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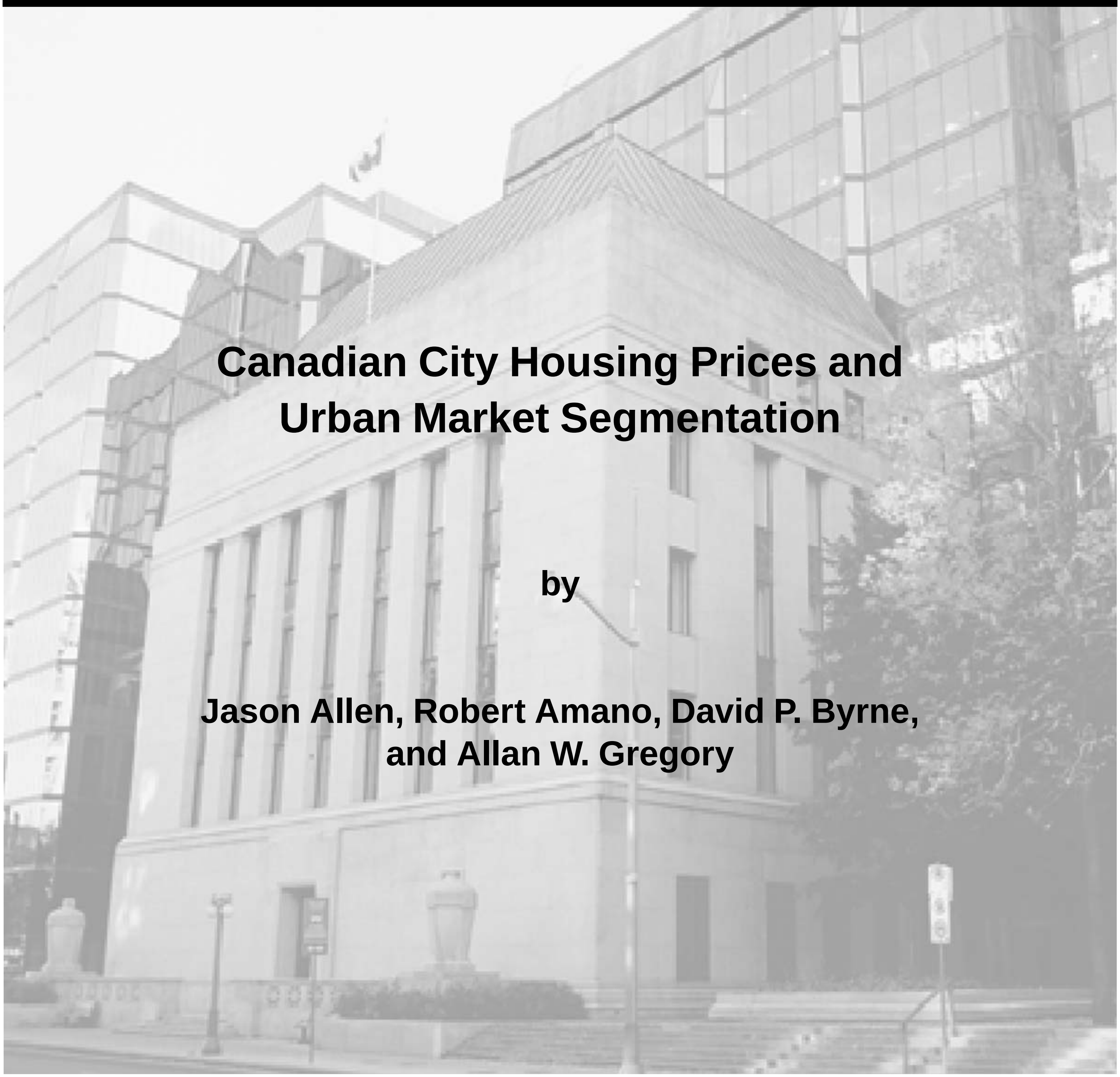

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Abstract

The authors provide a detailed empirical analysis of Canadian city housing prices. They examine the long-run relationship between city house prices in Canada from 1981 to 2005 as well as idiosyncratic relations between city prices and city-specific variables. The results suggest that city house prices are only weakly correlated in the long run, and that there is a disconnect between house prices and interest rates. City-specific variables such as union wage levels, new-housing prices, and the issuance of building permits tend to be positively related to city existing-house prices. Surprisingly, there is mixed evidence with respect to standard measures of economic activity, such as labour force and per capita GDP.

JEL classification: C22, C32, R2
Bank classification: Regional economic developments

Résumé

Les auteurs présentent une analyse empirique détaillée de l’évolution des prix des maisons en milieu urbain au Canada. Ils examinent la relation à long terme entre ces prix pour la période de 1981 à 2005 ainsi que les relations idiosyncrasiques entre ces mêmes prix et les variables propres à chaque ville. Leurs résultats donnent à penser que la corrélation entre les prix des maisons en milieu urbain est faible en longue période et que ceux-ci sont parfois déconnectés des taux d’intérêt. Les variables propres aux villes, dont le niveau de salaire des travailleurs syndiqués, les prix des maisons neuves et le nombre de permis de construire émis, sont liées positivement aux prix de revente des maisons. Fait étonnant, les résultats ne sont pas concluants en ce qui concerne les mesures courantes de l’activité économique telles que la population active et le produit intérieur brut par habitant.

