HEDONIC PRICE INDEXES AND MULTIPLE LISTING SERVICE AVERAGE PRICES FOR CANADIAN CENSUS METROPOLITAN AREAS 1990 TO 1993

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ABSTRACT

Over the last decade Canadian cities have seen booms and busts in house prices of a size unprecedented in the postwar period. These have had major impacts on the affordability of home ownership, on construction and on household wealth. This study aims to strengthen the analysis of swings in house prices by providing new indexes and by assessing the usefulness of the average MLS price. The new price indexes are based on home owners' estimates of value, 1990-1993, adjusted to control for differences in the quality of house. We find that the effect of the age of house on value varies greatly from city to city, likely reflecting different premiums for centrally located land. In contrast, the effect of luxury bathroom facilities--which is very large--is quite similar in different cities. The price indexes estimated from home owners' valuations have good technical properties. Their picture of price movements over 1990-1993 is substantially similar to that provided by the average MLS price, lending support to the use of the MLS average as a price index.

Two cautions are important. First, the indexes are estimated after the systematic removal of outlier observations, because of concern for gross errors in some owners' valuations. While in most cities this makes little difference, it greatly reduces the estimated drop in prices in 1991 in Toronto and the estimated rise in prices in Victoria 1990-1993. In both cities removing outliers increases the similarity between the index and the MLS average. We conclude that outliers should be removed. Second, the indexes based on home owner valuations show a bigger drop in 1991 in most cities than does the MLS average. We believe this is attributable to real differences in price movements between houses which actually sold and untraded houses.

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EXECUTIVE SUMMARY

INTRODUCTION

Over the last decade Canadian cities have seen booms and busts in house prices of a size unprecedented in the postwar period. These have resulted in great swings in the affordability of home ownership, in housing construction and in household wealth. The busts have brought about heavily indebted households and high foreclosure rates.

For the analysis of booms and busts good indicators of house prices are needed. The pre-eminent indicator is the Multiple Listing Service (MLS) average price, but it is not a quality-adjusted index because of the changing mix of houses sold. An unexploited source is the Household Incomes, Facilities, and Equipment (HIFE), which has home owners' estimates of price by CMA starting in 1990.

The major motivation of this study is to use HIFE data to estimate quality-adjusted price indexes by CMA. These are useful by themselves and to assess MLS-based indexes. A secondary motivation is to investigate the impact of price trends on owners' estimates of house values. Owners' opinion of value will affect the likelihood they will "walk away" from mortgages in tough times.

METHODS

The basic element in this study is the hedonic regression. This is an equation expressing the assumption that the price of a house depends on its characteristics. We assume that a *unit* increase in a characteristic has a constant *percentage* effect on price, and that the *relative* effects of the characteristics remain the same over time. Thus the dependent variable is the logarithm of the home owner's estimate of price. This specification is the most widely used in the literature.

Several studies have found that there is a small upward bias in home owners' estimates but it is stable over time, so that an index based on these estimates should be unbiased. Studies have also found, however, that a substantial number of owners' estimates are grossly in error. To deal with this we remove outlier observations based on the value of their DFFITS (Belsley, Kuh and Welch, 1980).

To determine the effect of price trends on home owners' estimates we regress owners' estimates on home characteristics, the MLS average price and MLS trend variables.

SAMPLES, AND VARIABLES

The sample before editing consists of 19,182 records of owner-occupier households living in single or semi-detached houses in 15 CMAs, from the 1990-93 survey years of HIFE. Eliminating houses which are below standard quality or very large reduces this by 3.6 per cent. Excluding observations which do not pass the DFFITS criterion reduces the sample by a further 5.8 per cent.

The home owners' value is the actual estimated dollar value The age of the house is constructed from HIFE discrete categories. Both age and age squared are included in the regressions to allow the percentage depreciation rate to change as the house ages.

The number of bedrooms and of other rooms are included in the form of a linear spline to allow, for example, the "price" of the fourth other room to be different from that of the third.

Four dummy variables are included for bathrooms. Bathrooms add value directly, and in addition luxury bathroom facilities are an indicator of renovation in old houses. A dummy variable for an installed dishwasher is included as a proxy for the quality of a kitchen.

We also include a dummy variable for a semi-detached structure, two climate control variables, the number of cars owned by the household--as a proxy for the existence and size of garages--and dummy variables for major and minor repairs needed. As a proxy for the poverty level of the neighbourhood we include a dummy variable taking the value one if income is below the poverty line and the head is less than 65 years of age (heads over 65 are excluded because of poverty associated with retirement).

RESULTS

Characteristics of sample houses

Means for selected variables are shown in Table 3.1 The mean age in the sample, nationally, is 29 years. Differences in mean age between CMAs reflect differences in construction activity in houses for *owner-occupancy* in recent decades. The youngest mean ages are in Quebec and Montreal, reflecting the province's recent surge into subsidy programs for home ownership. Winnipeg and Quebec City houses have the fewest rooms and Calgary, London and Vancouver houses have the most.

The luxury feature of at least two bathrooms and at least one washroom is more prevalent in the two prairie cities than elsewhere (see Chart 3.3). Slightly over half of houses in the Ontario sample are reported to be centrally air conditioned, as are a substantial proportion in Montreal and Winnipeg, but few are elsewhere.

The means of the repair variables (Table 3.2) indicate that a relatively large proportion of houses in the sample are in good shape in the Quebec cities, but not in Winnipeg and Edmonton. Note that this statistic says nothing about the housing stock *overall* in the various cities, because rental housing is ignored. Together, the results for the poverty line and repair variables suggest that owner-occupied slum housing is much more likely to be found out west than elsewhere.

For most cities for most years, *outlier* houses are gauged by their owners, on average, to be much more valuable than other houses in the sample. In a few instances outliers are on average estimated to be worth much *less*. For example, in 1991, in Toronto, Kitchener and Hamilton, where there was a pronounced fall in prices, outlier houses were valued at less than other houses. In addition in 1991 the *number* of outliers in these cities was much greater than for other years. Outlier houses tend to be much older than other houses. For Montreal, outlier houses average 38 years and other houses only 21 years.

The major difference between the houses of recent (within 5½ years) movers and other houses is that the former are much newer.

What affects the value of houses in Canadian cities?

The results (Chapter 4) show that the effect of age on value varies greatly from city to city. Age is not merely an indicator of physical condition. In some of the largest cities--e.g.Vancouver, Toronto and Ottawa--houses are worth *more* than new ones with the same characteristics, likely because old houses tend to be located on valuable land close to the centre.

The size of houses has quite different effects from one city to another, but quite uniformly the effect of another room declines quite markedly as the number of rooms increases. The need-for-repair variables have the expected negative effects in almost all cities. The discount for needed major repairs is estimated to be distinctly greater in western cities than elsewhere. This discount may be in part the consequence of negative neighbourhood effects.

The variables having the greatest quantitative effects--highly consistent from city to city--are the amenity variables. A second bathroom adds around 10 per cent to value in most cities, while at least two baths and a washroom (rather than one bathroom) is estimated to add at least 25 per cent to value, in almost every city. Bathroom variables have very high levels of statistical significance. The presence of an installed dishwasher--taken to indicate high quality kitchen facilities--adds close to 10 per cent to value in most cities, and central air conditioning usually adds almost as much.

How good are home owners' estimates?

MLS averages are less than HIFE averages with the notable exceptions of Vancouver in 1991 and St. Catharines-Niagara in 1990 and 1991. The size of the HIFE-MLS difference in most cities suggests that home owners are overoptimistic in their valuation. Further, the data suggest that recent movers are more overoptimistic than nonmovers, especially in boom conditions like those prevailing in Vancouver and Victoria during the 1990-1993 period. Home owners' estimates of value are somewhat sticky: we estimate that if current prices were reached following a rise of 10 per cent a year for three years, home owners' valuations would be between 1.7 and 2.4 per cent lower than if past prices were the same as current prices.

What is the effect of outliers?

If Ordinary Least Squares is used for estimation, extreme errors in home owners' estimates of value will greatly influence the parameter estimates. To deal with this we have eliminated outlier observations. For some cities this has major effects. For example the Toronto price crash in 1991 is estimated to be much greater when the sample includes outliers than when it does not. The Victoria price *rise* is estimated to be much greater. Including outliers seems to exaggerate price change.

How well do the hedonic indexes do?

Technically, the estimated standard hedonic index is quite good: most index values have standard deviations of not much more than two percentage points. Are the estimated indexes consistent with our other knowledge of house prices? The answer is yes: if we use the hedonic index to place cities in four price categories for the period--large decline, little change, small increase and large increase--the hedonic index gives us almost precisely the same answer as does the MLS index.

The hedonic index based on the *recent movers* gives values which are in almost all cases within the 95 per cent confidence interval of the standard estimates. In the two boom cities, Vancouver and Victoria, movers' estimates show a substantially greater price increase than either the standard hedonic or the MLS index, which suggests boom psychology affects the usefulness of movers' estimates.

The MLS index

The MLS index in general does remarkably well, in the sense of giving the same qualitative picture of city price movements as the standard hedonic. At the same time, in virtually every city, but especially in Toronto, Hamilton, Edmonton and Vancouver the hedonic gives a more negative picture of the price change from 1990 to 1991 than does the MLS average, perhaps because the MLS is an index of the prices of houses which transact, not all houses in the stock.

RECOMMENDATIONS

- The MLS index is a good guide to price movements in all CMAs investigated for most purposes. It is possibly better than *any* alternative available on a timely basis.

- The MLS index should be used with caution, however, in periods of downturn, especially after the volume of sales drops. At these times the HIFE indexes are especially useful.

- HIFE hedonic indexes should be updated as new HIFE data arrives.

- HIFE data should only be used after outliers have been eliminated using the DFFITS criterion or some other systematic criterion and the HIFE final universal weight should not be used in estimation.

- In times of sharp changes in the number of MLS sales consideration should be given to attaching questions on house value and characteristics to a Labour Force Survey in November, so that semi-annual home owners' estimates of value are available.

«Indices de prix hédonistique et de prix moyens du Service inter-agences pour les régions métropolitaines de recensement, de 1990 à 1993»

RÉSUMÉ

INTRODUCTION

Au cours des dix dernières années, le prix des maisons au Canada a subi des fluctuations d'une ampleur inégalée depuis la dernière guerre. Ces fluctuations ont entraîné d'importantes variations en ce qui a trait à l'abordabilité de l'accession à la propriété, à la construction résidentielle et à l'avoir des ménages. Les périodes de récession ont eu pour effet d'endetter lourdement les ménages et d'accroître le nombre de faillites.

Afin de bien analyser les périodes de forte expansion et de récession, il faut disposer de bons indicateurs du prix des maisons. Le principal indicateur est le prix moyen des maisons du Service inter-agences (S.I.A.), mais cet indice ne tient pas compte de la qualité en raison de la diversité des logements vendus. L'Enquête sur le revenu des ménages et l'équipement ménager (ERMEM) constitue une source inexploitée de données sur la valeur des maisons estimée par les propriétaires-occupants, par région métropolitaine de recensement (RMR) depuis 1990.

La présente étude vise à utiliser les données de l'ERMEM afin d'estimer les indices de prix tenant compte de la qualité des logements, par RMR. Cet indice est utile en soi et peut aussi servir à évaluer les indices fondés sur les données du S.I.A. L'étude sert également à examiner l'incidence de l'évolution des prix sur la valeur estimée par les propriétaires-occupants. L'estimation que font les propriétaires-occupants du prix des maisons a une incidence sur leur décision de ne pas contracter une dette hypothécaire en période de récession.

MÉTHODOLOGIE

L'élément de base de la présente étude est le régression hédonistique. Il s'agit d'une équation qui exprime l'hypothèse voulant que le prix d'une maison dépend de ses caractéristiques. Nous supposons que l'ajout d'une unité à une caractéristique donnée a un effet en pourcentage constant sur le prix et que les effets relatifs sur les caractéristiques restent les mêmes. La variable dépendante est le prix de la maison (sous forme logarithmique) estimé par le propriétaire-occupant. Cette spécification est la plus courante dans les travaux sur ce sujet.

Selon diverses études, il y aurait un léger biais par excès dans les estimations des propriétaires-occupants, mais comme celui-ci est stable, l'indice fondé sur ces estimations n'est pas biaisé. Toutefois, les études ont également révélé qu'un grand nombre des estimations par les propriétaires étaient complètement erronées. Pour corriger la situation, nous avons éliminé les observations extrêmes fondées sur la valeur des résidus DFFITS (Belsley, Kuh et Welch, 1980).

