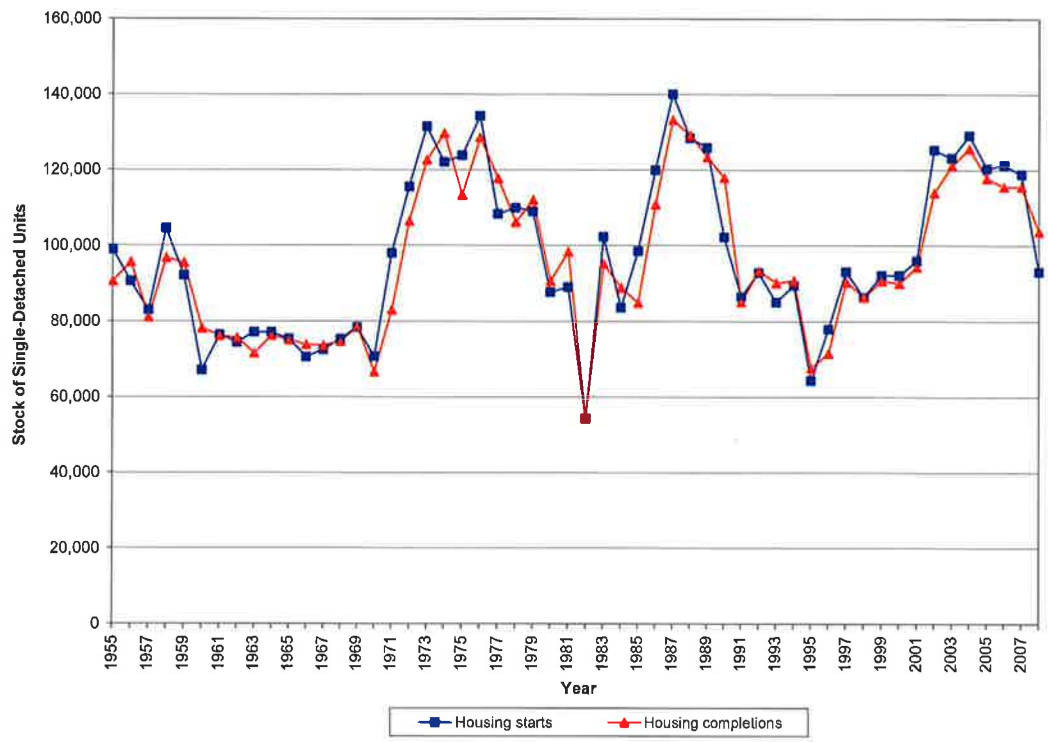

FIGURE 2: Housing Starts and Completions of All Units in Canada 1955-2008

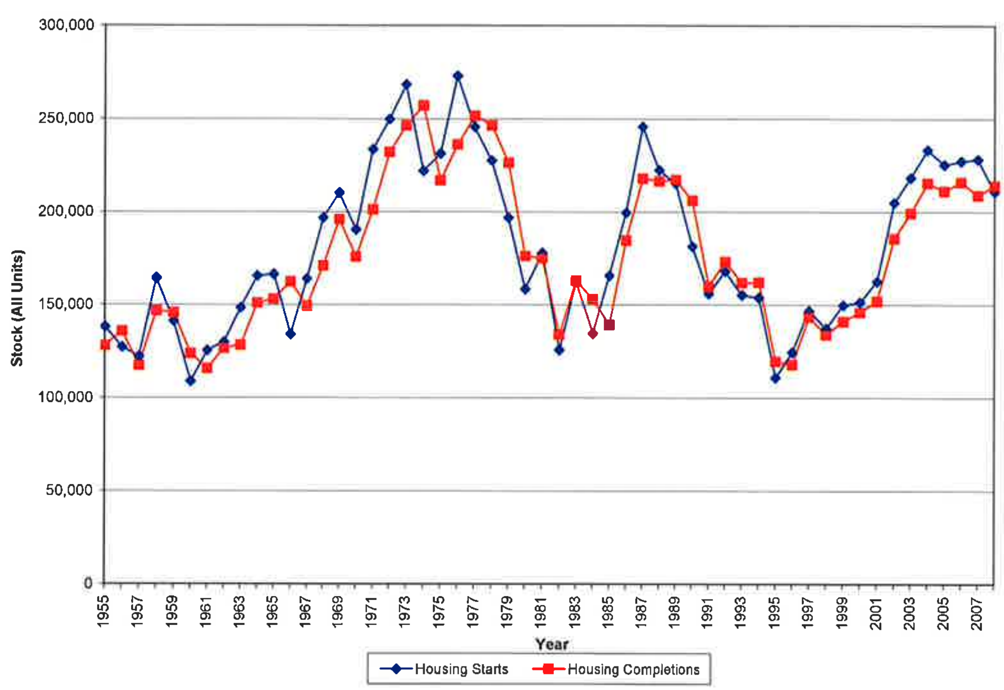

FIGURE 3: Total Real Investment in Residential Structures in Canada
1981-2008

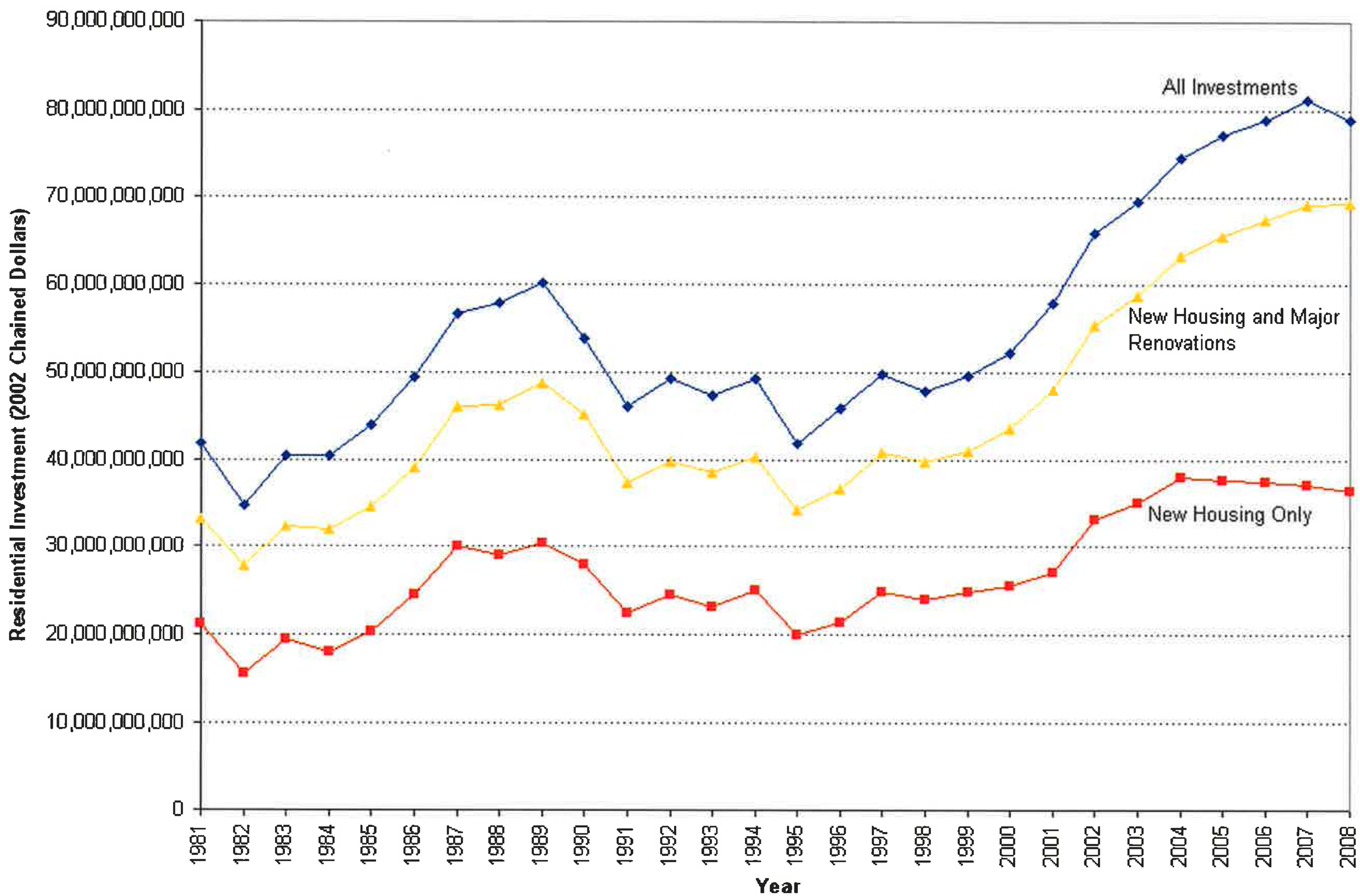