Classification JEL : C22, C32, R2
Classification de la Banque : Évolution économique régionale

1 Introduction

Canadian house prices have increased at rapid and sustained rates throughout the past two decades. In this time there has been an increase in home-ownership rates, a larger fraction of household wealth held in the home, and an increase in household debt. Although the rise in Canadian house prices has been modest by international standards, economists have, nonetheless, discussed the possibility of a house-price bubble in the Canadian real estate market, and the possible effects of rising mortgage rates and potential house-price collapse. Since many more Canadians participate in the housing market than the stock market, the notion of a house-price collapse understandably raises concern about its impact on the macroeconomy. Tkacz and Wilkins (2006), for example, find a link between house-price movements and output growth in Canada. Selody and Wilkins (2004) suggest that a central bank may occasionally want to lean against large changes in house prices. Moreover, these concerns are shared by many other developed countries. Nickell (2002), for instance, states that a key monetary policy concern in the United Kingdom is the increase in house prices and the buildup of household debt. The OECD, acknowledging the important role of housing wealth, has also recently studied the role of fundamentals in determining house-price movements in its member countries (OECD (2005)). Ahearne et al. (2005), citing recent debates in industrialized countries on how central banks should react to house prices, conduct a cross-country comparison and draw lessons for monetary policy.

Notwithstanding the attention to housing paid by economists, there has been surprisingly little recent work on Canadian house prices using modern time-series methods. The exceptions are Maclean (1994), who examines movements in new house prices using an error-correction model, and Sutton (2002), who examines changes in Canadian house prices using a vector-autoregression (VAR) approach. Lampert and Pomeroy (1998) present an overview of Canada's housing system and its economic components, and provide an excellent reference for Canadian real-estate-related data sources. The principal regressand for these studies and many other studies has been the aggregate price for existing houses. In addition to the authors mentioned above, England and Ioannides (1997) study aggregate house-price movements in OECD countries and conclude that lagged prices and GDP growth are important explanatory variables. Tsatsaronis and Zhu (2002) examine potential long- and short-term determinants of house prices in developed countries, including Canada, and conclude that inflation and interest rates are key determinants in explaining changes in aggregate house prices, although there are some differences across countries. Furthermore, the aggregate house-price index is often used by monetary authorities as well as government agencies (for example, the Canadian Mortgage and Housing Corporation) to measure the effect of interest rate changes on consumers' portfolio decisions.

In our view, the usefulness of the aggregate housing-price index for understanding house-price fluctuations is not straightforward. To state the obvious, house prices are unlikely to experience the arbitrage of tradable divisible commodities, and so it is unlikely that the law of one price holds. Even casual inspection of various municipal markets suggests that factors operating on a municipal level are perhaps more relevant to understanding house-price movements. Abraham and Hendershott (1994), using U.S. data, find that local variables such as construction costs, employment growth, and income growth are significant in predicting house prices across metropolitan housing markets. Consideration of local market segmentation can also improve our understanding of the transmission of aggregate shocks, such as an unanticipated change in the interest rate. Fratantoni and Schuh (2003), for instance, construct a VAR model that takes into account regional differences in housing markets, and they find that regional heterogeneity is important when tracing out the effects of a monetary policy shock.

Another potential concern in aggregating to a single index is that important individual city components may be lost or hopelessly confounded. Using a VAR approach, Sutton (2002) predicts that aggregate house prices in Canada should have increased substantially over the period 1995 to 2002 owing principally to strong growth and relatively low mortgage rates. This was not the case and thus this is a puzzle. The rather flat aggregate Canadian house-price profile masks substantial variation at the provincial and municipal levels. Although households across the country might face the same borrowing costs through common mortgage rates, and are linked somewhat by a common level of economic activity, there seem to be enough idiosyncratic conditions operating to suggest that movements in housing prices may be largely determined locally within a municipal environment.

In this paper, we examine city housing prices following what are now standard methods for handling non-stationary time-series data. The aim of this paper is to use these methods to examine relationships in housing prices. The analysis is empirical, with no specific theoretical model of housing prices advanced. At this stage, we believe it is of sufficient importance to provide a factual background from which theoretical models can be developed and tested. As such, we document results for a variety of empirical models, interacting house prices with mortgage rates, macroeconomic variables, and municipal variables.[1]

The paper is organized as follows. In sections 2 we present a systems approach to cointegration following the methodology of Johansen (1988). This leads to a detailed examination of the individual municipalities in section 3. In section 4 we offer some concluding remarks and discuss extensions. Data descriptions are provided in the appendix.

2 A Single Canadian Housing Market?

In this section, we use quarterly house-price data provided by the Multiple Listing Service (MLS) over the 1981Q1 to 2005Q1 sample period to examine whether city house prices are linked in the long run. MLS collects data related to the average price of existing houses sold in major municipalities in Canada.[2] The MLS aggregate price index is defined as the average price of existing houses sold in the 25 largest municipalities. We use the existing-house price instead of the new-house price, since the former represents a larger proportion of the housing market in Canada. In Figures 1 and 2 (see the appendix for data sources) we graph house prices for eight Canadian cities: St. John's, Halifax, Montréal, Ottawa, Toronto, Calgary, Edmonton, and Vancouver. These include the largest urban centers in Canada while geographically spanning the whole of the country. Table 1 presents nominal house prices for these eight cities. From these preliminary statistics, it is apparent that house prices in major Canadian cities have increased substantially over the past twenty years, with some very large increases in Toronto and Vancouver over the past decade, and that there is a great deal of intercity variability in house prices.

We test for time-series properties of each series by conducting augmented Dickey and Fuller (1979) (hereafter, ADF) and Phillips and Perron (1988) (hereafter, PP) tests. In all instances, we cannot reject the null hypothesis of a unit root. This result motivates the use of cointegration methods for our analysis.[3] More specifically, we apply the system cointegration approach developed in Johansen (1988), and refined in Johansen and Juselius (1990) and

[1]Indeed, we conduct extensive testing of our models. For the sake of brevity, we do not report these results in the paper; instead, they are available at Allan Gregory's website (www.econ.queensu.ca/pub/faculty/gregory).