Afin de déterminer l'effet de l'évolution des prix sur les estimations des propriétaires-occupants, nous avons procédé à la régression des estimations des propriétaires-occupants d'après les caractéristiques des maisons, du prix S.I.A. moyen et des variables de tendance S.I.A.

ÉCHANTILLONS ET VARIABLES

L'échantillon avant vérification comprend 19 182 dossiers visant des propriétaires-occupants qui habitent une maison individuelle ou une maison jumelée dans quinze RMR et qui ont participé aux enquêtes ERMEM réalisées entre 1990 et 1993. La taille de l'échantillon a diminué de 3,6 % une fois que les maisons non conformes aux normes de qualité et des maisons de très grande taille ont été éliminées. Après avoir exclu les observations qui ne répondent pas aux critères DFFITS, l'échantillon a encore diminué de 5,8 %

La valeur donnée par les propriétaires-occupants est une valeur estimative. L'âge de la maison est établie en fonction des catégories discrètes de l'ERMEM. L'âge et l'âge au carré sont inclus dans les régressions afin de permettre au taux de dépréciation en pourcentage de changer en fonction de l'âge de la maison.

Le nombre de chambres et de pièces sont inclus sous forme d'ajustement linéaire de discontinuité de sorte que, par exemple, le «prix» de la quatrième chambre soit différent de celui de la troisième chambre.

Quatre variables binaires sont incluses pour les salles de bains. Les salles de bains ajoutent une valeur directe, et les salles de bains luxueuses sont une indication que des travaux de rénovation ont été effectués dans le cas de vieilles maisons. Une variable binaire pour un lave-vaisselle installé est incluse comme variable de substitution en ce qui a trait à la qualité de la cuisine.

Nous avons également une variable binaire pour les logements jumelés et deux variables de contrôle, soit le nombre de voitures que possède le ménage qui sert de variable pour l'existence te la taille du garage et les variables binaires pour les travaux de réparation mineurs et majeurs requis. Pour ce qui est du niveau de pauvreté du quartier, nous avons inclus une variable binaire qui prend la valeur 1 lorsque le revenu est inférieur au seuil de pauvreté et que le chef est âgé de moins de 65 ans (les chefs de ménage de plus de 65 ans sont exclus en raison de la pauvreté associée à la retraite).

CONCLUSIONS

Caractéristiques des maisons de référence

Les moyennes des variables sélectionnées sont fournies au tableau 3.1. L'âge moyen de l'échantillon, à l'échelle nationale, est de 29 ans. Les écarts observés entre les âges moyens des différentes RMR reflètent les niveaux d'activité enregistrés au cours des dernières décennies dans sur le marché de la construction des maisons destinées aux propriétaires-occupants. Les âges moyens les plus bas ont été signalés au Québec et à Montréal à cause des divers programmes de subventions pour l'accession à la propriété. Les maisons situées à Winnipeg et dans la ville de Québec comptent le moins grand nombre de chambres, tandis que celles de Calgary, de London et de Vancouver en comptent le plus.

Les maisons situées dans les villes des Prairies présentent le plus souvent comme caractéristiques de luxe au moins deux salles de bains et au moins une salle de toilette (voir le tableau 3.3). Un peu plus de la moitié des maisons composant l'échantillon en Ontario sont dotées d'une installation centrale de conditionnement d'air, tout comme une grande proportion des maisons à Montréal et à Winnipeg, alors qu'ailleurs peu de maisons le sont.

Les moyennes des variables associées aux réparations (tableau 3.2) indiquent qu'une proportion relativement grande de maisons de référence sont en bon état dans les villes du Québec, contrairement à Winnipeg et à Edmonton. Il est à noter que cette statistique ne donne aucune information sur l'ensemble du stock de logements dans les différentes villes, étant donné que les logements locatifs sont exclus. Selon les résultats relatifs à la pauvreté et aux variables de réparation, il semble que les cas où les taudis sont occupés par les propriétaires soient plus fréquents dans l'Ouest qu'ailleurs au pays.

Dans la plupart des villes et la plupart du temps, les maisons qui affichent une valeur extrême sont habituellement surévaluées par leur propriétaire par rapport aux autres maisons de l'échantillon. Dans quelques cas, elles sont sous-évaluées. Par exemple, en 1991, à Toronto, Kitchener et Hamilton, où la baisse des prix a été particulièrement prononcée, les maisons affichant une valeur extrême avaient été évaluées à un prix moindre que les autres maisons. De plus, cette même année, le nombre de maisons affichant une valeur extrême dans ces villes étaient beaucoup plus élevé qu'au cours des années précédentes. Les maisons affichant une valeur extrême sont habituellement plus vieilles. À Montréal, les maisons à valeur extrême étaient âgées en moyenne de 38 ans, alors que les autres maisons n'avaient que 21 ans.

La principale différence entre les maisons des ménages ayant récemment déménagé (5 ½ ans et moins) et les autres est que, dans le premier cas, les maisons sont plus récentes.

Quels facteurs ont une incidence sur la valeur des maisons dans les villes canadiennes?

Les conclusions (chapitre 4) indiquent que l'effet de l'âge sur la valeur varie énormément d'une ville à l'autre. L'âge n'est pas qu'un simple indicateur de l'état du logement. Dans certaines grandes agglomérations, comme Vancouver, Toronto et Ottawa, les vieilles maisons valent plus que les maisons neuves qui offrent les mêmes caractéristiques, probablement parce qu'elles sont construites sur des terrains dont la valeur est élevée à cause de leur emplacement central.

La taille des maisons a aussi un effet qui varie selon la ville, mais de façon générale plus il y a de chambres moins l'effet d'une chambre additionnelle est grand. Les variables relatives aux travaux de réparation requis ont eu l'effet négatif prévu dans presque toutes les villes. La réduction du prix découlant du fait que des réparations majeures sont requises serait plus important dans les agglomérations de l'Ouest qu'ailleurs au pays. Cette réduction de prix est peut-être attribuable aux effets négatifs du quartier.

Les variables qui ont les effets quantitatifs les plus importants -- effets qui sont très constants d'une ville à l'autre -- sont les variables relatives aux commodités. Dans la plupart des villes, une deuxième salle de bains peut faire monter la valeur d'une maison d'environ 10 %. On estime qu'une maison qui comprend au moins deux salles de bains et une salle de toilette (plutôt qu'une seule salle de bains) voit sa valeur augmenter d'au moins 25 %. Les variables visant les salles de bains ont une grande importance sur le plan statistique. Un lave-vaisselle installé -- variable qui sert à indiquer la qualité de la cuisine -- ajoute près de 10 % à la valeur de la maison dans la plupart des villes, et une installation central de conditionnement d'air presque autant.

Dans quelle mesure les estimations des propriétaires sont-elles exactes?

Les moyennes S.I.A. sont plus basses que les moyennes de l'ERMEM, sauf dans le cas de Vancouver en 1991 et de St. Catharines-Niagara en 1990 et en 1991. Compte tenu de l'importance de l'écart entre les moyennes de l'ERMEM et du S.I.A. dans la plupart des villes, il semble que les propriétaires-occupants ont tendance à surévaluer leur maison. De plus, les données semblent indiquer que les ménages ayant récemment déménagé surestiment davantage la valeur de leur maison que les personnes n'ayant pas déménagé, particulièrement durant les périodes de forte croissance économique comme celles qu'ont connues Vancouver et Victoria de 1990 à 1993. Les estimations des propriétaires-occupants sont quelque peu rigides : nous estimons que si les prix courants avaient été atteints après une hausse annuelle de 10 % pendant trois ans, les évaluations des propriétaires seraient de 1,7 à 2,4 % moins élevées que si les prix antérieurs correspondaient au prix courant.

Quels sont les effets des valeurs extrêmes?

Si l'on utilise la méthode des moindres carrés ordinaires pour les estimations, les erreurs extrêmes dans les estimations des propriétaires auront une grande incidence sur les estimations paramètres. Pour régler le problème nous avons éliminé les valeurs extrêmes, ce qui a eu des répercussions importantes dans le cas de certaines villes. Par exemple, l'effondrement des prix à Toronto en 1991 semble être plus important lorsqu'on inclut dans l'échantillon les valeurs extrêmes que lorsque celles-ci sont exclues. La hausse des prix à Victoria est également perçue comme étant plus élevée. Le fait d'inclure les valeurs extrêmes semble accentuer les variations des prix.

Quel genre de résultats l'indice hédonistique des prix donne-t-il?

Sur le plan technique, les estimations de l'indice hédonistique des prix sont plutôt bonnes : la plupart des valeurs de l'indice présentent des écarts normaux d'au plus deux points de pourcentage. Les indices estimés correspondent-ils à ce que nous connaissons des prix? La réponse est oui. Lorsque nous utilisons l'indice hédonistique pour classer les villes dans quatre catégories de prix durant une période donnée -- baisse importante, peu de changement, légère hausse et hausse importante -- celui-ci nous donne pratiquement les mêmes résultats que l'indice S.I.A.

L'indice hédonistique visant les personnes ayant récemment déménagé donne des valeurs qui, dans presque tous les cas, se trouvent dans l'intervalle de confiance de 95 % des estimations type. À Vancouver et à Victoria, les estimations des ménages ayant récemment déménagé montrent une hausse de prix plus marquée que l'indice hédonistique ou l'indice S.I.A., ce qui laisse supposer que les effets psychologiques de l'essor économique affectent l'utilité des estimations des ménages ayant déménagé.

Indice des prix S.I.A.

En général, l'indice des prix S.I.A. obtient une bonne note et il donne les mêmes observations qualitatives en ce qui concerne l'évolution des prix dans une ville donnée que l'indice hédonistique type. De plus, dans presque chaque ville, mais particulièrement à Toronto, Hamilton, Edmonton et Vancouver, l'indice hédonistique donne une image plus négative de l'évolution des prix de 1990 à 1991 que la moyenne S.I.A. Cette situation s'explique peut-être par le fait que l'indice S.I.A. porte sur le prix des maisons vendues et non de l'ensemble du stock de maisons.

RECOMMANDATIONS

- En général, l'indice S.I.A. est un bon point de repère en ce qui concerne l'évolution des prix dans toutes les RMR visées par l'enquête. Cet indice est tout aussi valable que n'importe quel autre solution offrant des données à jour.

- Toutefois, l'indice S.I.A. devrait être employé avec discernement durant les périodes de fléchissement de l'activité, surtout après une baisse des ventes. Dans ces cas, les indices ERMEM sont particulièrement utiles.

- Les indices hédonistiques ERMEM devraient être mis à jour chaque fois que de nouvelles données sont recueillies.

- Les données de l'ERMEM ne devraient être utilisées qu'une fois les valeurs extrêmes éliminées au moyen des critères DFFITS ou tout autre critère systématique. De plus, le coefficient de pondération de l'ERMEM ne devrait pas être utilisé dans les estimations.

- Lorsque le nombre de ventes S.I.A. varie de façon considérable, il faudrait songer à ajouter des questions sur la valeur et les caractéristiques des maisons dans l'Enquête sur la population active de novembre, de façon à obtenir des estimations semestrielles de la part des propriétaires.

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CHAPTER I

INTRODUCTION

I. THE NEED FOR A HIFE-BASED HEDONIC HOUSE PRICE INDEX

The last decade has seen booms in house prices in some Canadian cities of a size unprecedented in the post war period. Variation among cities in the timing and extent of these booms has been great. Booms have been followed by busts. In the 1990s the downturns in house prices have been prolonged and severe.

Large fluctuations in house prices are of great importance, because they imply disruptive fluctuations in household wealth for the majority of households who hold most of their wealth, and they imply great swings in the affordability of home ownership to renters. A normal pattern of transition from rental tenure to home ownership may be disrupted during the period of the boom. Or households may assume imprudent debt loads in order to acquire a first home or to move up in the market. In the aftermath of the boom casualties accumulate: households overburdened with debt; foreclosures; super-cautious lenders; and a depressed housing market.

For the analysis of booms and busts in house prices, and for the analysis of the affordability of home ownership, it is important to have good indicators of house prices. The pre-eminent indicator available for existing houses is the average Multiple Listing Price, by city. These series have been available for a long period of time and can be expected to continue to be available. They are widely used by some chartered banks and some government agencies, for example the federal Department of Finance.

A problem with the MLS average for a city, however, is that variation in the mix of houses sold varies over the price cycle may distort it. For example if high quality houses are relatively likely to sell towards the end of the boom, the rise in average price will give an exaggerated picture of the rise in quality-adjusted prices. Further, the mix of houses may vary over long periods of time. In particular, if houses improve in quality over time, the secular rise in the MLS average will reflect that improvement as well as the rise in prices. The results in Goy (1992) indicate that the MLS index for Kitchener-

Waterloo overstates the quality-adjusted average annual rate of increase over 1988 to 1990 by more than a percentage point. Hosios and Pesando (1992) obtain quite similar results for Toronto, using data over a longer period of time.