FIGURE 4: End of Year Net Stock of Residential Capital in Canada
Single and Multiple Dwellings, 1942-2007

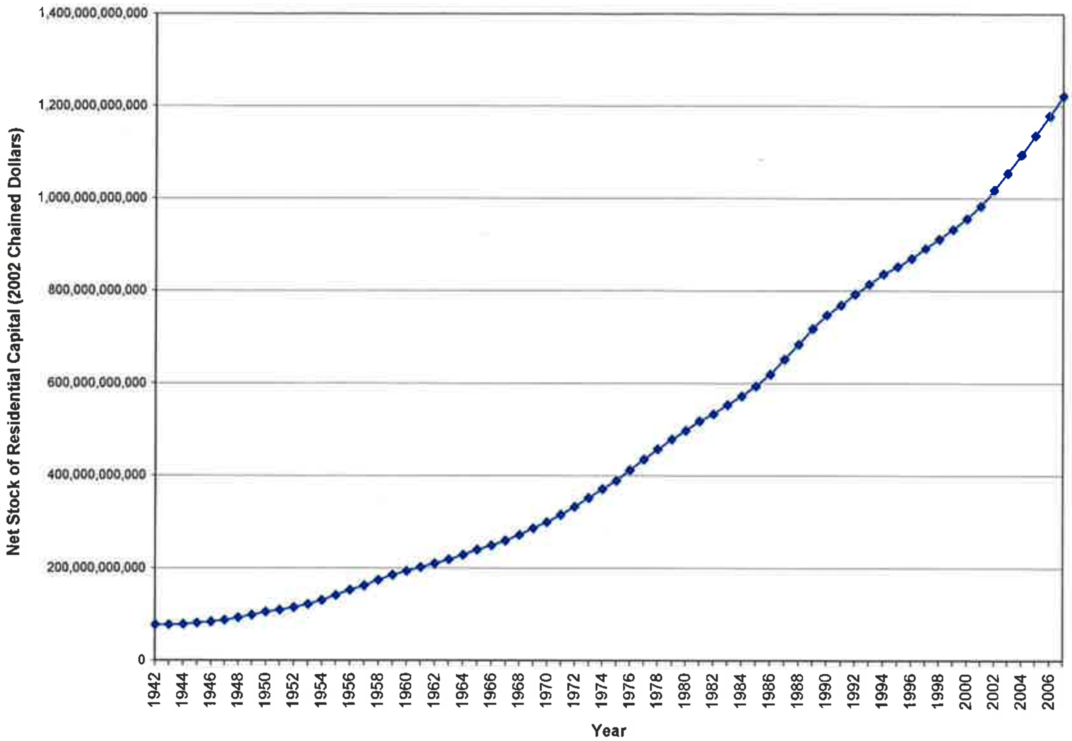

FIGURE 5: End of Year Per Capita Net Stock of Residential Capital in Canada
Single and Multiple Dwellings, 1942-2007