[2]An alternative housing price measure is the Royal LePage series. We use MLS data because of its public availability over a substantially longer time period, and it is highly correlated with the Royal LePage series.

[3]The results are available on the paper's website at www.econ.queensu.ca/pub/faculty/gregory.

Table 1
MLS Existing-Housing Prices (Nominal Can$): 1984-2004

	STJ		HAL		MON		OTT	
Year	Price	% Δ	Price	% Δ	Price	% Δ	Price	% Δ
1984	61,366	-	77,589	-	64,549	-	102,052	-
1994	91,981	49.89%	103,450	33.33%	110,410	71.05%	146,663	43.71%
2004	131,378	42.83%	173,545	67.76%	185,127	67.67%	237,380	61.85%
	TOR		**CAL**		**EDM**		**VAN**	
Year	Price	% Δ	Price	% Δ	Price	% Δ	Price	% Δ
1984	95,276	-	86,520	-	79,294	-	113,565	-
1994	199,214	109.09%	133,079%	53.81%	113,186	42.74%	305,519	169.03%
2004	312,743	56.99%	221,158%	66.19%	177,843	57.12%	365,111	19.51%

Note: STJ, HAL, MON, OTT, TOR, CGY, EDM, and VAN represent, respectively, St. John's, Halifax, Montréal, Ottawa, Toronto, Calgary, Edmonton, and Vancouver.

Johansen and Juselius (1992), to determine whether there is any evidence of a long-run relationship between the eight city house prices and the Canadian aggregate price index (CAN) for existing homes from MLS.[4] If city house prices are linked at low frequencies, one would expect to find evidence consistent with eight cointegrating vectors, with a single I(1) variable driving the prices for the country. In the absence of such municipal price cohesion, we might need to study individual house markets, or at least a subset of the cities, to better understand their underlying dynamics. The results, reported in Table 2, are the opposite of a highly integrated market with the presence of only one cointegrating vector.[5] In particular, the trace statistic indicates the presence of cointegration at the 1 per cent level and the $\lambda-$max statistic

[4] In the accompanying statistical appendix, linked from the paper's website, we perform various systems tests for cointegration with the cities used in this paper and with additional cities: Hamilton, London, Winnipeg, and Regina. Further, we employ the Johansen approach under various specifications for the deterministic terms of the model as a robustness check. We find similar results to those reported here for various combinations of cities under the different specifications. For brevity, they are not reported here, but are completely documented in the statistical appendix.

[5] A constant and trend are included in the empirical model. A lag length of four is selected for the vector-error correction model (VECM), since this selection minimizes the Bayesian Information Criterion (BIC) statistics and admits well-behaved residuals. These results may be found at the paper's website. Gregory (1994) finds that the Johansen approach to testing for cointegration has a tendency to overreject in finite samples, especially in cases when the number of variables in the system is relatively large. To help control for this problem, we use the small-sample correction for the trace statistic developed in Cheung and Lai (1993). We also simulate via Monte Carlo critical values for our data-generating process (DGP), since we have a large number of variables.

at the 5 per cent level. The presence of only one significant cointegrating vector suggests that the cities' average housing prices are not determined by some underlying national pricing model linking the cities into a single unique market. This lack of cointegration casts some doubt on exactly what the Canadian aggregate housing index is capturing. Studying aggregate price movements, for example, would not be a shortcut for understanding housing markets for Canada's large urban centres. Thus, the lack of long-run relationships among the city house prices presents a challenge in terms of understanding the Canadian house-price market. In contrast, the strong evidence of long-run relationships between house prices across Australian cities allows Abelson and Joyeux (2004) to use the average Australian house price in their study of the Australian housing market.

Further evidence of this apparent urban market segmentation is presented in Tables 3 and 4. The tables present all pairwise cointegration tests between the eight Canadian city house prices and the Canadian aggregate index. ADF test statistics are presented for the case of a constant only, and a constant with a time trend, for the residuals from the pairwise regressions of MLS pricing data.[6] While there are occasions of statistical significance, and hence a rejection of the no cointegration null hypothesis, the rejections show no meaningful economic or geographic pattern. Most of the rejections occur with Edmonton, which is borderline stationary. Also, given that we are doing 36 interdependent residual tests that we are interpreting jointly, the actual level of the type I error is not at all clear. These results suggest, at best, an extremely weak link among a subset of Canadian city house prices. This finding is not that surprising, given that house-price movements can mainly reflect a diversified economy where regional growth is due to different sectors and cycles. In this respect, our evidence on city-level house-price movements is similar to the evidence on regional GDP movements documented in Wakerly et al. (2006).

In light of the empirical results, a natural question that arises is the relevance of an aggregate price index for the understanding of Canadian house-price movements. Canada is a relatively large country with heterogeneous economic, provincial, municipal, and demographic regions. Houses are not mobile commodities, and so the law of one price need not hold. These factors, in addition to our empirical evidence, suggest that an aggregate index may not be representative of any particular housing location. In smaller countries, where housing options exist across state/provincial boundaries, one might expect the aggregate index to be a

[6]These results are indeed robust to the method used. We report additional pairwise findings in the statistical appendix for the ADF and PP tests with and without trend. As well, pairwise findings based on the trace and λ-max tests also point to a lack of cointegration. Please see the paper's website for details.

more meaningful indicator of pricing activity for the country. Certainly, the aggregate house-price index would be a poor measure for cost-of-living allowances, since it would not reflect relevant local cost conditions.