The results in Goy (1992) and Goy and Steele (1994) do suggest, however, that the MLS average is much better, in accurately capturing quality-adjusted price change, than a number of other currently available indexes. For instance, the Royal-LePage-based index lags the true price movement, and appears to suffer from the "excessive smoothing" common to appraisal-based indexes. Also, Goy and Steele (1994), using a sample of sales of new houses sold through the MLS, show that the Statistics Canada new house price index is strongly downward biassed, even as an indicator of the price change in *new* houses, and certainly is unsatisfactory as an indicator of overall market price change.

It seems quite clear that of *currently available* price indexes the MLS average ranks high. It is available on a timely and continuing basis. and is inexpensive. Unlike repeat sales indexes and hedonic indexes based on transactions data, it does not requires access (by the public or government agencies) to individual data over which others have proprietary rights. One objection to the use of the MLS averages is that users have no control over the sample on which it is based and are not in a position to assess possible changes in its quality from city to city and year to year. Clearly there is a need to provide an inexpensive method to periodically asses the quality of the MLS indexes.

One important motivation for this report is to provide such a method and apply it. We do this by estimating hedonic price indexes by Census Metropolitan Area using Statistics Canada's Household Incomes, Facilities and Equipment (HIFE) individual survey data. CMA-level data have only recently become available in this source. Fortunately, the beginning year for these data is (May) 1990, when house prices in some cities were at their peak or very little past it (see Goy and Steele, 1994 for evidence for Kitchener), so that a meaningful segment of the house price cycle is available for analysis.

The hedonic indexes are of interest in their own right, as alternative indicators of quality-adjusted price change, and providing them is a second motivation for this report.

A third motivation is to estimate the impact of price trends, as indicated by MLS averages, on home owners' estimates of the worth of their houses. This is of intrinsic interest because home owners' estimates of value will affect the security of mortgages--a home owner who thinks his/her house is relatively valuable is less likely to "walk away" from it. It is also of interest because it aids us in assessing the validity of home owners' estimates for price index purposes.

A final motivation for this report is to determine what the hedonic regressions reveal about the factors affecting the value of houses in different cities in Canada. Despite the limited number of characteristics represented in HIFE, hedonic estimates using this source can tell us a great deal.

2. A FIRST LOOK AT THE HIFE DATA

Chart I.1 shows MLS average price and the average prices from HIFE for Canada's three largest cities, for 1990 to 1993, and also for earlier years, in the case of the MLS data. There are several reasons to expect the two to be quite different: the MLS price is the average for mix of renter and owner-occupied residential properties -- including houses, condominiums, row houses, duplexes and other structures--which transact, while the HIFE price shown here is the average for the stock of owner-occupied single and semi-detached houses only ;[1] the MLS is the average for the year while the HIFE is for May; the prices making up the MLS average are realized market prices while those making up the HIFE average are home owner value estimates. In view of this, the extent of similarity of the level of, and especially the movement in, the averages is remarkable. For Montreal, both price series showed almost no change over the 1990-93 period; for Toronto, both moved down over the period, although the HIFE showed a dip in 1991 not shown by the MLS; and for Vancouver, both showed a substantial rise, although again, a dip in the HIFE price in 1991 was not shared by the MLS average.

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[1] Further, the HIFE sample is edited in a way which ensures that many very low value houses are absent from the sample. Houses without minimal facilites (e.g. houses without an inside flush toilet) are eliminated. For more information see Chapter 3. Note that the MLS average excludes large apartment buildings.

A pervasive characteristic of the HIFE averages is that they are higher than MLS averages. Some of this is likely attributable to the fact that the HIFE sample used here excludes--while the MLS data do not--condominiums and tenant-occupied housing, which are apt to be cheaper than single and semi-detached houses. But some of the difference is almost certainly largely attributable to the over-optimism of home owners. Steele and Buckley (1976) using Canadian Census data find that home owners, on average, overestimate the value of their homes compared to the price actually received for the home in a sale close to the date of the home owner estimate. The overestimate is however, less than six per cent. U.S. studies (Goodman and Ittner, 1992; di Pasquale and Somerville, 1993) using American Housing Survey data, which are very much like HIFE data, find a similar relationship. These studies indicate, however, that the upward bias is substantially stable. Thus, the *change* in home owners' estimates is a good indicator of the true change.

In this study we construct indexes not using the HIFE averages but rather coefficients from hedonic equations, because our aim is to provide quality-corrected indexes. The close similarity between the HIFE average and the MLS average shown in Chart 1.1, however, gives us the assurance that the basic data are fundamentally sound.

3. THE PLAN OF THIS REPORT

The next chapter of this report discusses the specification of the hedonic regressions. These include the hedonic regressions, by Census Metropolitan Area, which are used to generate quality-adjusted price indexes, and regressions for all CMAs together, which incorporate the MLS average price and its change. This chapter also discusses the DFFITS criterion for removing outlier observations.

Chapter 3 gives a detailed description of the editing, and the specification of variables, including linear splines for number of rooms. It also discusses the data. Two splits of the edited sample are made. The first is into outliers and the remaining, homogenized sample. Comparisons of means of these two reveals striking differences.

The second split is into recent movers and non-movers, and means are compared for these two subsamples.

Chapter 4 discusses the hedonic results, comparing the effects on value of the age of houses, need for repair, bathroom facilities and other characteristics from city to city.

Chapter 5 presents the hedonic indexes and their confidence intervals, computed both for the "all" sample and the mover subsample. Index values are compared to MLS index values (as derived from MLS average). The weighted average of HIFE values is also assessed as an indicator of house price change.

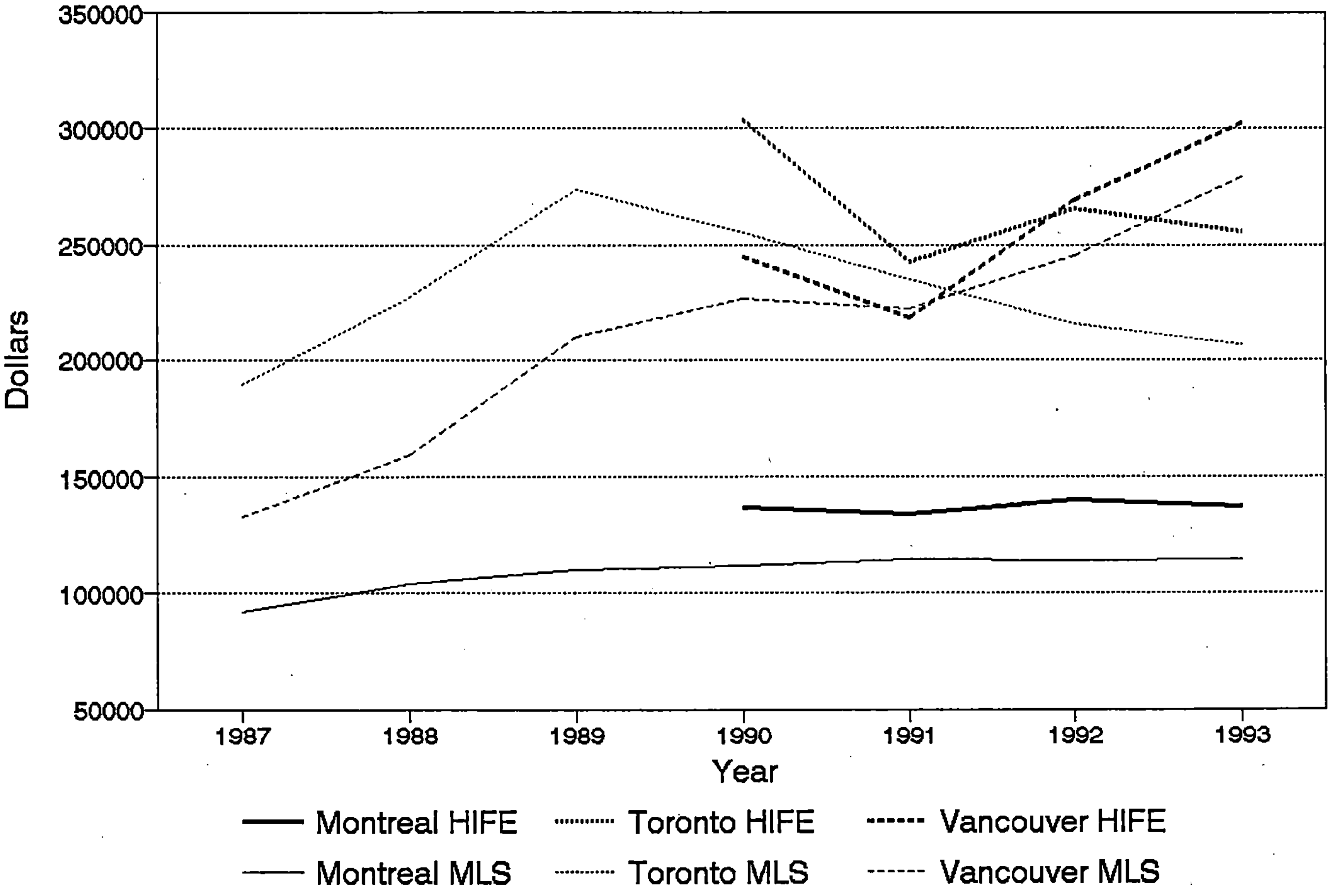
Chapter 6 sets out the important findings of this study and recommendations arising from them.

Table 1.1
Average annual MLS Price
and Owner's Estimate of Average House price in HIFE

Year	Montreal		Toronto		Vancouver	
	MLS	HIFE	MLS	HIFE	MLS	HIFE
1987	92292	-	189105	-	132659	-
1988	103674	-	227014	-	158756	-
1989	110015	-	273698	-	209671	-
1990	111956	136157	254890	303174	226392	244348
1991	114379	133686	234313	242282	221874	217863
1992	113688	139535	214971	265371	245260	269650
1993	114293	137292	206489	255612	279759	302628

Chart 1.1

Average price, MLS and HIFE
Montreal, Toronto, Vancouver



CHAPTER 2
MODELLING AND ESTIMATION ISSUES

1. THE MODEL

The model we use in this study is one derived from the insight that the price of a house depends on its characteristics, such as its age, its number of bedrooms and its number of bathrooms. For house *i* we may write

$$P*_i = f(X_i,u_i) \tag{2.1}$$

where $P*_i$ is the price of house i, X_i is a vector of characteristics of i and u_i is a stochastic term. We are interested in the price of a house not just at one point of time, but at many points of time, and so we generalize (2.1) to

$$P*_{ti} = f(X_{ti},u_{ti}) \tag{2.2}$$

To obtain an equation for estimation we make a number of additional assumptions which are quite standard in the hedonic index literature (Goodman and Ittner, 1992; di Pasquale and Somerville, 1993; Gatzlaff and Ling, 1994). We assume that

(a) the *relative* marginal price of every characteristic remains constant over time;

(b) a unit increase in any characteristic has a constant percentage effect on price;

(c) the stochastic term u_{ti} is identically and independent distributed.

According to the first assumption, if in year one an additional bathroom adds three times as much to value as does an additional bedroom, it also does so in year five. According to the second assumption, the addition of a second bathroom has a given *percentage* effect on price, not a given dollar effect; the dollar effect will then be greater the more expensive is the house. This is plausible on the grounds that the more expensive a house, the larger its bathrooms will tend to be, and the more expensive their fixtures, so that an extra bathroom will tend to cost more.

These assumptions give the quite standard similogarithm hedonic equation. In this specification the natural logarithm of price equals a linear function of a set of characteristic variables, which may be in continuous or dummy variable form, and a set of time dummy variables. Specifically, we assume:

$$\ln P*_{ti} = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_k X_{ki} + \lambda_2 T_{2i} + \lambda_3 T_{3i} + \lambda_4 T_{4i} + u_{ti} \tag{2.3}$$

where X_{ji} is the amount of the jth characteristics of house i for j = 1,...k and $T_{mi} = 1$ if the price is observed in period m and zero otherwise, for $m = 2,3,4$; our data start in 1990 and finish in 1993, so that $m = 2$ refers to 1991 and m = 4 refers to 1993. The characteristics and their coefficients have no time subscripts because we have assumed that the effects of characteristics do not depend on the time period.