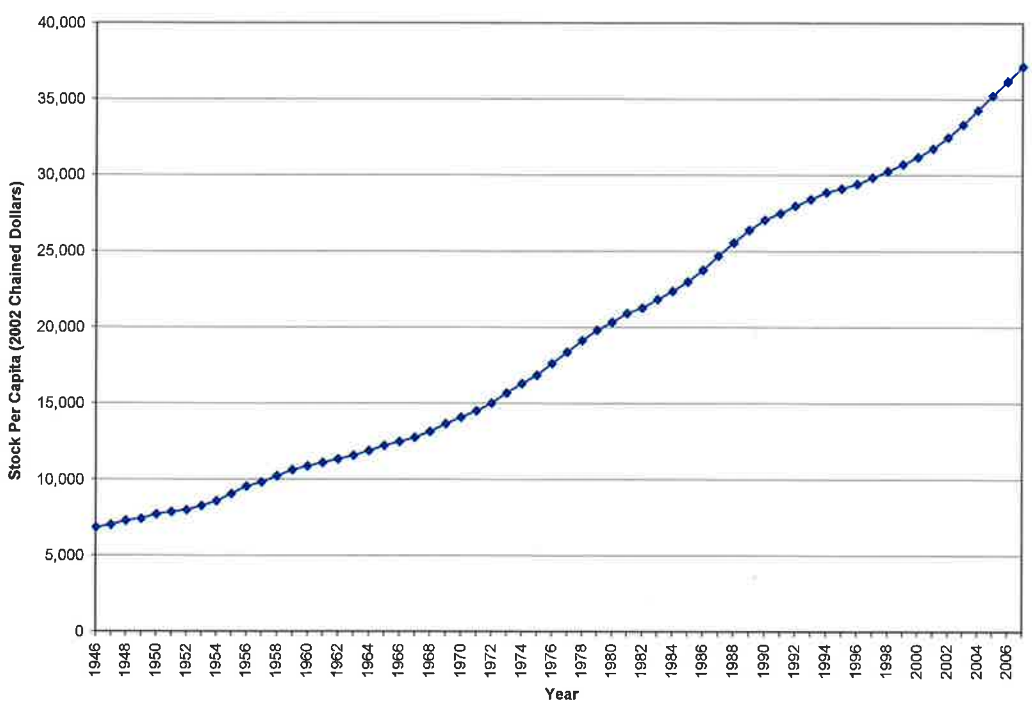

FIGURE 6: Growth in Total Residential Investment Relative to the Inflation in Canada, 1981-2008