Table 2
Cointegrating Rank Determination for MLS Existing-House Prices

H_0	H_1	Trace	Critical value	λ_{max}	Critical value	λ
$r = 0$	$r \geq 1$	224.25†	204.95	60.76	62.8	-
$r \leq 1$	$r \geq 2$	163.49	168.36	48.27	57.69	0.672
$r \leq 2$	$r \geq 3$	115.21	133.57	37.28	51.57	0.587
$r \leq 3$	$r \geq 4$	77.94	103.18	27.03	45.1	0.495
$r \leq 4$	$r \geq 5$	50.91	76.07	21.14	38.77	0.391
$r \leq 5$	$r \geq 6$	29.77	54.46	12.70	32.24	0.321
$r \leq 6$	$r \geq 7$	17.07	35.65	8.78	25.52	0.208
$r \leq 7$	$r \geq 8$	8.29	20.04	7.75	18.53	0.149
$r \leq 8$	$r \geq 9$	0.543	6.65	0.543	6.65	0.132
$r \leq 9$	$r \geq 10$	-	-	-	-	0.010

† Significant at the 1 per cent level.

Table 3
Pairwise Cointegration Tests for MLS Existing-House Prices (Constant)

	STJ	HAL	MON	OTT	TOR	CAL	EDM	VAN	CAN
STJ	-	-1.941	-3.045	-3.707†	-2.535	-2.937	-4.295†	-1.996	-1.456
HAL	-	-	-1.688	-1.881	-0.706	-3.165	-5.327†	-2.530	-1.037
MON	-	-	-	-3.416	-2.037	-3.268	-3.317	-1.664	-1.773
OTT	-	-	-	-	-1.158	-3.508	-3.781†	-3.529†	-3.261
TOR	-	-	-	-	-	-2.664	-2.752	-2.012	-1.835
CAL	-	-	-	-	-	-	-1.646	-0.756	-1.163
EDM	-	-	-	-	-	-	-	-0.329	-1.863
VAN	-	-	-	-	-	-	-	-	-2.876

Notes: STJ, HAL, MON, OTT, TOR, CGY, EDM, and VAN represent, respectively, St. John's, Halifax, Montréal, Ottawa, Toronto, Calgary, Edmonton, and Vancouver. † Significant at the 1 per cent level.

Table 4
Pairwise Cointegration Tests for MLS Existing-House Prices (Trend and Constant)

	STJ	HAL	MON	OTT	TOR	CAL	EDM	VAN	CAN
STJ	-	-1.960	-3.355	-4.335†	-2.855	-2.802	-4.115†	-1.962	-1.573
HAL	-	-	-1.703	-2.556	-0.968	-3.179	-5.420†	-2.406	-1.165
MON	-	-	-	-3.648	-2.100	-3.368	-3.231	-1.617	-1.745
OTT	-	-	-	-	-1.214	-3.195	-3.146	-3.358	-3.252
TOR	-	-	-	-	-	-2.276	-2.528	-1.989	-2.071
CAL	-	-	-	-	-	-	-0.438	-3.202	-2.292
EDM	-	-	-	-	-	-	-	-0.558	-2.623
VAN	-	-	-	-	-	-	-	-	-3.150

Notes: STJ, HAL, MON, OTT, TOR, CGY, EDM, and VAN represent, respectively, St. John's, Halifax, Montréal, Ottawa, Toronto, Calgary, Edmonton, and Vancouver. † Significant at the 1 per cent level.

3 City-Level Housing-Price Determinants

The lack of long-run relationships for the cross-city house prices prompts us to seek city-specific house-price determinants using single-equation methods in an effort to better understand Canadian house-price fluctuations.[7] Specifically, we first use the Engle and Granger framework to test for the presence of cointegration between city house prices and a vector of other potentially relevant variables. Once we find evidence consistent with cointegration, we estimate elasticities via Phillips and Hansen's (1990) fully modified ordinary least squares (FM-OLS) for valid inference.

Like many other areas in economics, the literature on housing prices has yet to find a dominant empirical model. A variety of models have been proposed, each based on variables which the authors view as important in the market (Smith (1988)). Finding high-quality, comparable Canadian data at the municipal level is problematic. Bearing this limitation in mind, we opt to use a city-specific new-housing price index (NPI), union-wage index (UWI), the value of building permits (BP), and the municipal labour force (LF) as possible explanatory variables. These variables are readily available and consistently defined across the eight Canadian cities. Also included are the cost of financing, proxied by the five-year mortgage rate (R_t), and a measure of economic activity, per capita provincial gross domestic product, which we denote

[7]Since there is a natural normalization for the dependent variable (city housing prices), we use a single-equation approach for this part of our study.

GDP.[8] The NPI is collected by Statistics Canada on a monthly basis and is an index of new-house prices based on a survey of builders. The UWI is an index of wages set in 16 trades engaged in construction in 20 metropolitan areas. The value of building permits issued, BP, is collected monthly by Statistics Canada and is used as a leading indicator of building activity. The building permit measure is the only one that displays strong seasonality, and thus we seasonally adjust it using dummy variables in a simple application of the Frisch-Waugh-Lovell theorem (Lovell (1963)). The idea of this set-up is to find out whether there is any role played by the common mortgage rate, once we control for local conditions through these city-specific variables.