It can be seen that λ_2 gives the log of the ratio of P_{2i} to P_{1i}, where P_{2i} refers to the price in quarter 2 and P_{1i} refers to the price in quarter 1, the base quarter. In other words, λ_2 is the log of the price index number for period two, where the price index number for quarter one is set at 1.00. Thus the index number for quarter two is e^{λ_2}. The formulas for estimated prices and index numbers are given more fully in Table 2.1.[1]

Table 2.1. Constrained Hedonic Index

Period	*Estimated price*	*Estimated index number*
1	$e^{(.)}$	1
2	$e^{(.)+\lambda_2}$	e^{λ_2}
3	$e^{(.)+\lambda_3}$	e^{λ_3}
4	$e^{(.)+\lambda_4}$	e^{λ_4}

where (.) refers to the estimated value of (2.3) exclusive of the time dummy portion, with the characteristics values taking the same values in all periods.

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[1] This can be seen by noting that if property i is sold in quarter 1, all the time dummies are equal to zero so that $\ln P_{1i} = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_k X_{ki} + u_{1i}$
If it is sold in quarter 2, $T_{2i} = 1$ and other time dummies are equal to zero so that

$$\ln P_{2i} = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_k X_{ki} + \lambda_2 + u_i \ .$$

Thus, $\ln \frac{P_{2i}}{P_{1i}} = \ln P_{2i} - \ln P_{1i} = \lambda_2$ and so the index number for quarter 2 is e^{λ_2}.

The model so far uses the true house price, rather than an estimate. To take account of the fact that the house price observed is an home owner's estimate which in general is subject to error, we assume

$$P_{ti} = P*_{ti}e^{\varepsilon_{ti}}$$

where $P*_{ti}$ is the true price and ε_{ti} is an identically and independently distributed stochastic term which is independent of u_{it}. Substituting (2.3) into the log of (2.4) we get the model for estimation:

$$\ln P_{ti} = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_k X_{ki} + \lambda_2 T_{2i} + \dots + \lambda_h T_{hi} + u_{ti} + \varepsilon_{ti} \tag{2.5}$$

Note that we do not assume that $E(\varepsilon_{ti}) = 0$. There is abundant evidence (Ihlanfeldt and Martinez-Vazquz ,1986; Goodman and Ittner, 1992) that owners on average overestimate the value of their homes. A price index estimated using the coefficients $\lambda_2 \dots \lambda_h$ will not be affected by this overestimate so long as the independent variables are independent of the stochastic term.

2. EFFECTS OF THE MLS AVERAGE PRICE AND ITS TREND ON THE HIFE PRICE.

Basic Specification

One purpose of this study is to determine (a) the extent to which the MLS average price is a proxy for a quality adjusted price index and (b) whether or not the past trend in prices, as indicated by the change in the MLS average price, affects the home owners' estimate. We investigate these issues with a specification which amends (2.4) and (2.5) in two basic ways. First, we replace the price index components, that is, the time dummies and their associated coefficients, with the MLS price average, which we refer to as M. In effect, we treat M as a price index over time. Second, we take account of the possible effect of past changes in prices on home owners' estimates by including price trend variables based on MLS prices. The rationale for the price trend variables is that home owners' estimates are expected to be affected by house price trends. Goodman and Ittner (1992) find that home owners overestimate the value (as given by recent sales price)[2] of their homes on average by six per cent, but overestimation is less if prices have recently risen. Buckley and Steele (1976), in a study comparing Canadian Census data with sales prices a few months later, find results which are remarkably similar to this: homeowners overestimate by five per cent and overestimation is reduced by recent price increases.[3]

More formally, letting $\mathbf{X}_i\boldsymbol{\beta}$ refer to $\beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_k X_{ki}$, our specification amends (2.4) and (2.5) as follows:

$$P_{ti} = e^{\alpha} e^{\mathbf{X}_i\boldsymbol{\beta}} M_{ti}^{\delta_0} \left(\frac{M_{ti}}{M_{t-1,i}}\right)^{\delta_1} \left(\frac{M_{t-1,i}}{M_{t-2,i}}\right)^{\delta_2} \left(\frac{M_{t-2,i}}{M_{t-3,i}}\right)^{\delta_3} e^{u_{ti}+\varepsilon_{ti}} \tag{2.6a}$$

or, in logarithm form

$$\ln P_{ti} = \alpha + \mathbf{X}_i\boldsymbol{\beta} + \delta_0 \ln M_{ti} + \delta_1(\ln M_{ti} - \ln M_{t-1,i}) + \delta_2(\ln M_{t-1,i} - \ln M_{t-2,i}) + \delta_3(\ln M_{t-2,i} - \ln M_{t-3,i}) + u_{ti} + \varepsilon_{ti} \tag{2.6b}$$

This specification says two things. First, a one percent change in the MLS average price, M increases the price of a given home by δ_0 percent. If the MLS average is a pure price index, δ_0 would equal one, that is an increase in the MLS average by 10 per cent would increase the price of the house by 10 per cent. But we wish to allow for the possibility that the MLS average is upward biased as a price index and so we do not constrain δ_0 to be equal to one, but allow it be be less (or more) than one. A slight bias, probably attributable to gradual quality improvement in the stock over time, has been found in Hosios and Pesando (1992) and Goy and Steele (1994). The specification also says that the effects of changes in the MLS price over time on the home owners' estimate are given by δ_1, δ_2, δ_3. If δ_1 for example is -0.08, a rise in the MLS average of ten percent over the past year reduces the home owner's estimate by about 0.8 of a percent; thus a rise in the MLS average over the past year has two effects which are partially offsetting--it tends to increase the home owner's estimate because of the pure price effect, but this is offset in small part by a negative effect through the price trend parameter δ_1.[4]

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[2] The sales price in their study is the price the house sold for within two years after the interview date in 1985, after adjustment for market price changes between the date of estimate and the date of sale.

[3] Buckley and Steele (1976) find a 10 percent increase in market prices in each of the current and previous two years reduces the overestimate by 3.4 per centage points, but this is not statistically significant. Goodman and Ittner find that a an average increase of 10 percent over the three previous years reduces the overestimate by 2.4 percentage points, which is significant at the 5% level.

We also estimate a version of (2.6b) which assumes the effects of the current and lagged price trend variables are the same, i.e it assumes $\delta_1 = \delta_2 = \delta_3$, so that $(\ln M_{ti} - \ln M_{t-1,i})$, $(\ln M_{t-1,i} - \ln M_{t-2,i})$, $(\ln M_{t-2,i} - \ln M_{t-3,i})$ collapse into a single variable, $(\ln M_{ti} - \ln M_{t-3,i})/3$.

Amendments arising from econometric considerations

Because we have only four years of data and because the MLS average price and its changes are the same for all observations in a city in a given year, multicollinearity makes it infeasible to estimate (2.6b) separately for each city. Instead, we estimate (2.6b) for the "national" sample, that is for a sample of all 15 CMAs . To account for the fact that the ratio of the MLS average price to the price of owner-occupied single and semi-detached houses differs from city to city--because for example the MLS average includes more condominiums in Vancouver than it does in London--we add dummy variables for 14 CMAs to the specification. Thus, where $\mathbf{C}_i\boldsymbol{\gamma} = \gamma_1 C_1 + \gamma_2 C_2 + \cdots + \gamma_{14} C_{14}$ and where $C_i = 1$ if the observation is in CMA i, (2.6a) is now

$$P_{ti} = e^{\alpha} e^{\mathbf{C}_i\boldsymbol{\gamma}} e^{\mathbf{X}_i\boldsymbol{\beta}} M_{ti}^{\delta_0} \left(\frac{M_{ti}}{M_{t-1,i}}\right)^{\delta_1} \left(\frac{M_{t-1,i}}{M_{t-2,i}}\right)^{\delta_2} \left(\frac{M_{t-2,i}}{M_{t-3,i}}\right)^{\delta_3} e^{u_{ti} + \varepsilon_{ti}}$$

The specification in logarithm form is

$$\ln P_{ti} = \alpha + \mathbf{C}_i\boldsymbol{\gamma} + \mathbf{X}_i\boldsymbol{\beta} + \delta_0 \ln M_{ti} + \delta_1(\ln M_{ti} - \ln M_{t-1,i}) + \delta_2(\ln M_{t-1,i} - \ln M_{t-2,i}) + \delta_3(\ln M_{t-2,i} - \ln M_{t-3,i}) + u_{ti} + \varepsilon_{ti}$$

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[4] This assumes this parameter is negative.

Next, we deal with the issue of the robustness of the estimated effects in the presence of collinearity. There is some concern that the price trend variables might be collinear with the number of other rooms, city dummy variables or other variables, so that the estimated price trend coefficients might be highly sensitive to small changes in the observations and in the specification.

To allay this concern, we estimate a lower bound for the effects of the price trend variables. We do this as follows. First, we estimate *for each CMA* a regression in which price trend variables are excluded. In this specification the homeowner's estimate is assumed to depend only on the characteristics of the home and the MLS average, and the coefficient of the MLS average is constrained to be one. In effect, the MLS average is assumed to be a quality adjusted price index, and home owners' estimates are assumed not to be affected by price trends. We interpret a residual from these regressions as an indicator of error in the home owner's estimate. More broadly, the residual is the part of the house price that house characteristics and the MLS average cannot explain.

Next we stack the residuals from the 15 CMA regressions and estimate a single regression, to determine the extent to which the price trend variables explain these residuals. If the price trend variables are statistically significant in this regression, this is strong evidence that these variables affect the error in the home owner's estimate.

More formally, for the first step in this estimation, the specification is

$P_{tji} = e^{\alpha_j} e^{\mathbf{X}_i \boldsymbol{\beta}_j} M_{tji} e^{v_{tji}}$ or, equivalently, $\dfrac{P_{tji}}{M_{tji}} = e^{\alpha_j} e^{\mathbf{X}_i \boldsymbol{\beta}_j} e^{v_{tji}}$

or in logarithm form, $\ln P_{tji} - \ln M_{tji} = \alpha_j + \mathbf{X}_i \boldsymbol{\beta}_j + v_{tji}$

where $v_{tji} = u_{tji} + \varepsilon_{tji}$ and where j refers to the jth CMA. Notice that because this specification is estimated CMA by CMA--in contrast to (2.6b) which is not--the characteristics effects are allowed to vary by CMA.

For the second step of the estimation we assume that

$$v_{tji} = \delta_1(\ln M_{tji} - \ln M_{t-1,ji}) + \delta_2(\ln M_{t-1,ji} - \ln M_{t-2,ji}) + \delta_3(\ln M_{t-2,ji} - \ln M_{t-3,ji}) + u_{tji}$$

Because v_{tji} is unobserved we replace it with $\hat{v}_{tji}$ the residual from the step one regression.

3. USING THE DFFITS CRITERION TO DEAL WITH GROSS ERRORS IN HOME OWNERS' ESTIMATES

The estimating equation (2.5) includes a random error term to account for the fact that home owners, in general, will not be able to estimate the value of their home precisely. For ordinary least squares estimation of this equation to be satisfactory , it is important that the random error term be approximately normally distributed. Gross errors--absurdly low or absurdly high estimates--threaten the attainment of this requirement. For this reason we systematically remove outlier observations. Such observations have the potential to greatly affect estimated coefficients used in the computation of index numbers because the least squares criterion makes outliers heavily influential. We call the sample with outliers removed the homogenized sample. We obtain it by first estimating (2.5) (more specifically, the specification seen in Tables 4.2) by CMA using the original sample, edited to remove houses wihout basic facilities (see Chapter 3). We compute the DFFITS residuals and eliminate all those which fail the criterion outlined below. This yields the sample used for all regressions reported in this report (unless specified otherwise).

The DFFITS value for an observation (Belsley, Kuh and Welsch, 1983) is the scaled difference in the fit of the estimated dependent variable (the natural logarithm of price) when the observation is included in the sample used to estimate the regression, as compared to when it is not.

The DFFIT value, formally, is given by

$$\text{DFFIT} = \hat{y}_i - \hat{y}_i(i)$$

where $\hat{y}_i$ is the predicted value of dependent variable (here, natural log of price), for observation i, when observation i is included in the sample used to estimate the regression and $\hat{y}_i(i)$ is the predicted value when observation i is excluded from the sample used to estimate the regression. Suppose, for example, a house is estimated by a depressed owner to be worth much less than its true value. If it were part of the 1991 survey this low value will tend to depress the estimated coefficient of the 1991 dummy variable, which in turn will give a predicted value which is too low for this house (and all others surveyed in 1991). The predicted price for this house will tend to be lower when the house has been used to estimate the hedonic equation than when it has not been used and so the DFFIT will be negative and large.