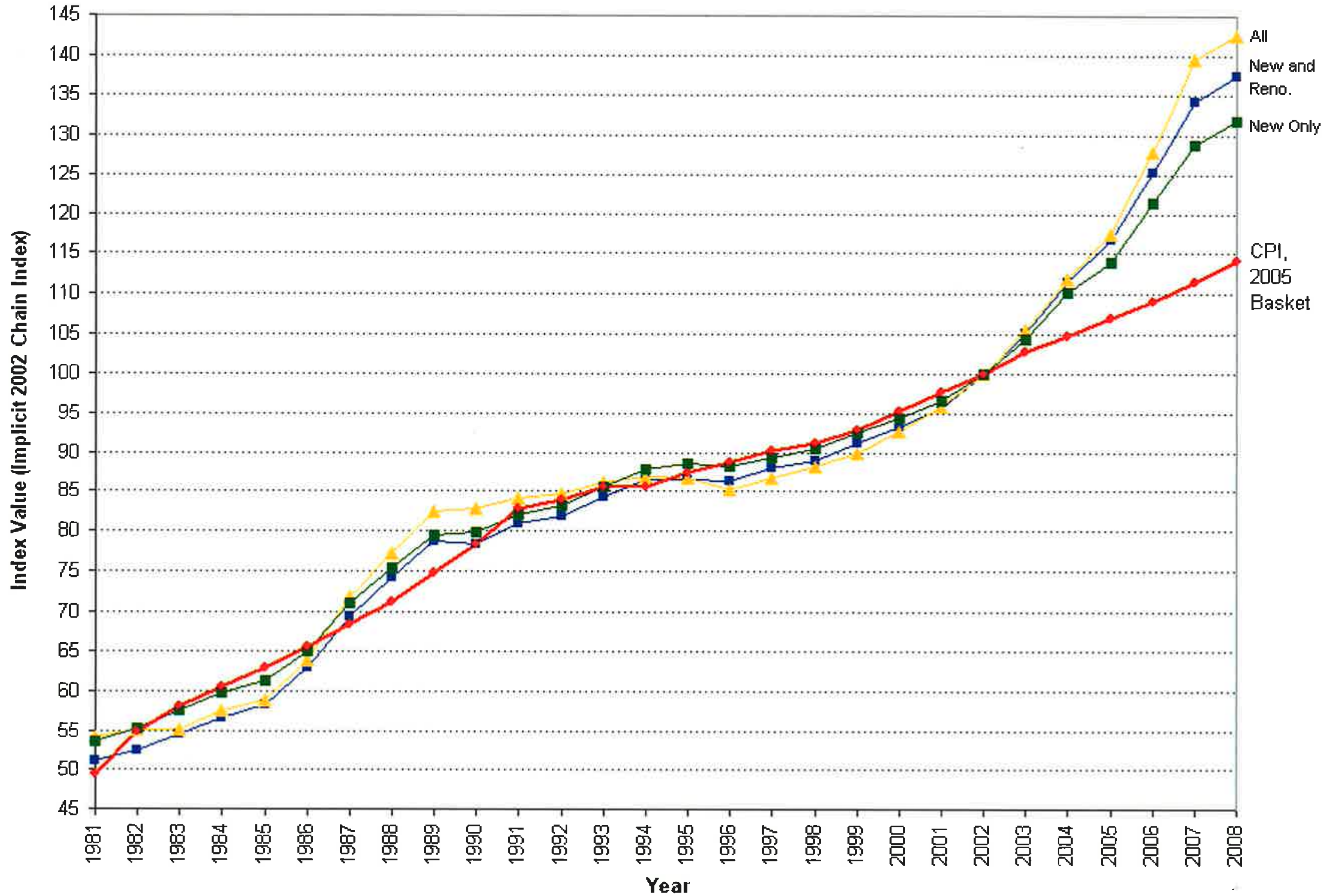

FIGURE 7: Measures of Per Capita Income in Canada
1981-2007

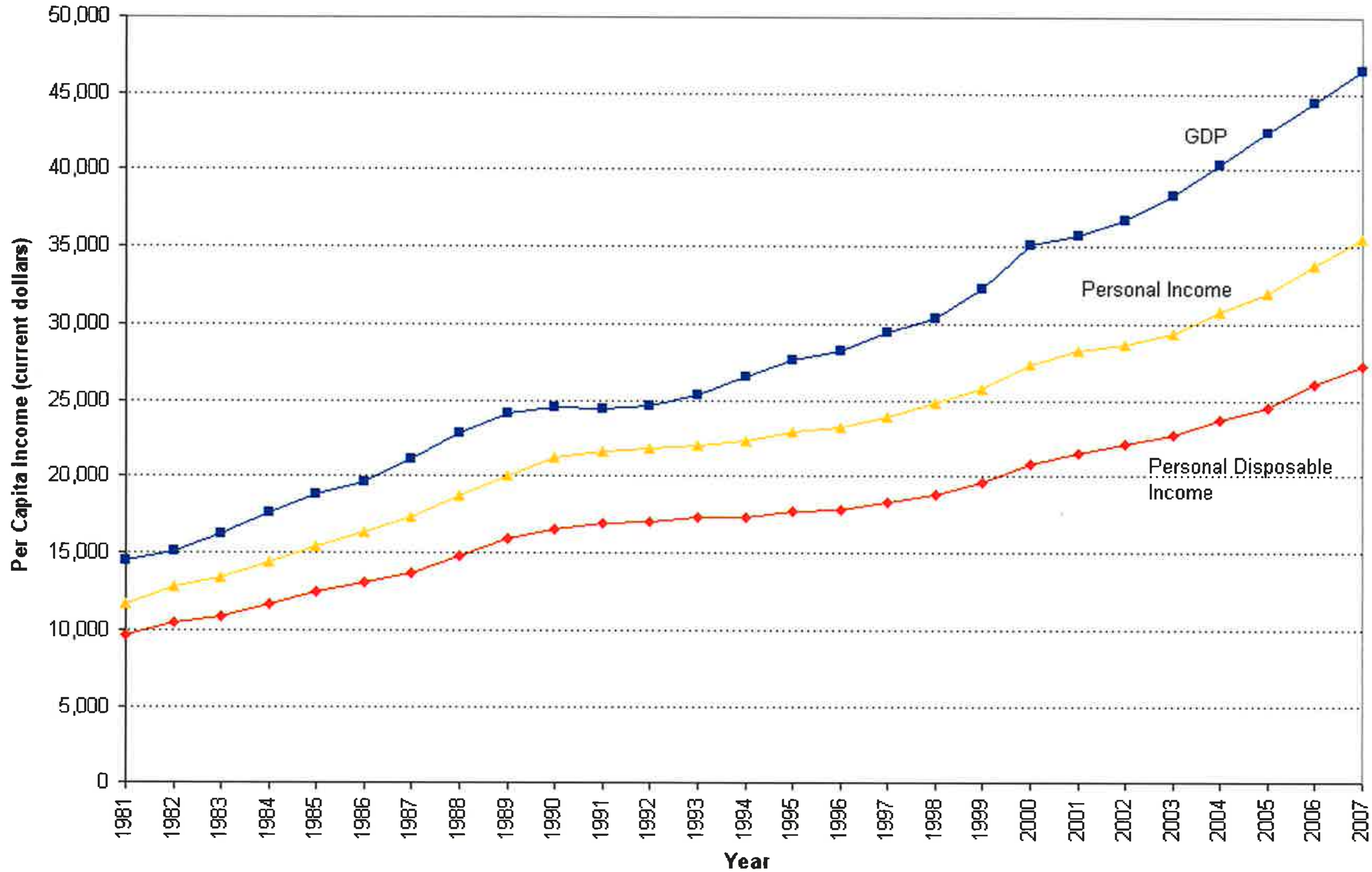

FIGURE 8: Percentage Change in Price Deflators: the Consumer Price Index and the Implicit GDP Deflator for Canada 1981-2008