We use the five-year mortgage rate as our proxy for the cost of home financing, since it is highly correlated with other maturities and over 50 per cent of Canadian households use this term. The one-, three-, and five-year interest rates are plotted in Figure 3. All three follow the same downward path throughout the sample. All data, except the interest rate, are in log-form, so that the estimates on each of the independent variables can be interpreted as elasticities. As in section 2, we test the time-series properties of the data using the ADF and PP tests. We find that each series may be described as non-stationary, except building permits in St. John's and Halifax, and the union wage in Halifax.[9]

Each of the variables in the regression analysis seems economically reasonable for explaining existing-house price movements in the eight Canadian cities we examine. City-specific new-house prices are included to determine the extent to which new and existing houses are substitutes in the long run. We include the UWI to capture the labour costs of building a new house or improving an existing one. An increase in union wages, which includes wages to construction workers, should lead to a rise in the price of existing homes through either an increase in the price of new houses built (via a substitution effect) or, more directly, via the cost of home improvements of existing houses or both. We include building permits to capture costs associated with construction. Poterba and Engelhardt (1991) also consider construction costs when examining the determination of house prices in an efficient asset market. Arguments in the popular press have at least informally suggested that labour entry/exit has an impact on house prices. An increase in a city's labour force puts added pressure on demand for housing and therefore leads to house-price increases. The price increase may be somewhat mitigated by the fact that an increased labour force tends to bid down wages and thereby

[8] In preliminary work, we also considered ownership accommodation cost and rental accommodation cost in our regressions, but they did not improve our understanding of city-specific house-price fluctuations.

[9] The results are available on the paper's website.

puts downward pressure on house prices. However, to the extent that the union wages are sticky downward, this offsetting effect should be small. Case and Shiller (1989) and Case and Shiller (1990) find that changes in local demographics can significantly explain house prices. As mentioned, we include the five-year mortgage rate to capture the interest cost of owning a home with a mortgage, and a per capita provincial GDP measure to proxy economic activity. We would prefer a measure of per capita municipal GDP, but such a variable does not exist for the span of data in this paper.

To determine whether the variables under consideration are cointegrated, we obtain the residuals from the following linear regression (for each city i):

$$MLS_t^i = \beta_0^i + +\beta_1^i NPI_t^i + \beta_2^i UWI_t^i + \beta_3^i BP_t^i + \beta_4^i LF_t^i + \beta_5^i R_t + \beta_6^i GDP_t^i + u_t^i, \tag{1}$$

and test whether the estimated residuals, $\hat{u}_i$, are I(1) or, in other words, whether there is cointegration between the variables in equation (1). The cointegration test results are presented in Table 5 and indicate the presence of cointegration for all individual city house prices. This allows us to use the FM-OLS estimator to estimate the long-run correlation of each regressor with each city house price.[10] FM-OLS also permits us to conduct valid inference within a cointegrating framework, even in the presence of endogeneity and non-spherical residuals.

The estimation results are presented in Table 6. The results are somewhat mixed, but there are consistent correlations across the cities. There is a statistically significant positive relationship between the average price of existing homes and new-housing prices in Canada. Interestingly, in most cities the estimated coefficient on new-house prices is not significantly different from one suggesting that new and old houses are perfect substitutes. However, for Montréal and Vancouver, existing houses are valued approximately 25 per cent higher than new houses, whereas in Edmonton existing houses trade at a 40 per cent discount. Of course, there is no control for the quality of the houses. The UWI also has a statistically significant positive effect on housing prices, with an elasticity ranging from 0.2 in Toronto to 1.01 in Edmonton. The exceptions are Halifax, Montréal, and Ottawa, where the estimate parameters are not statistically different from zero. With the exception of Vancouver, building permits appear to be positively related to house prices. The parameter estimates range over a tight interval of 0.03 to 0.09, suggesting, relative to NPI and UWI, only a small economic effect. In

[10] The Saikkonen (1991) and Stock and Watson (1993) dynamic OLS estimator gives similar qualitative results. These estimates can be obtained from the paper's webpage.

Table 5
MLS Model: Residual Stationarity Tests

	Test with constant		Test with constant and trend		Test with constant		Test with constant and trend	
Variable	ADF	*p*-value	ADF	*p*-value	PP	*p*-value	PP	*p*-value
STJ	-6.392†	0.000	-6.369†	0.000	-9.817†	0.000	-9.764†	0.000
HAL	-8.026†	0.000	-7.975†	0.000	-8.026†	0.000	-7.975†	0.000
MON	-8.545†	0.000	-8.495†	0.000	-8.545†	0.000	-8.495†	0.000
OTT	-4.462†	0.002	-4.437†	0.002	-5.086†	0.000	-5.056†	0.000
TOR	-5.411†	0.000	-5.387†	0.000	-6.743†	0.000	-6.704†	0.000
CAL	-5.598†	0.000	-5.584†	0.000	-5.814†	0.000	-5.787†	0.000
EDM	-2.302	0.170	-2.214	0.482	-5.020	0.000	-4.950†	0.003
VAN	-5.060†	0.000	-5.035†	0.000	-5.464†	0.000	-5.433†	0.000

Notes: STJ, HAL, MON, OTT, TOR, CGY, EDM, and VAN represent, respectively, St. John's, Halifax, Montréal, Ottawa, Toronto, Calgary, Edmonton, and Vancouver. ADF and PP test statistics and the *p*-values are provided. † is significant at the 1 per cent level.

Toronto, for instance, a 1 per cent increase in the value of home-building permits is estimated to increase existing house prices by only 0.056 per cent, whereas a 1 per cent increase in new-house prices and union wages is associated with a rise in existing-house prices of 1.2 and 0.2 per cent, respectively.