DFFIT is scaled by the estimated standard deviation of $\hat{y}_i$, $s(i)\sqrt{h_i}$, where h_i is the ith diagonal element of the hat matrix, H, as implicitly defined by $\hat{y} = Hy$ (so that $H = X(X'X)^{-1}X'$ where X is the regressor matrix) and $s(i)$ is the standard error of the regression. Thus,

$$\text{DFFITS} = \frac{\hat{y}_i - \hat{y}_i(i)}{s(i)\sqrt{h_i}}$$

DFFITS may also be expressed (Belsley, Kuh and Welsch, 1980) in terms of the ordinary residual, e_i, or the studentized residual, e_i^*:

$$\text{DFFITS} = \left[\frac{h_i}{1 - h_i}\right]^{\frac{1}{2}} e_i^* = \left[\frac{h_i}{1 - h_i}\right]^{\frac{1}{2}} \frac{e_i}{s(i)\sqrt{1 - h_i}}$$

The cut-off value for DFFITS is based on the facts that the studentized residual has the t distribution under reasonable assumptions and the average value of h_i is k/n where k is the number of regressors and n is the sample size (Welsch, 1980). For the 5 per cent significance level, our DFFITS cut-off is $\left[\frac{k}{n - k}\right]^{\frac{1}{2}} t_{.025}$.

CHAPTER 3

THE DATA: SAMPLES, VARIABLE SPECIFICATION AND DESCRIPTION

I. THE BASE SAMPLE

The sample consists of 17,407 household records for the survey years 1990-93 from the Household Income, Facility and Equipment (HIFE) datafiles. All households are owner-occupiers living in single detached or semi detached houses under freehold tenure in one of the 15 Census Metropolitan Areas[1] identified in HIFE. Houses which tend to be at the two extremes of the quantity/quality spectrum--below standard houses and very large ones--have been eliminated. Below standard houses are defined as ones missing certain basic facilities such as a private flush toilet;[2] very large houses are defined as ones with 13 or more rooms or 7 or more bedrooms. In addition, houses identified as outliers in the estimation of the hedonic regression (2.5) are eliminated.[3] The final sample of 17, 407 is called the "homogenized sample," "After DFFITS sample," or, when it is contrasted to the mover subsample, the "all sample."

The accounting of the effect of these eliminations on sample size is as follows. The number of owner-occupied single and semi-detached houses for Canada in the 1990-93 HIFE files is 93,007.[4] Selecting observations which are in the 15 CMAs reduces the sample to 19,182. Eliminating quality extremes reduces the sample by 3.6 per cent to

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[1] The CMAs are sometimes referred to as "cities." In any discussion of the HIFE data, reference to a "city" always relates to the CMA concept.

[2] Specifically, records without at least one private flush toilet (i.e. with no flush or chemical toilet inside dwelling, with a "chemical or other type" toilet, or with toilet shared with another household) were deleted. Other exclusions are records without at least one private bathroom with installed shower or bathtub(i.e. with no such bathroom or with bathroom shared with another household); with no piped hot water; with fuel for piped hot water bottled gas (including propane), wood, or other; with principal heating equipment heating stove or cook stove; with principal heating fuel propane, wood or other. We call the samples after these eliminations the edited sample.

[3] These are, in part, houses whose owner estimates their worth to be very different from their predicted value. The predicted value is obtained by plugging information on the house's characteristics into the hedonic regression (2.5) estimated for the relevant CMA . In effect this procedure assigns to the house's characteristics the shadow prices estimated for houses in the same CMA. See also the discussion in Chapter 2.

[4] This is the number after eliminating about 5,000 houses for which value falls in the "not applicable" category. These are presumably farm dwellings.

18,482. Eliminating outliers based on the DFFITS criterion reduces the sample a further 5.8 per cent to the final sample of 17,407.

2. SPECIFICATION OF VARIABLES

Structure characteristics

The age of the house is included as a continuous variable. This is a constructed variable because HIFE provides only discrete categories, e.g. "constructed 1971 to 1980." Categories are converted to continuous form by assuming a house is built in the middle of the period to which it is assigned, and for the open-ended class, constructed "before 1941," we assume the date is 1920.[5] Both age and age squared are included in the regressions to allow the percentage depreciation rate to change as the house ages; the importance of this is suggested by the fact that detailed data for Kitchener (Goy and Steele, 1993) provide strong evidence that the rate of depreciation is much higher for newer houses than for older ones. In addition, two vintage dummy variables are included. The vintage dummy for the 1970s is included because many houses built in that decade were subsidized under the Assisted Home Ownership Plan and were constrained in value by that program. There is reason to believe that rooms and lots in these houses tend to be small, and the HIFE data do not allow us to control for size directly. The vintage dummy for houses built before 1941 is included because this open-ended class is the last age class in HIFE and covers a very long span of ages, so that the single number representing it in the age variable is apt to be a less than fully adequate characterization.

Room variables in the first instance are the number of bedrooms and the number of other rooms (total rooms minus bedrooms). Both rooms variables are entered in the regressions in the form of a linear spline in order to allow for nonlinearities in their effects. For example, the linear spline specification allows the "price" (more precisely the marginal shadow price) of the fourth or fifth other room to be different from the price of the second or third other room. More precisely, the effect of other rooms on the logarithm of house price is specified to be

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[5] More specifically, the average age of houses surveyed in 1991 and reported built in 1991 to 1990 is assumed to be one. This assumption is made recalling that the survey is undertaken in May and houses built in any year are largely completed in the latter months of the year. Other ages are assigned to be consistent with this. For example for the survey year 1993, the average age of houses built 1981-90 is taken as 7, 1971-80, 17, 1961-70, 27, before 1941, 72; for the survey year 1990, average age of houses built 1986-90 is taken as 2, 1981-85 as 6.5, 1971-80, 14, 1961-70, 24, before 1941, 69.

$$\beta_1*OR + \beta_2*OR4P + \beta_3*OR6P,$$

where OR = number of other rooms

OR4P = number of other rooms minus 3, for houses with 4 or more other rooms; otherwise zero

OR6P = number of other rooms minus 5, for houses with 6 or more other rooms; otherwise zero,

and β_1, β_2, β_3 are unknown parameters. Thus, for example,
if there are 3 other rooms, the (total) effect is $3\beta_1$ so that the effect of the third room is β_1;
if there are 4 other rooms, the effect is $4\beta_1 + \beta_2$; the effect of the fourth room is $\beta_1 + \beta_2$;
if there are 5 other rooms, the effect is $5\beta_1 + 2\beta_2$; the effect of the fifth room is $\beta_1 + \beta_2$;
if there are 6 other rooms, the effect is $6\beta_1 + 3\beta_2 + \beta_3$; the effect of the sixth is $\beta_1+\beta_2+ \beta_3$.

In the case of bedrooms, the effect of the number of rooms on the logarithm of house price is given by $\beta_1*BEDS + \beta_2 *BD3P+ + \beta_3*BD4P$,
where

BEDS = number of bedrooms
BD3P = number of bedrooms minus 2, for houses with 3 or more bedrooms; otherwise zero
BD4P = number of bedrooms minus 3, for houses with 4 or more bedrooms; otherwise zero

This specification allows the shadow price of the third bedroom to be different from that of the second, and the shadow price of the fourth and later bedrooms to be different from that of the third.

The specification for bathrooms is quite detailed, because of the great importance of bathrooms in determining the value of a house. Dummy variables are included for one full bathroom and one washroom, for two full baths, for one bath and two or more washrooms and for at least two full bathrooms and one or more washrooms.[6] Bathrooms add value to a house and also are an indicator of whether substantial renovation has occurred. If a house is old--e.g. built before 1941--the existence of two bathrooms and a washroom suggests that major renovation has occurred.

HIFE contains no variable indicating how recently the kitchen was renovated, or the quality of the kitchen. For this reason we include a dummy variable for an installed dishwasher (installed dishw) on the assumption that a *built-in* dishwasher is a good proxy for the modernity and quality of a kitchen.

We also include a dummy variable for a semi-detached structure,"semi-detached". Two climate control variables included are "central air" for central air conditioning, and "hot w heating" for hot water heating. As a proxy for the existence and size of garage, "no. of cars" indicates the number of automobiles owned by the household. "Major rep need" and "minor rep need" are dummy variables for major and minor repairs needed.

A Proxy for Quality of Neighbourhood

No variable is available in HIFE for the condition of the neighbourhood, but Goy and Steele (1994) find that the incidence of poverty of a neighbourhood has a negative impact on price. As a proxy for the poverty level of the neighbourhood we include a dummy variable taking the value one if the households has income below the poverty line and has a head less than 65 years of age. Heads over 65 are excluded from this category because their current poverty status may be associated with retirement and is likely to be different from what it was at the time they purchased and were paying for their house.

3. CHARACTERISTICS OF SAMPLE HOUSES IN DIFFERENT CITIES

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[6] Strictly, these dummies in terms of HIFE categories are, respectively, as follows: one bathroom (with installed baths or shower), two toilets; two or more bathrooms, two toilets; one bathroom, three or more toilets; two or more bathrooms, three or more toilets. In the text we refer to the number of toilets minus the number of bathrooms as either the number of half bathrooms or the number of washrooms.

Means for selected variables are shown in Table 3.1[7] The mean age in the sample, nationally, is 29 years. Differences in mean age between CMAs reflect differences in construction activity in houses for *owner-occupancy* in recent decades rather than differences in the age of all houses. For almost all CMAs the average age (see also Chart 3.1) is within five years of the Canada average. Houses older than this range are found, surprisingly, in Victoria and Winnipeg-- both western cities which were settled comparatively late-- and in Windsor. Houses outside the range on the new side are found in both Quebec cities. The average house in Quebec is a remarkably new 20 years, reflecting the province's recent surge into home ownership.[8]

The mean number of bedrooms in the sample is just over three, nationally, with Winnipeg and Victoria having notably fewer on average and the two prairie cities having notably more. In the case of other rooms (see also Chart 3.2), Winnipeg houses are again at the small end, but Quebec ones are even smaller, while houses in Kitchener, London, Calgary and Vancouver are relatively big. Houses vary much more in the number of other rooms than in their number of bedrooms: the standard deviation of other rooms is about twice as great as standard deviation of bedrooms, although this contrast is less in western cities than elsewhere.

The luxury feature of at least two bathrooms and at least one washroom is more prevalent in the two prairie cities than elsewhere, and Vancouver also has a high incidence (see Chart 3.3). Semi-detached houses are rare out west but make up 18 per cent of the sample in Toronto and a substantial part of the sample in the two Quebec cities. The incidence of climate control equipment varies greatly across the country, not surprisingly in view of the variations in the cost of heating fuels and the weather. Hot water heating is virtually non-existent in the prairie cities, but 29 per cent of Halifax houses use it. Slightly over half of houses in the Ontario sample are centrally air conditioned, as are a substantial proportion in Montreal and Winnipeg, but few are elsewhere.

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[7] Full details, including standard deviations are given in the appendix, in Table A3.1. It is important to note that in this table and in others, unless indicated, (a) the sample used is the "homogenized" or "all" sample (that is the sample after outliers were eliminated using the 5% DFFITS criterion), and (b)statistics are based on unweighted computation.

[8] Note that the estimated mean age is somewhat distorted by the arbitrary assignment of a an average year of construction to the open ended category "built before 1941" and this distortion means that ages for old cities like Halifax and Quebec are understated relative to relatively young cities like Victoria.

The means of the repair variables (Table 3.2) indicate that a relatively large proportion of houses in the sample in both Quebec cities are in good shape, while a relatively large percentage of houses in Winnipeg and Edmonton are not. This result is consistent with the fact that Quebec houses in the sample are notably newer on average than houses elsewhere. Note that this statistic says nothing about the housing stock *overall* in the various cities, because rental housing is ignored.[9] Because there are no neighbourhood variables, the incidence of household heads who are less than 65 and below the poverty line, is of interest. The higher this incidence, the more sizeable neighbourhoods of poor owners are expected to be. The incidence is low in Kitchener, London and Victoria, and high in three western cities-- Winnipeg, Calgary and Vancouver. Together with the results for repair variables, this suggests that owner-occupied slum housing is more likely to be found out west than in central or eastern Canada, especially in prairie cities. This may be associated with the high proportion of native peoples, whose housing conditions are generally poor, living in the deteriorated core of prairie cities.