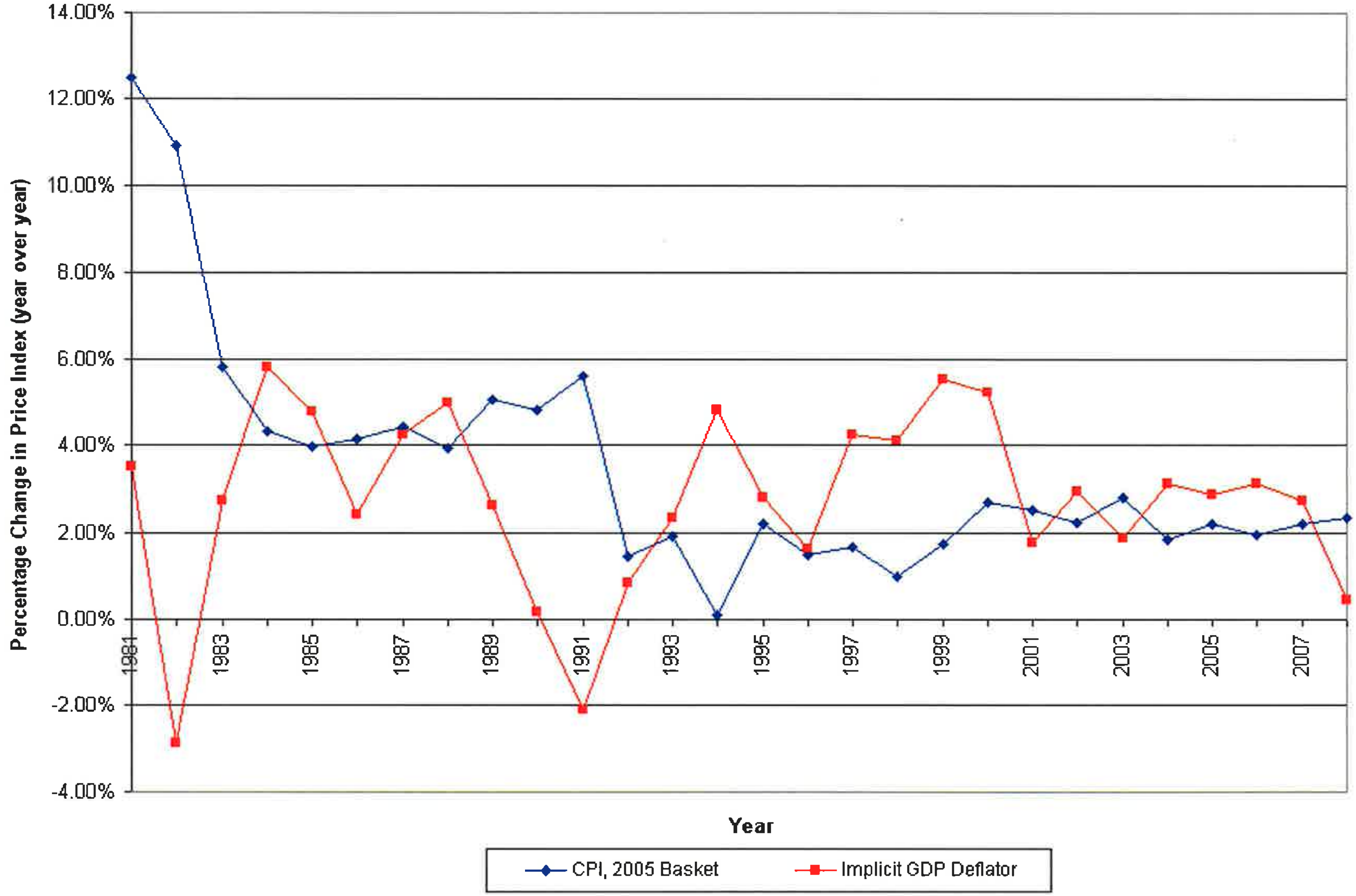

FIGURE 9: Price Deflators for the New Housing Price Index: the Consumer Price Index and the Implicit GDP Deflator for Canada, 1981-2008