The remaining candidate variables offer much less consistency across the cities. Coefficients on the labour force variables are statistically significant in only three cities: Montréal, Vancouver, and Toronto. The effect is quite large for Montréal and Vancouver, with parameter estimates of 2.3. The effect of per capita GDP is similarly inconsistent. Only St. John's, Halifax, and Vancouver admit statistically significant results, with the effect of economic activity measured being greater than 2 for Halifax and Vancouver, and a much more modest 0.55 for St. John's. Finally, the five-year interest rate is largely statistically insignificant, and in the three cities where it is significant it is positive (Calgary, Edmonton, and Vancouver). The coefficient on the interest rate is negative and significant only in Ottawa and Toronto. The results associated with the interest rate are not surprising, since other researchers find it difficult to link mortgage interest rates to the housing market in linear models (Muelbauer and Murphy (1997)). At this stage, the question remains as to how mortgage rates and housing prices are related in Canada. One possibility for future research is to examine non-linear relationships between housing prices and interest rates.

Table 6
City-Specific Estimates via FM-OLS

City	Regressors						Test statistics		
	NPI	UWI	BP	LF	GDP	R	L_c	*SupF*	*MeanF*
STJ	0.9661*	0.3227*	0.0408*	0.1622	0.5490*	-0.0042	1.757	43.04	18.74
	(0.092)	(0.111)	(0.007)	(0.267)	(0.066)	(0.0023)			
HAL	0.7914*	0.1477	0.0526*	0.4311	2.0491*	-0.0073	3.297	84.79	32.56
	(0.255)	(0.213)	(0.018)	(0.719)	(0.495)	(0.0045)			
MON	1.2757*	-0.1202	0.0585*	2.2646*	-0.5837	-0.0019	1.310	17.33	12.90
	(0.105)	(0.0178)	(0.014)	(0.725)	(0.380)	(0.0044)			
OTT	1.1275*	0.1007	0.0772*	0.3134	-0.2134	-0.0143*	1.498	30.58	16.34
	(0.105)	(0.108)	(0.014)	(0.571)	(0.319)	(0.0042)			
TOR	1.169*	0.201*	0.056*	0.170	0.325	-0.0134*	2.174	461.3	190.8
	(0.028)	(0.078)	(0.016)	(0.255)	(0.259)	(0.0032)			
CAL	0.9170*	0.6911*	0.0329*	0.1513	-0.5030	0.0209*	3.560	225.2	127.6
	(0.102)	(0.155)	(0.015)	(0.412)	(0.463)	(0.0043)			
EDM	0.5775*	1.0054*	0.0953*	0.6229	-0.5592	0.0284*	1.053	89.50	31.25
	(0.095)	(0.191)	(0.019)	(0.783)	(0.386)	(0.0055)			
VAN	1.2391*	0.8001*	-0.0556*	2.3109*	2.1560*	0.0109*	2.012	462.9	93.84
	(0.086)	(0.170)	(0.024)	(0.421)	(0.546)	(0.0055)			

Notes: STJ, HAL, MON, OTT, TOR, CGY, EDM, and VAN represent, respectively, St. John's, Halifax, Montréal, Ottawa, Toronto, Calgary, Edmonton, and Vancouver. Standard errors are in parentheses. * is significant at the 5 per cent level. Asymptotic and finite-sample critical values for the break tests were estimated via simulation. The 1 per cent asymptotic and finite-sample critical values for the L_c test are 2.933 and 3.908, respectively. Similarly, the 1 per cent asymptotic and finite-sample critical values for the *SupF* test are 29.33 and 58.36, respectively. Lastly, the 1 per cent asymptotic and finite sample critical values for the *MeanF* test are 16.64 and 28.082, respectively.

As a final experiment, we test the stability of our city-level cointegration relationships using a series of tests proposed by Hansen (1992): the *Lc*, *MeanF*, and *SupF* tests. All three tests are developed under the assumption of cointegration, and they have the same null hypothesis of parameter stability but differ in their implicit alternative hypotheses. Specifically, the *SupF* test is useful in testing whether there is a sharp shift in a regime, while the *Lc* and *MeanF* tests are useful for determining whether the specified model captures a stable relationship. The results, reported on the right-hand side of Table 6, are again mixed. As pointed out by Hansen (1992), the tests can be conflicting because they have power against different alternative hypotheses. The three tests suggest that the parameter estimates corresponding to St. John's, Montréal, and Ottawa are stable over the sample period, whereas the *SupF* and *MeanF* tests find evidence of unstable relationships for Halifax, Toronto, Calgary, and Vancouver. Overall, these results suggest that we should interpret our results with some caution, since they may be unstable. Indeed, one might have been surprised if the long-run relationships had been constant. We note that Hansen (1992) argues that the *Lc* test results may be viewed as a test for cointegration, against the alternative of no cointegration. Thus, our *Lc* test results corroborate the previous conclusion of cointegration among the variables under study.

4 Conclusion

In this paper, we have presented a detailed empirical investigation of Canadian house prices. We study long-run relationships between city house prices in Canada over the 1981 to 2005 sample period. We also examine idiosyncratic relations between city prices and city-specific variables. The results indicate that city house prices are only weakly related in the long run, and that there are only a few city-specific variables that are consistently related to city house prices. These include new-house prices, union wages, and issuance of building permits.

Our conclusions, resulting from the lack of cointegration among city house prices, are similar, at least in spirit, to those reported in Wakerly et al. (2006). In particular, Wakerly et al. (2006) find that Canadian regional output fluctuations are driven by an economically important set of disaggregated propagation and growth mechanisms, and that studying regional output movements may improve our understanding of Canadian business cycles. Studying aggregate housing-price indexes alone will not lead to a deeper understanding of the Canadian housing market. We think a better course for future research is to take into account local factors such as land availability, expected future economic activity, and institutions. Such analysis is likely to produce housing models based on city fundamentals that can be applied across a variety of urban centers.