4. THE CHARACTERISTICS OF OUTLIER OBSERVATIONS

In order to eliminate observations which are very different from the rest of the sample, we have used the DFFITS criterion to eliminate from the sample any house whose owner estimates its worth to be very different from its value predicted on the basis of our estimated equation.[10] The outliers eliminated in this way account for slightly under six per cent of the edited[11] sample. In Table 3.3 are shown the mean owners' estimates for outlier houses and for the remaining houses. For most cities for most years, outlier houses are gauged by their owners, on average, to be much more valuable than other houses in the sample.[12] This is especially noteworthy because many of the high end houses--ones with 7 or more bedrooms or 13 or more rooms--were edited out of the sample before the DFFITS criterion was applied. For Toronto, in 1993, outliers have a mean estimated value of $343,000 while the remaining houses have a mean of only $251,000. In Montreal, in 1992 the mean value of outliers is over twice the mean value of the remaining houses. In a few instances, however, outliers are on average estimated to be worth much *less*. For example, in 1991, when there was a pronounced fall in prices in Toronto, Kitchener and Hamilton, outlier houses were valued at less than other houses in these three places. In addition, in that year the *number* of outliers in these cities was much greater than for other years; apparently a substantial number of home owners reacted to the price slump by taking an unduly pessimistic view of the value of their home. More generally, a reasonable inference from the relatively large number of outliers in almost all of the CMAs in 1991 is that when prices have recently fallen home owners have a difficult time gauging the value of their home.

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[9] It is also important to note that the incidence of need for major and minor repair will inevitably partially reflect differences in standards from one region to another.

[10] See footnote 2 of this chapter and see Chapter 2, for more details.

The "error" in values for outlier houses is attributable partly to the error home owners make when asked to estimate the value of their home and partly to special features of their house which are not taken into account in the prediction regression. For example, it takes no account of the closeness of a house to the centre of the city, the size of its lot, the size of its rooms, the amenities close by, or whether or not it was recently renovated. The HIFE data set simply does not include information on these attributes.

Table 3.4 reveals the contrasts between outlier houses and other houses in certain characteristics known from the data. The most striking difference is in age. For the national sample, outlier houses are nearly a third older than other houses. For Montreal and Toronto the age contrast is much greater: for Montreal, outlier houses average 38 years and other houses only 21 years. Outlier houses are much more likely to be semi-detached than other houses, but nonetheless have slightly more rooms.

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[11] After houses with unusual characteristics, but before outliers, were removed.

[12] The mean outlier values are based on very few observations in many cases so that the differences are sometimes not statistically significant. Table 3.3 is most useful for the patterns it reveals., rather than for individual differences.

These data suggest that many outliers are old, centrally-located houses which have been renovated. While owners' major errors in estimation undoubtedly accounts for much of the poor ability of the our equations to predict owners' valuation of outlier houses, the incompleteness of the equations clearly accounts for some of it. Centrally located, old, but renovated houses are generally worth far more, in certain cities, than newer houses of the same size located elsewhere.

This analysis indicates some of the advantages of using the DFFITS criterion for removing outliers rather than alternative procedures. Ihlanfeldt and Martinez-Vazquz (1986), like us, find that some expensive properties are badly predicted and they also note that in their American Housing Survey data set, as in HIFE, there is no information for size of lot or distance to the centre of the city. Their method of dealing with this is to include in the hedonic equation household income and other characteristics of the household. A difficulty with this is that our data suggest that it is not expensive properties *in general* which are badly predicted but expensive properties which are old. Further, in some instances outliers are cheap properties.

5.. CHARACTERISTICS OF THE HOUSES OF RECENT MOVERS

There is some presumption (Goodman and Ittner, 1992; Follain and Malpezzi's,1981) that recent movers will be more accurate evaluators of the worth of their houses than owners who have lived in their home for many years. Recent movers will have recent experience in assessing market values in the process of search and purchase of their current house, and in some cases, selling a previous house. For this reason we split the (homogenized) sample into houses with owner-occupants who have lived in them for five and a half years or less and houses with non-mover occupants. Table 3.5 shows the average values of houses in the two groups. In the national (all cities) sample, the values of the houses of movers and non-movers are quite similar, with movers' values above those of nonmovers in 1990 and 1991, virtually the same in 1992 and below in 1993. In Toronto, where house prices fell throughout the period, and in Montreal, there is a general pattern of declining values for movers relative to nonmovers. For Vancouver the pattern is roughly the reverse.

On average, over the period, movers' houses are valued more highly then nonmovers' in most cities, including Toronto, Montreal and Vancouver. The characteristics means shown in Table 3.6 do not unambiguously support this higher valuation. Movers' houses have about the same number of bedrooms although in almost every city they have slightly more other rooms. About the same proportion are centrally air conditioned. A substantially greater proportion have luxury bath facilities, but that is at least partially offset by the fact that a substantially greater proportion are semi-detached. On average, they are much newer, especially in the major CMAs Montreal, Toronto and Vancouver. For example, the average age of non-mover houses is 32 years but just 20 years for movers, in Vancouver. This younger age by itself would tend to support a higher valuation of movers' houses but the results of the hedonic regression in Chapter 4 indicate that in Toronto and Vancouver older houses are worth more than newer ones--presumably because they are more centrally located.

If movers do overstate the value of their house more than nonmovers, this would be consistent with Follain and Malpezzi's (1981) finding that movers value a property with given characteristics more highly than do nonmovers.[13]

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[13] This evidence suggests that one reason huge default rates among recent movers do not occur in price crashes is that they overestimate the value of their houses.

Table 3.1
Means of selected structure characteristics

	Age	Bedrooms	Other rooms	Semi detached	At least 2 full bath, 1 washroom	Hot water heat	CAC
				%	%	%	%
All cities	29.30	3.14	3.91	6.36	17.05	6.14	34.36
Halifax	25.81	3.19	3.98	4.28	12.18	29.32	1.61
Quebec	18.43	3.11	3.30	12.22	1.19	5.43	4.07
Montreal	21.02	3.11	3.77	9.13	8.17	4.73	20.35
Ottawa	28.54	3.24	4.00	7.95	22.16	3.82	47.61
Toronto	31.52	3.26	4.03	18.17	24.89	10.54	58.15
Kitchener	27.78	3.14	4.20	9.74	19.55	3.55	38.95
Hamilton	33.93	3.09	3.87	2.90	12.08	4.83	56.43
St.Catharines	33.30	2.99	3.73	6.31	3.93	7.41	51.77
London	29.92	3.15	4.32	2.74	17.04	4.41	56.73
Windsor	34.55	2.98	3.86	2.16	5.88	3.43	64.93
Winnipeg	34.92	2.90	3.41	6.04	11.12	5.07	48.75
Calgary	25.76	3.33	4.23	4.09	28.45	0.96	4.17
Edmonton	24.36	3.36	3.91	1.89	31.09	1.35	5.26
Vancouver	27.84	3.24	4.20	0.79	30.89	8.20	2.71
Victoria	35.59	2.94	4.00	2.62	23.03	7.49	4.87

Table 3.2
Means of repair/neighbourhood proxy variables

City	In need of major repair	In need of minor repair	Occupant less than 65 and below poverty line
	%	%	%
All cities	8.95	13.58	5.02
Halifax	9.24	13.92	4.42
Quebec	6.96	11.54	5.26
Montreal	6.97	9.78	4.89
Ottawa	7.32	16.86	3.18
Toronto	6.60	13.02	5.33
Kitchener	8.04	11.05	2.47
Hamilton	8.99	12.95	5.02
St.Catharines	7.66	12.69	4.19
London	8.94	13.71	3.10
Windsor	11.24	11.62	5.51
Winnipeg	11.52	18.59	6.33
Calgary	9.29	16.11	8.17
Edmonton	12.27	14.23	5.53
Vancouver	7.77	11.26	6.02
Victoria	10.11	14.79	3.37

Note: Unweighted estimates using "After DFFITS" sample.

Table 3.3

Mean house value by years, for outliers and for homogenized sample

	Sample	1990	1991	1992	1993
Halifax	Outlier	269000	137400	92773	106111
	Homogenized	110406	107422	110742	121070
Quebec	Outlier	146846	138412	132333	103200
	Homogenized	84659	92176	93000	96230
Montreal	Outlier	197614	168290	262789	238724
	Homogenized	128725	128296	130455	126849
Ottawa	Outlier	276917	170120	171200	143508
	Homogenized	177657	164646	179645	177355
Toronto	Outlier	336500	202886	340933	343429
	Homogenized	302359	249758	262813	250997
Kitchener	Outlier	221571	157250	233806	187639
	Homogenized	167993	162264	168749	165586
Hamilton	Outlier	218750	143400	333000	162500
	Homogenized	207576	176347	169688	161326
St.Catharines	Outlier	108000	165574	269667	188957
	Homogenized	133148	127596	135031	128429
London	Outlier	103300	158667	300000	176250
	Homogenized	158020	153528	166175	164898
Windsor	Outlier	200214	130829	195833	137450
	Homogenized	114471	119408	124247	125474
Winnipeg	Outlier	182679	174957	121778	148238
	Homogenized	88083	87516	89137	87292
Calgary	Outlier	228846	198226	314667	158143
	Homogenized	132008	131288	136532	140708
Edmonton	Outlier	152286	181630	162174	121615
	Homogenized	117454	111007	123634	122819
Vancouver	Outlier	294500	269875	290000	203875
	Homogenized	241319	210062	271222	305535
Victoria	Outlier	136238	117667		200000
	Homogenized	172069	168980	220701	237863

Note:
1. Homogenized sample is "After DFFITS" sample. Ouliers are observations removed to create the "After DFFITS" sample.
2. Means are unweighted means.
3. Most outlier samples have very few observations.

Table 3.4
Mean characteristics for sample of outliers only and for sample without outliers, by CMA

		Age	Bedrooms	Other Rooms	Semi detached	Hot water heat	CAC
					%	%	%
All cities	Outlier	38.85	3.04	4.15	10.51	17.58	33.86
	Homogenized	29.30	3.14	3.91	6.36	6.14	34.36
Halifax	Outlier	40.74	2.63	3.94	8.57	20.00	5.71
	Homogenized	25.81	3.19	3.98	4.28	29.32	1.61
Quebec	Outlier	34.36	3.30	3.98	21.28	27.66	8.51
	Homogenized	18.43	3.11	3.30	12.22	5.43	4.07
Montreal	Outlier	37.87	2.97	4.35	25.74	32.67	21.78
	Homogenized	21.02	3.11	3.77	9.13	4.73	20.35
Ottawa	Outlier	41.61	3.27	4.15	13.56	16.95	30.51
	Homogenized	28.54	3.24	4.00	7.95	3.82	47.61
Toronto	Outlier	44.98	2.97	4.17	20.95	16.19	54.29
	Homogenized	31.52	3.26	4.03	18.17	10.54	58.15
Kitchener	Outlier	35.64	2.90	4.21	6.49	12.99	42.86
	Homogenized	27.78	3.14	4.20	9.74	3.55	38.95
Hamilton	Outlier	49.84	2.92	4.52	3.03	16.67	46.97
	Homogenized	33.93	3.09	3.87	2.90	4.83	56.43
St.Catharines	Outlier	41.79	3.18	4.02	7.14	18.37	34.69
	Homogenized	33.30	2.99	3.73	6.31	7.41	51.77
London	Outlier	42.32	2.73	4.30	6.06	12.12	45.45
	Homogenized	29.92	3.15	4.32	2.74	4.41	56.73
Windsor	Outlier	38.15	3.03	3.91	8.05	19.54	58.62
	Homogenized	34.55	2.98	3.86	2.16	3.43	64.93
Winnipeg	Outlier	40.52	2.89	4.06	4.90	15.69	47.06
	Homogenized	34.92	2.90	3.41	6.04	5.07	48.75
Calgary	Outlier	37.59	3.28	4.44	7.50	8.75	23.75
	Homogenized	25.76	3.33	4.23	4.09	0.96	4.17
Edmonton	Outlier	28.64	3.30	4.03	5.49	15.38	16.48
	Homogenized	24.36	3.36	3.91	1.89	1.35	5.26
Vancouver	Outlier	35.03	2.92	3.88	6.06	16.67	18.18
	Homogenized	27.84	3.24	4.20	0.79	8.20	2.71
Victoria	Outlier	29.07	3.18	4.36	3.57	3.57	10.71
	Homogenized	35.59	2.94	4.00	2.62	7.49	4.87

Note: 1. Homogenized sample is "After DFFITS" sample. Outliers are observations removed to create the "After DFFITS" sample.