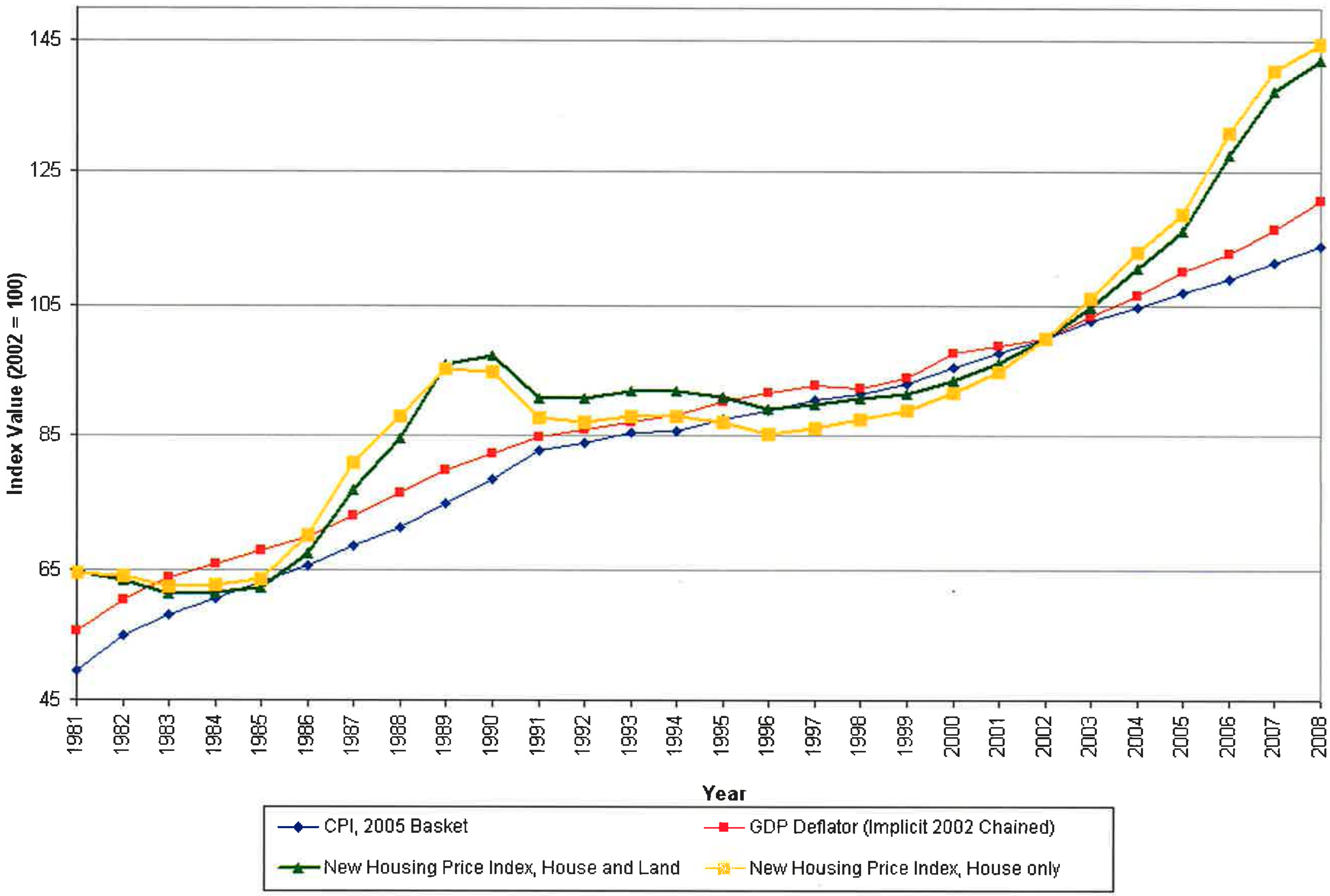

TABLE 1: Estimation of the Relative Price of New Housing for Model 1
Uncorrected Estimation

$$ln(\text{relativepriceofnewhousing}) = \lambda_0 + \lambda_1 ln(\text{GDPpercapita}) + \lambda_2 ln(\text{population})$$

Explanatory Variables	Dependent Variable: House Only (CPI)	House Only (GDP Deflator)	House and Land (CPI)	House and Land (GDP Deflator)
GDP Per Capita				
coef.	1.234266	0.9930999	0.6416331	0.4004651
se	0.4252168	0.3742696	0.4152563	0.3696242
prob > t	0.008	0.014	0.135	0.289
Population				
coef.	-2.08163	-1.452312	-1.124363	-0.4950427
se	0.6803859	0.5988657	0.6644482	0.5914327
prob > t	0.005	0.023	0.103	0.411
Constant				
coef.	27.65067	19.2963	17.35129	8.996875
se	7.562749	6.656621	7.385595	6.574
prob > t	0.001	0.008	0.027	0.183
No. of observations	28	28	28	28
Adjusted R^2	0.2145	0.1621	0.0337	-0.0116
F (2, 25) =	4.69	3.61	1.47	0.84
prob > F	0.0187	0.0419	0.2490	0.4415

The natural logarithm of all variables was used.

TABLE 2: Estimation of the Relative Price of New Housing for Model 1
Estimation with Corrections for Autocorrelated and Heteroskedastic Errors

$$ln(\text{relativepriceofnewhousing}) = \lambda_0 + \lambda_1 ln(\text{GDPpercapita}) + \lambda_2 ln(\text{population}) + \lambda_3\, ln(\text{relativepriceofnewhousing})_{-1}$$

Explanatory Variables	Dependent Variable			
	House Only (CPI)	House Only (GDP Deflator)	House and Land (CPI)	House and Land (GDP Deflator)
GDP Per Capita				
coef.	0.8019181	0.7235796	0.7035194	0.6321049
se	0.2139081	0.1893445	0.209171	0.1922913
prob > t	0.001	0.001	0.003	0.003
Population				
coef.	-1.057997	-0.9534603	-0.8993512	-0.8137404
se	0.3689875	0.3217201	0.3548429	0.3306268
prob > t	0.009	0.007	0.019	0.022
GDP Per Capita^{-1}				
coef.	0.8313569	0.8247928	0.8567522	0.8675007
se	0.0734592	0.0741491	0.0937606	0.0981963
prob > t	0.000	0.000	0.000	0.000
Constant				
coef.	10.65185	9.693447	8.827184	8.042993
se	4.395675	3.824466	4.063714	3.738316
prob > t	0.024	0.019	0.040	0.042
No. of observations	27	27	27	27
R^2	0.8722	0.8577	0.7995	0.7869
F (3, 23) =	94.05	88.88	40.09	39.06
prob > F	0.0000	0.0000	0.0000	0.0000
The natural logarithm of all variables was used.				

TABLE 3: Estimation of the Relative Price of New Housing for Model 1
Prais-Winsten Estimation with Corrections for Heteroskedastic Errors

$$ln(\text{relativepriceofnewhousing}) = \lambda_0 + \lambda_1 ln(\text{GDPpercapita}) + \lambda_2 ln(\text{population})$$

	Dependent Variable			
Explanatory Variables	**House Only (CPI)**	**House Only (GDP Deflator)**	**House and Land (CPI)**	**House and Land (GDP Deflator)**
GDP Per Capita				
coef.	1.138308	0.936035	0.9833136	0.7652311
se	0.453864	0.3741663	0.4871692	0.4119745
prob > t	0.019	0.019	0.054	0.075
Population				
coef.	-1.701908	-1.224798	-1.516165	-0.9932814
se	0.7612981	0.6156717	0.8309146	0.6802899
prob > t	0.035	0.058	0.080	0.157
Constant				
coef.	22.18238	16.01478	20.58657	13.8038
se	9.592783	7.691664	10.38163	8.342291
prob > t	0.029	0.048	0.058	0.110
No. of observations	28	28	28	28
Adjusted R^2	0.9786	0.9842	0.9809	0.9846
rho	0.9081126	0.8752818	0.8730814	0.8464931
D-W statistic (original)	0.279577	0.305983	0.326531	0.353276
D-W statistic (transformed)	0.777355	0.884761	0.79641	0.880858
The natural logarithm of all variables was used.				