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Figure 1. MLS Existing-House Prices (Nominal Can$): 1980Q1-2005Q2

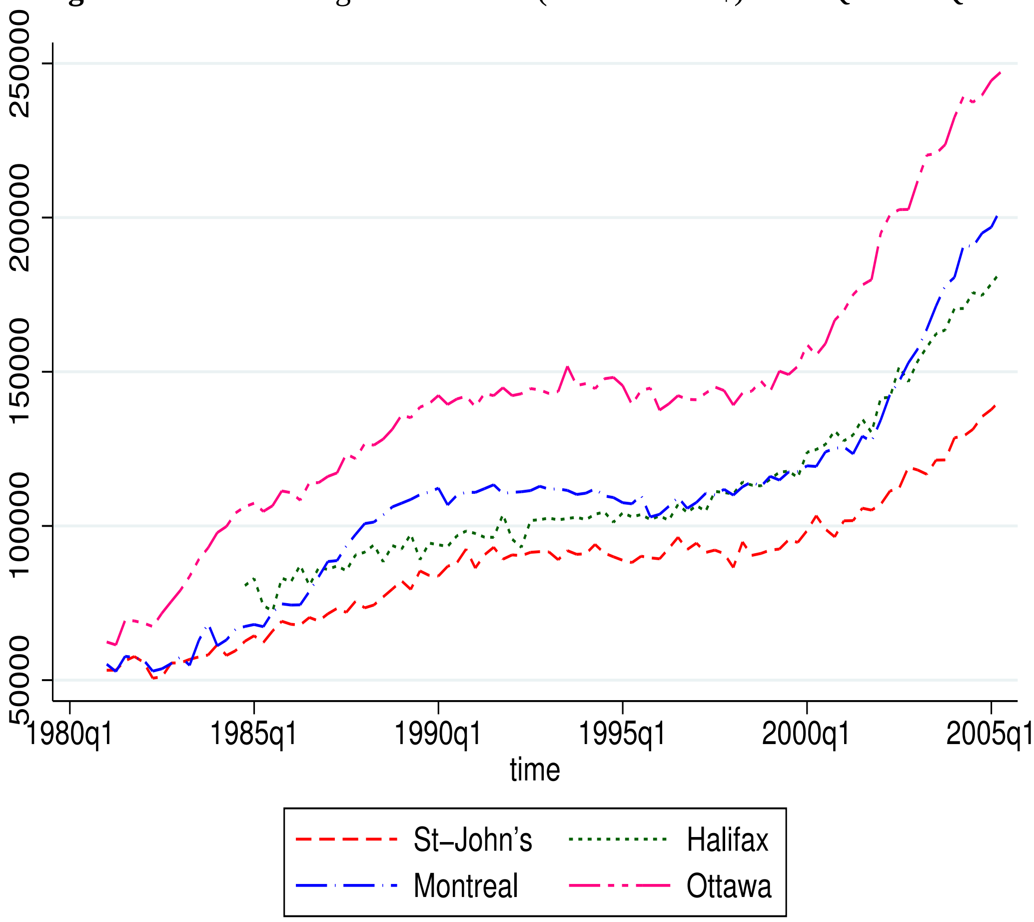


Figure 2. MLS Existing-House Prices (Nominal Can$): 1980Q1-2005Q2

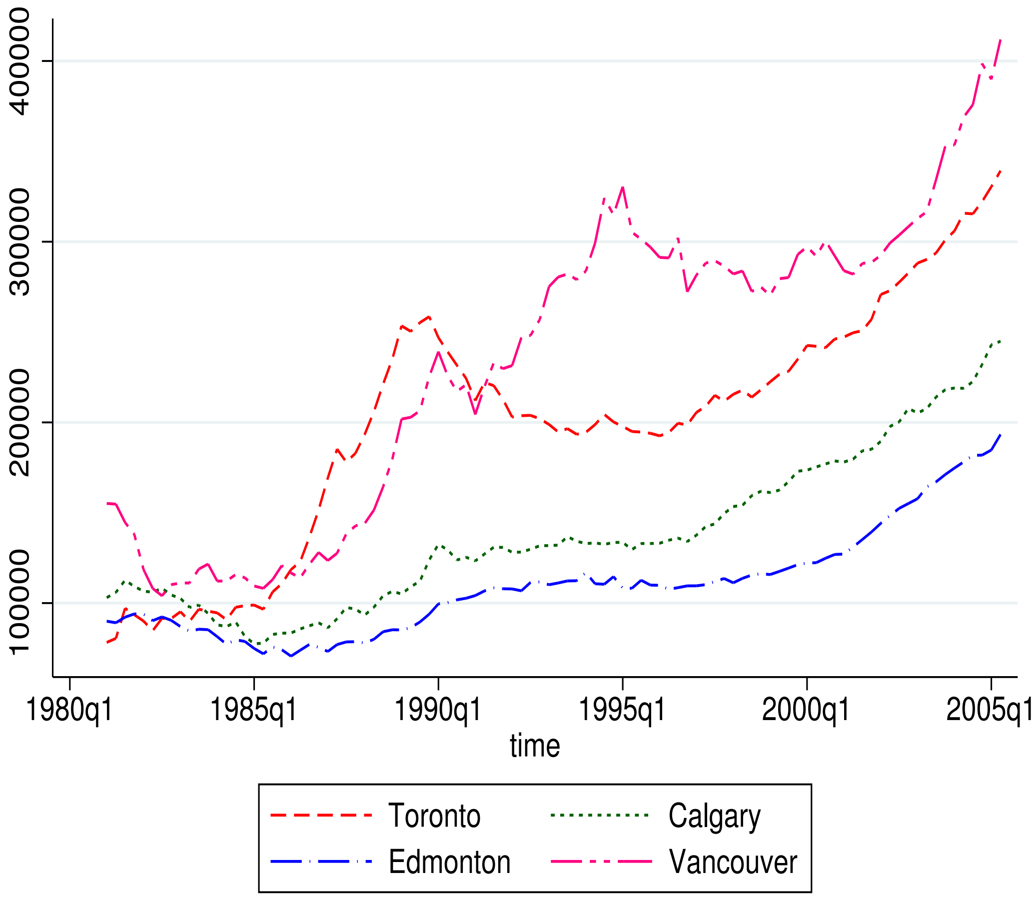
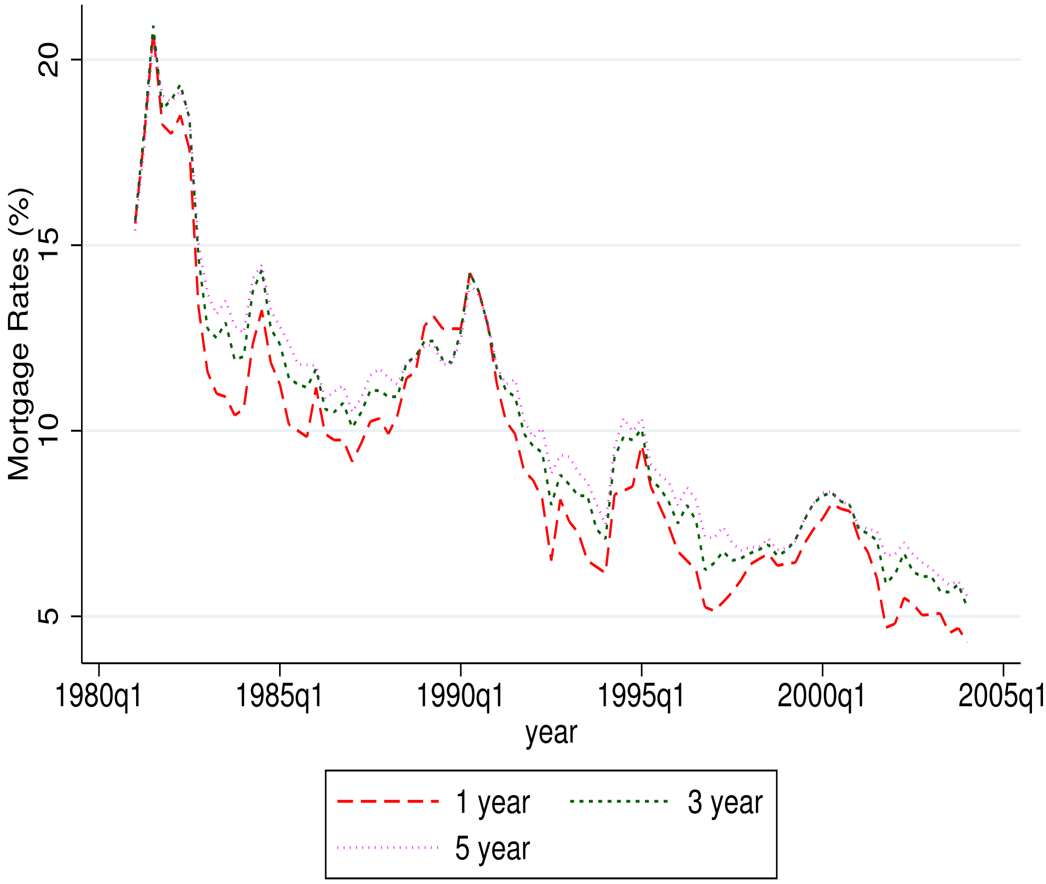


Figure 3. Mortgage Rates: 1980Q1-2005Q2



Appendix: Data Descriptions

MLS house-price data are provided by the Multiple Listing Service. In addition, Statistics Canada has provided an extensive list of data. Statistics Canada also produces a publication entitled *Useful Information for Construction* (2002), which provides catalogue numbers for key statistics collected by the agency that provide a detailed overview of the construction industry. Data are summarized below.

Existing-House Price Index (source: MLS)

- Multiple Listing Services
- Measured monthly
- Residential average sale price of existing homes

New-House Price Index (source: Statistics Canada)

- CANSIM Table 327-0005
- Measured monthly
- Tracks contractors' selling price of new residential houses
- Price includes development costs paid by the contractor. They exclude GST and provincial sales taxes.
- Canadian price is the aggregate of 21 urban centre groupings covering 24 metropolitan areas.

Building Permits (source: Statistics Canada)

- CANSIM Tables 026-0001 to 026-0008, and 026-0010 to 026-0012
- Monthly observations
- Issuance of building permits by municipality

Union-Wage Index (source: Statistics Canada)

- CANSIM Table 327-0003
- Monthly observations
- Union wages (hourly compensation) for the construction industry

- Survey of 20 metropolitan areas

Owner Accommodation costs (source: Statistics Canada)

- CANSIM Table 326-0001
- Owner accommodation component of the CPI (base=1992)

Renter Accommodation costs (source: Statistics Canada)

- CANSIM Table 326-0001
- Renter accommodation component of the CPI (base=1992)

Labour Force (source: Statistics Canada)

- CANSIM Tables 282-0001 to 282-0094
- Labour Force Survey/Employment data
- Monthly observations

Interest Rates (source: Bank of Canada)

- One-, three-, and five-year average mortgage rates
- Monthly observations

Per Capita Gross Domestic Product (source: Canadian Conference Board)

- Gross domestic product and population data
- Quarterly observations

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