2. Means are unweighted means.

Table 3.5

Mean home values by year, non-movers and movers

		1990	1991	1992	1993
All cities	Non-movers	157437	141452	158153	165586
	Movers	163484	152494	159400	154825
Halifax	Non-movers	105358	101866	108674	116045
	Movers	117793	118871	115173	126760
Quebec	Non-movers	82199	93465	94295	95609
	Movers	89627	89873	90490	97354
Montreal	Non-movers	122108	123297	125950	126893
	Movers	138069	137416	139304	126760
Ottawa	Non-movers	179019	162141	183034	180258
	Movers	175396	169594	173488	171513
Toronto	Non-movers	298846	246338	261336	249021
	Movers	309678	259448	266830	254854
Kitchener	Non-movers	165793	157205	164365	159072
	Movers	173318	171132	175280	173951
Hamilton	Non-movers	198782	164851	169195	160258
	Movers	223323	201025	171267	164782
St.Catharines	Non-movers	131468	124758	134242	129735
	Movers	136631	134752	137483	124647
London	Non-movers	145415	145665	164699	163505
	Movers	174432	166028	168585	167171
Windsor	Non-movers	109855	113431	119596	120983
	Movers	121499	128444	132446	136700
Winnipeg	Non-movers	85052	86851	91163	86596
	Movers	94291	89233	83992	89000
Calgary	Non-movers	131224	130667	138646	140808
	Movers	133546	132469	131719	140489
Edmonton	Non-movers	118655	108162	122907	120905
	Movers	115228	117994	124970	126990
Vancouver	Non-movers	243781	208145	263473	293525
	Movers	237483	213032	291333	324653
Victoria	Non-movers	180961	165033	222535	240787
	Movers	155175	180921	216664	232643

Note: Unweighted estimates using "After DFFITS" sample.

Table 3.6
Mean characteristics of mover and non-movers

		Age	Bedrooms	Other rooms	Semi detached	2 full bath, 1 washroom	Hot water heat	CAC
					%	%	%	%
All cities	Non-movers	29.30	3.14	3.91	6.36	17.06	6.14	35.36
	Movers	23.81	3.16	4.05	8.46	22.25	5.00	33.81
Halifax	Non-movers	29.65	3.14	3.80	2.35	6.84	33.76	1.07
	Movers	19.37	3.27	4.29	7.53	21.15	21.86	2.51
Quebec	Non-movers	21.52	3.19	3.34	10.91	1.82	7.01	4.42
	Movers	12.59	2.96	3.22	14.71	0.00	2.45	3.43
Montreal	Non-movers	25.07	3.13	3.71	8.64	6.38	5.76	21.65
	Movers	13.81	3.07	3.89	10.02	11.36	2.90	18.04
Ottawa	Non-movers	31.43	3.24	3.96	6.04	18.76	3.75	48.29
	Movers	23.18	3.22	4.08	11.52	28.48	3.94	46.36
Toronto	Non-movers	34.06	3.23	3.99	18.31	21.68	12.18	57.60
	Movers	25.56	3.34	4.12	17.85	32.45	6.69	59.43
Kitchener	Non-movers	31.70	3.11	4.12	7.34	14.80	4.35	38.56
	Movers	21.35	3.19	4.33	13.67	27.35	2.24	39.59
Hamilton	Non-movers	36.75	3.06	3.83	1.77	8.16	5.58	55.65
	Movers	27.03	3.18	3.98	5.67	21.67	3.00	58.33
St.Catharines	Non-movers	34.96	3.00	3.66	4.38	2.68	7.50	51.88
	Movers	29.03	2.98	3.91	11.32	7.16	7.16	51.50
London	Non-movers	32.60	3.09	4.19	2.17	13.41	4.93	55.62
	Movers	25.83	3.23	4.53	3.61	22.59	3.61	58.43
Windsor	Non-movers	38.08	2.97	3.74	1.63	3.49	4.07	63.60
	Movers	28.28	2.99	4.07	3.11	10.14	2.28	67.29
Winnipeg	Non-movers	36.34	2.93	3.39	4.77	10.59	4.53	49.07
	Movers	31.53	2.83	3.46	9.09	12.38	6.38	47.97
Calgary	Non-movers	26.84	3.32	4.14	2.37	25.86	0.83	4.63
	Movers	23.51	3.34	4.43	7.65	33.83	1.23	3.21
Edmonton	Non-movers	25.57	3.35	3.89	1.30	30.29	1.60	5.32
	Movers	21.88	3.40	3.95	3.09	32.72	0.82	5.14
Vancouver	Non-movers	31.98	3.17	4.16	0.68	25.51	7.37	2.59
	Movers	20.50	3.36	4.26	0.97	40.44	9.69	2.91
Victoria	Non-movers	38.30	2.98	3.92	1.09	22.28	8.70	5.98
	Movers	29.59	2.84	4.16	6.02	24.70	4.82	2.41

Note: Unweighted estimates using "After DFFITS" sample.

Chart 3.1

Average age, by CMA

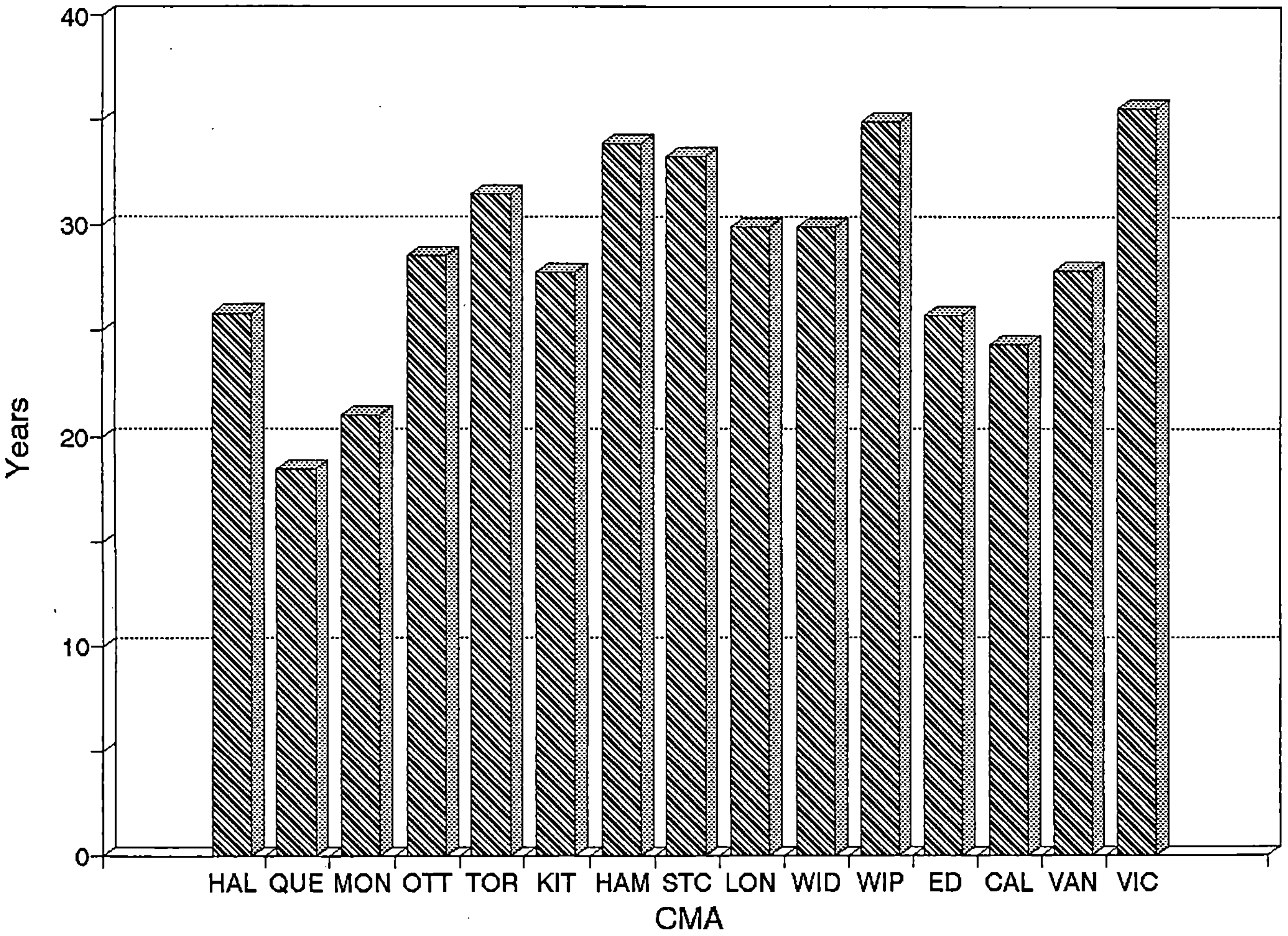


Chart 3.2

Number of other rooms, by CMA

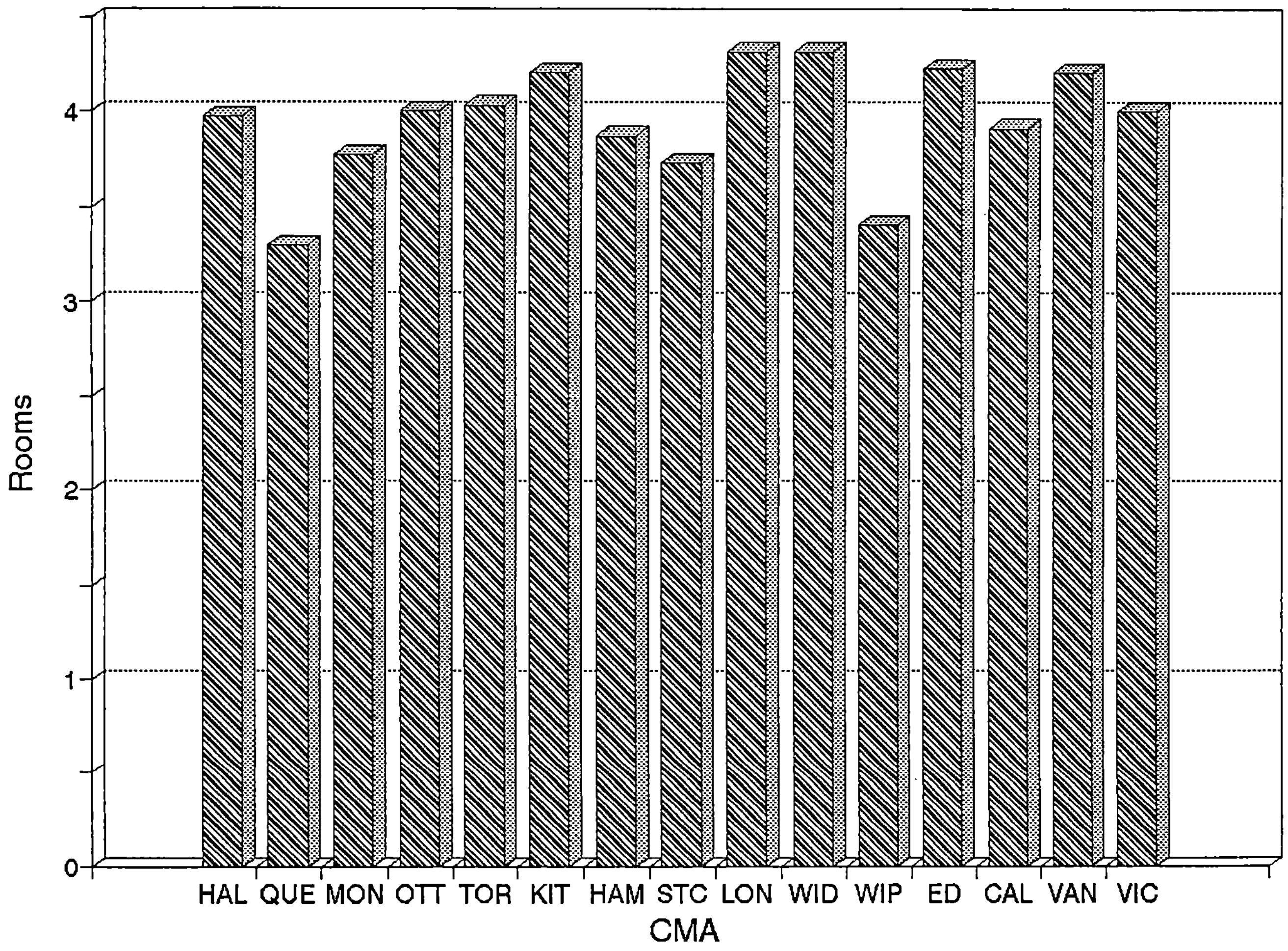
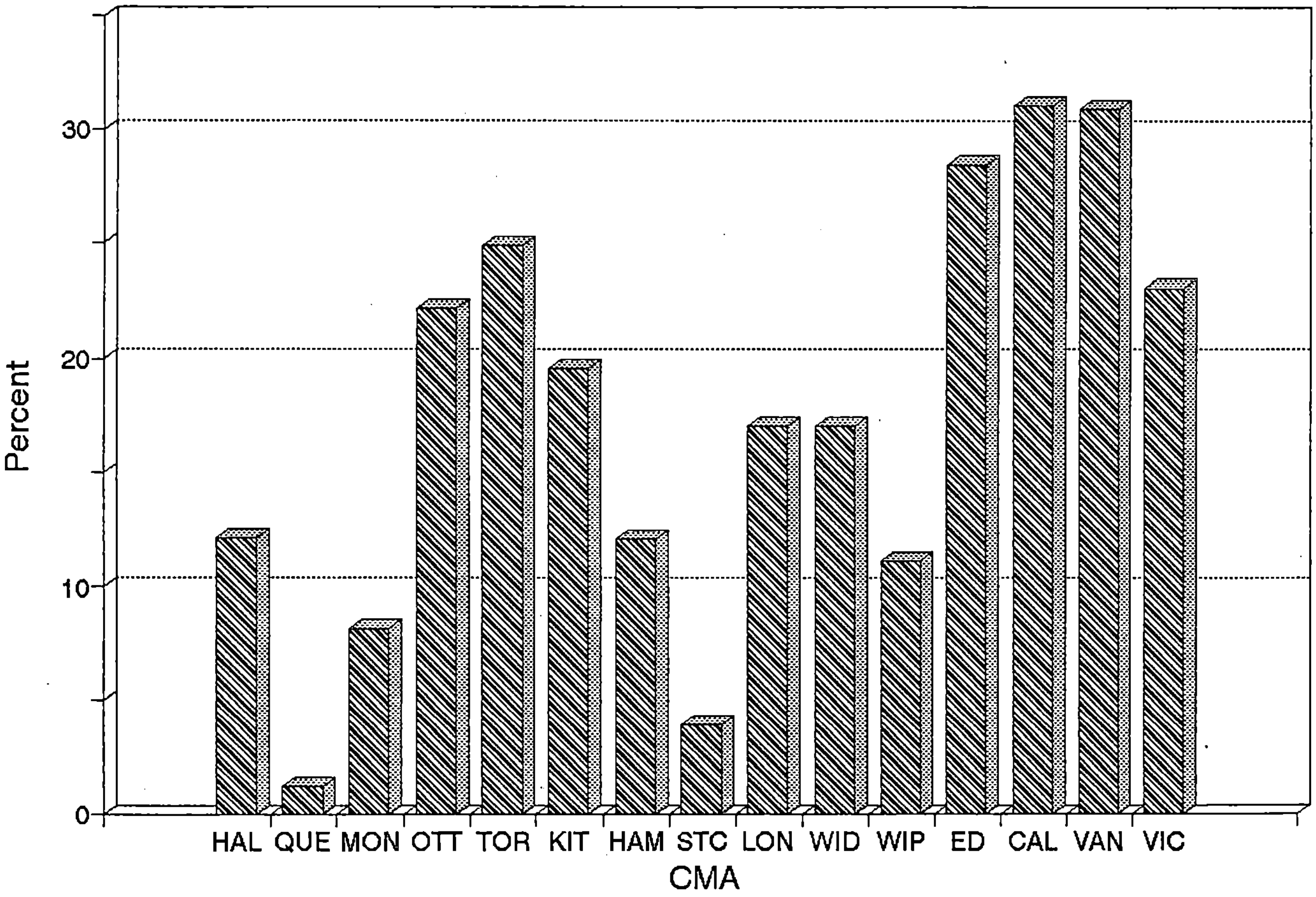