TABLE 4: Estimation of the Relative Price of New Housing for Model 1
Estimation with Newey-West Standard Errors (Autoregressive Processes Up to the Fourth Order)

$$ln(\text{relativepriceofnewhousing}) = \lambda_0 + \lambda_1 ln(\text{GDPpercapita}) + \lambda_2 ln(\text{population})$$

Explanatory Variables	Dependent Variable			
	House Only (CPI)	House Only (GDP Deflator)	House and Land (CPI)	House and Land (GDP Deflator)
GDP Per Capita				
coef.	1.234266	0.9930999	0.6416331	0.4004651
se	0.3679461	0.3440375	0.3474642	0.3220303
prob > t	0.003	0.008	0.077	0.225
Population				
coef.	-2.08163	-1.452312	-1.124363	-0.4950427
se	0.534484	0.5248023	0.5696794	0.5457414
prob > t	0.001	0.010	0.060	0.373
Constant				
coef.	27.65067	19.2963	17.35129	8.996875
se	6.355886	6.124403	6.967214	6.579652
prob > t	0.000	0.004	0.020	0.184
No. of observations	28	28	28	28
F(2, 25) =	7.60	4.28	1.99	0.87
prob > F	0.0026	0.0252	0.1572	0.4298
The natural logarithm of all variables was used.				

TABLE 5: Estimates of the Price Elasticity of the New Housing Supply for Model 1 for Canada, 1981-2008
(Based on Coefficient Estimates from Table 3)

	Dependent Variable			
Estimates	**House Only (CPI)**	**House Only (GDP Deflator)**	**House and Land (CPI)**	**House and Land (GDP Deflator)**
Coefficient Estimate (α_1)	0.8019181	0.7235796	0.7035194	0.6321049
Parametric Assumptions				
$\delta_1 = -0.5$, $\delta_2 = 0.5$	0.123505069	0.191008978	0.210712455	0.291007948
$\delta_1 = -0.5$, $\delta_2 = 1.0$	0.747010137	0.882017956	0.92142491	1.082015896
$\delta_1 = -0.1$, $\delta_2 = 0.5$	0.523505069	0.591008978	0.610712455	0.691007948
$\delta_1 = -0.1$, $\delta_2 = 1.0$	1.147010137	1.282017956	1.32142491	1.482015896

TABLE 6: Estimation of the Relative Price of New Housing for Model 2
Uncorrected Estimation

$$ln(\text{relativepriceofnewhousing}) = \lambda_0 + \lambda_1 ln(\text{GDPpercapita}) + \lambda_2 ln(\text{population}) + \lambda_3 ln(\text{netstock})_{-1}$$

Explanatory Variables	Dependent Variable			
	House Only (CPI)	House Only (GDP Deflator)	House and Land (CPI)	House and Land (GDP Deflator)
GDP Per Capita				
coef.	1.350927	1.125187	0.7292081	0.5034658
se	0.3211811	0.2674457	0.2890768	0.2441827
prob > t	0.000	0.000	0.019	0.051
Population				
coef.	-13.05255	-11.9125	-12.06824	-10.9282
se	2.547649	2.121413	2.292994	1.936888
prob > t	0.000	0.000	0.000	0.000
Net Stock $^{-1}$				
coef.	3.753998	3.562004	3.768538	3.576549
se	0.8334858	0.694039	0.7501731	0.6336701
prob > t	0.000	0.000	0.000	0.000
Constant				
coef.	112.039	100.0131	101.1767	89.15084
se	20.33953	16.93661	18.30645	15.46343
prob > t	0.000	0.000	0.000	0.000
No. of observations	27	27	27	27
Adjusted R^2	0.5355	0.5875	0.4932	0.5676
$F(3, 23) =$	10.99	13.15	9.43	12.38
prob > F	0.0001	0.0000	0.0003	0.0001
The natural logarithm of all variables was used.				

TABLE 7: Estimation of the Relative Price of New Housing for Model 2
Estimation with Corrections for Autocorrelated and Heteroskedastic Errors

$$ln(\text{relativepriceofnewhousing}) = \lambda_0 + \lambda_1 ln(\text{GDPpercapita}) + \lambda_2 ln(\text{population}) + \lambda_3 ln(\text{netstock})_{-1} + \lambda_4 ln(\text{relativepriceofnewhousing})_{-1}$$

Explanatory Variables	Dependent Variable			
	House Only (CPI)	House Only (GDP Deflator)	House and Land (CPI)	House and Land (GDP Deflator)
GDP Per Capita				
coef.	0.9431412	0.8482505	0.777594	0.6573099
se	0.1779245	0.1611572	0.146007	0.1356921
prob > t	0.000	0.000	0.000	0.000
Population				
coef.	-5.607004	-5.359347	-6.623969	-6.216171
se	1.267155	1.256352	1.085848	1.05889
prob > t	0.000	0.000	0.000	0.000
Net Stock $^{-1}$				
coef.	1.479525	1.452626	1.92054	1.855075
se	0.4081134	0.3940695	0.3597759	0.3401069
prob > t	0.001	0.001	0.000	0.000
GDP Per Capita $^{-1}$				
coef.	0.6987407	0.6631423	0.6764114	0.6476975
se	0.0716718	0.0829137	0.0716697	0.084034
prob > t	0.000	0.000	0.000	0.000
Constant				
coef.	47.4141	45.03436	54.62027	50.77663
se	10.60932	10.55859	8.869385	8.751549
prob > t	0.000	0.000	0.000	0.000
No. of observations	27	27	27	27
R^2	0.912	0.9026	0.8945	0.8845
F(4, 22) =	131.06	113.92	61.17	50.45
prob > F	0.0000	0.0000	0.0000	0.0000
The natural logarithm of all variables was used.				

TABLE 8: Estimation of the Relative Price of New Housing for Model 2
Prais-Winsten Estimation with Corrections for Heteroskedastic Errors

$$ln(\text{relativepriceofnewhousing}) = \lambda_0 + \lambda_1 ln(\text{GDPpercapita}) + \lambda_2 ln(\text{population}) + \lambda_3 ln(\text{netstock})_{-1}$$

Explanatory Variables	Dependent Variable			
	House Only (CPI)	House Only (GDP Deflator)	House and Land (CPI)	House and Land (GDP Deflator)
GDP Per Capita				
coef.	0.8356188	0.7269475	0.5411711	0.3829119
se	0.6490425	0.4925865	0.5301304	0.3754463
prob > t	0.211	0.154	0.318	0.318
Population				
coef.	-7.320349	-7.34881	-8.213549	-8.192913
se	3.442233	3.064764	3.160519	2.784284
prob > t	0.044	0.025	0.016	0.007
Net Stock $^{-1}$				
coef.	2.064615	2.191922	2.531359	2.68183
se	1.220221	1.057688	1.152345	0.9646616
prob > t	0.104	0.050	0.038	0.011
Constant				
coef.	65.23358	63.30039	70.82302	67.93552
se	27.76602	24.45367	24.06657	21.44552
prob > t	0.028	0.016	0.007	0.004
No. of observations	27	27	27	27
Adjusted R^2	0.9856	0.9888	0.9870	0.9877
rho	0.8301809	0.737035	0.6821404	0.5788817
D-W statistic (original)	0.574637	0.71242	0.700778	0.844154
D-W statistic (transformed)	1.213757	1.315151	1.274455	1.365024

The natural logarithm of all variables was used.

TABLE 9: Estimation of the Relative Price of New Housing for Model 2
Estimation with Newey-West Standard Errors (Autoregressive Processes Up to the Fourth Order)

$$ln(\text{relativepriceofnewhousing}) = \lambda_0 + \lambda_1 ln(\text{GDPpercapita}) + \lambda_2 ln(\text{population}) + \lambda_3 ln(\text{netstock})_{-1}$$

Explanatory Variables	Dependent Variable			
	House Only (CPI)	House Only (GDP Deflator)	House and Land (CPI)	House and Land (GDP Deflator)
GDP Per Capita				
coef.	1.350927	1.125187	0.7292081	0.5034658
se	0.3613558	0.3009532	0.3508172	0.2922669
prob > t	0.001	0.001	0.049	0.098
Population				
coef.	-13.05255	-11.9125	-12.06824	-10.9282
se	3.854836	2.910962	3.245547	2.492046
prob > t	0.003	0.000	0.001	0.000
Net Stock $^{-1}$				
coef.	3.753998	3.562004	3.768538	3.576549
se	1.255991	0.9280139	1.034705	0.768126
prob > t	0.007	0.001	0.001	0.000
Constant				
coef.	112.039	100.0131	101.1767	89.15084
se	29.50329	22.60939	25.19574	19.85215
prob > t	0.001	0.000	0.001	0.000
No. of observations	27	27	27	27
F(3, 23) =	8.48	6.59	8.31	9.58
prob > F	0.0006	0.0022	0.0006	0.0003
The natural logarithm of all variables was used.				

TABLE 10: Estimates of the Price Elasticity of the New Housing Supply for Model 2 for Canada, 1981-2007
(Based on Coefficient Estimates from Table 8)

	Dependent Variable			
Estimates	**House Only (CPI)**	**House Only (GDP Deflator)**	**House and Land (CPI)**	**House and Land (GDP Deflator)**
Coefficient Estimate (α_1)	0.9431412	0.8482505	0.777594	0.6573099
Parametric Assumptions				
$\delta_1 = -0.5, \delta_2 = 0.5, \gamma = 0.3$	0.009042994	0.026834555	0.042902723	0.078202861
$\delta_1 = -0.5, \delta_2 = 1.0, \gamma = 0.3$	0.168085988	0.203669111	0.235805446	0.306405723
$\delta_1 = -0.1, \delta_2 = 0.5, \gamma = 0.3$	0.129042994	0.146834555	0.162902723	0.198202861
$\delta_1 = -0.1, \delta_2 = 1.0, \gamma = 0.3$	0.288085988	0.323669111	0.355805446	0.426405723
$\delta_1 = -0.5, \delta_2 = 0.5, \gamma = 0.6$	0.018085988	0.053669111	0.085805446	0.156405723
$\delta_1 = -0.5, \delta_2 = 1.0, \gamma = 0.6$	0.336171975	0.407338221	0.471610892	0.612811446
$\delta_1 = -0.1, \delta_2 = 0.5, \gamma = 0.6$	0.258085988	0.293669111	0.325805446	0.396405723
$\delta_1 = -0.1, \delta_2 = 1.0, \gamma = 0.6$	0.576171975	0.647338221	0.711610892	0.852811446