Chart 3.3

Percent of dwellings with at least two bathrooms and a washroom



CHAPTER 4
HEDONIC REGRESSION RESULTS

1. INTRODUCTION

In this chapter we discuss the results of the hedonic regressions using the HIFE data for the "national" sample, for individual cities, for all households and for movers. We then discuss regressions which are designed to reveal the relationship between the MLS average and the HIFE values.

When interpreting the results it is important to make note of three points. The first is about interpretation. The hedonic regressions all use a semi-logarithm specification, one in which the logarithm of the HIFE estimated value is the dependent variable and characteristics and time dummies are independent variables (see also Chapter 2). The estimated coefficient of any characteristics is thus *approximately* its estimated proportional effect on price. For example, suppose we have the very simple regression

$$\ln\hat{P} = 11.7 + 0.13\mathit{BATH2} + 0.06\mathit{ROOMS}$$

where BATH2 is one if a house has two or more bathrooms and zero otherwise, and where ROOMS is the number of rooms. The coefficient of BATH2 tells us that having two or more bathrooms adds about 13 per cent to the value of a house. More specifically and fully, if the house does not have two bathrooms and has seven rooms, the predicted price is $\hat{P} = e^{11.7}e^{(0.06)(7)}$ which is \$183,505; if the house is the same except that it has two bathrooms, its value is given by $\hat{P} = e^{11.7}e^{(0.06)(7)}e^{0.13}$, which is \$208,981 or 1.139 times price of the first house. Thus, having two bathrooms is estimated to add approximately 13 percent (more precisely, 13.9 per cent) to the price of the house.

The second point to note is that the specifications omit variables which importantly affect the price of a house, simply because of data limitations inherent in the HIFE data set. For example, the distance of the house from the centre of the city is omitted, because HIFE does not give this information. These omissions vary in importance depending on the city. The variation in the price of houses because of location is expected to be much greater in larger cities than in smaller ones: in a small city commuting from almost any location is quick so that the premium for close-in houses tends to be slight.

The omission of variables creates biases in estimates of the effects of included variables. Some included variables will tend to be proxies for excluded variables, capturing the effects of these variables as well as their own effects. For example, because old houses were built when the city was younger and smaller, they will usually be located relatively close to the centre. Thus the estimated effect of the *age* of house will partly reflect the effect on price of being *close to the centre*. If an old house is estimated to be worth more than a new house, this may merely reflect the fact that the old house is situated in a prime location.

Another omitted characteristic is whether or not the house has recently undergone a major renovation. This omission will tend to bias upwards the estimated effect of having luxury bathroom facilities such as two bathrooms and a washroom. For example, it is implausible that adding a second full bathroom and a washroom to a house which has only one bathroom would add 40 per cent to the value of the house, taking it from say, \$100,000 to \$140,000. Where we get an estimated effect of this magnitude, it is reasonable to take it as an indication that the additional bathroom facilities are a proxy for renovation or for other quality variables, such as a fireplace, which are absent in HIFE. We will comment further on this aspect in the discussion below.[1]

2. RESULTS FOR THE NATIONAL SAMPLE

The hedonic regression is first estimated for the "national" sample, containing observations for all 15 CMAs. Its $\bar{R}^2$, at 0.693, is quite high for a regression using individual observations; and almost all variables are statistically significant at least at the five per cent level.[2]

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[1] It is also important to note that all samples used in this study, unless specifically indicated, are sample after outliers identified by DFFITS are removed. Outliers were identified using the specification shown in Table 4.2 estimated city by city. That is, the regressions shown in Table 4.2 were run on the original edited sample and outliers were identified city by city on the basis of the 5% DFFITS criterion; the remaining observations, sometimes called the homogenized sample, are used everywhere in this study unless otherwise indicated. See also Chapter 2.

The coefficient of the age of house indicates that the percentage depreciation rate when a house is almost new is about one half a percent, but this rate falls as the house ages; the phenomenon of a faster depreciation of new than old houses was also observed in our detailed study of Kitchener (Goy and Steele, 1994). There is an extra discount of about five percent for houses built in the 1970s when many new houses were targeted at modest income families. The extra discount for old houses--those built before 1941--is only about 3.5 per cent. Note that, starting at age 47, houses are estimated to *appreciate*, not depreciate. As noted earlier, however, age is a proxy for location, so the estimated results are likely the result of the fact that old houses tend to be worth more than newer ones because they are located close to the centre. The positive effect may partially arise, also, from the fact that no variable is available to indicate renovation and the oldest houses may be gentrified ones with attractive architecture-- a "renovated Victorian," for example.

Two characteristics indicating the size of the house--bedrooms and other rooms--are each entered in linear spline form. If the marginal shadow price of a room is constant, only the simple number of rooms would be statistically significant.[3] As can be seen, this is not the case. Additional rooms have a declining marginal effect on price. Each "other room," i.e. room which is not a bedroom, adds over 5 per cent to price, until the fourth and fifth rooms, which are estimated to add only about 4 per cent ($\{e^{0.052-0.010} - 1\} * 100$); the sixth and later rooms are estimated to add only about 1 per cent; a house with six other rooms is estimated to be worth 16 per cent more than a house with only two other rooms. A three bedroom house is estimated to be worth 5.4

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[2] These statistics are substantially better than analogous statistics for regressions run on the sample prior to the removal of outliers using the DFFITS criterion. The removal of outliers here puts into question the classical interpretation of t statistics. But it also does so in studies where outliers are removed in a more ad hoc way. Goodman and Ittner (1992), DiPasquale and Somerville (1993); Ihlanfeldt and Martinez-Vazquz (1986) all remove outliers, using a variety of criteria. It would be inappropriate to use home owners' estimates and not do so.

[3] See Chapter 3 for more detail about the interpretation of the linear splines used here..

per cent more than a two bedroom house; a fourth bedroom adds less to value, 3.7 per cent.

The number of bathrooms and washrooms is estimated to have a very great impact on its price, with a house having two bathrooms estimated to be worth about 13 per cent more than a house with only one bathroom. A house with at least two bathrooms and a washroom is estimated to be worth a whopping 36 per cent more than than a house with only one bathroom. These impacts are so large that it is clear than this variable is to some extent acting as a proxy for excluded quality variables.

Central air conditioning and an installed dishwasher both are highly significant variables and each add about 8 per cent to value. An installed dishwasher adds about as much to value as does a washroom (i.e. a half bathroom), a result consistent with the view that an installed dishwasher is an indicator of a high quality in a kitchen or its recent renovation.

The need-for-repair variables have a negative effect, as expected, with the need for major repairs having about twice the impact on value as the need for minor repairs. The poverty variable also has a negative effect, indicating a discount of 5 per cent. The number of cars owned by the household, a proxy for garage spaces, indicates that a house where there are two cars is worth about 3 per cent more than where there is only one. This is much less than the estimated effect of a garage in most studies, so that the proxy is clearly picking up only part of the effect of a garage.

The city effects indicate the estimated price of a house in a city relative to the default, or base city London, Ontario. Houses in Winnipeg are estimated to be the cheapest, at 39 per cent below the London price; and houses in Toronto and Vancouver are estimated to be the most expensive, at 65 per cent and 52 per cent, respectively, above the London price. Note, however, that the estimation assumes that price increases over time are the same for all cities and that is clearly far from the truth in this period.

The time dummy effect indicate that for the "national" sample prices are estimated to have fallen by about 7 per cent in 1991, with a recovery by 1993 to a mere one per cent below the 1990 price.

Results for Movers in the National Sample

There is a case for the view that recent movers are in a position to estimate the value of their home more precisely than nonmovers. On these grounds the hedonic regression is estimated on a sample which is confined to those who have moved to their house within the last 5 and 1/2 years. As Table 4.1 shows, movers amount to one-third of the "all" sample. Corroborating somewhat the view that movers estimate values more precisely, the $\bar{R}^2$, at 0.714, is a little higher than in the "all" regression.

The coefficient estimates for movers are in general reassuringly like those for the total sample. The detectable differences mostly have to do with newness--recent movers, whose houses are in fact on average substantially newer, think newness is worth somewhat more. First, movers implicitly estimate the depreciation rate for a new house at more than 0.6 per cent in contrast to the all-sample's rate of less than 0.5 per cent. Second, movers place a higher value on central air conditioning and on an installed dishwasher (an indicator of a renovated kitchen). Despite the fact movers' houses are substantially more likely than those of non-movers to have at least two bathrooms and a washroom, the estimated shadow price of this is essentially the same in the two samples. Movers discount value less for a house in need of major repair, however. Their estimates imply a slightly smaller drop in the price index in 1991 relative to 1990 than in the full sample regression. Both samples imply a recovery in 1992 and essentially no change in 1993, yielding an estimated price in 1993 only slightly less than that in 1990.

3. HEDONIC RESULTS BY CITY

The Three Biggest CMAs : Montreal, Toronto and Vancouver

For two major fundamental variables the estimated effects for Montreal are distinctly different from those for Toronto and Vancouver (see Table 4.2). The estimated depreciation rate is much greater in Montreal. For new houses it is more than 1 per cent in Montreal and less than a third that rate in Toronto and Vancouver, although *movers* in both the latter cities implicitly estimate depreciation to be much closer to the Montreal rate. A more complete picture of age and vintage effects is given in Charts 4.1a to

4.1e. These charts show age and vintage effects assuming the survey year is 1990[4]. It can be seen that in Montreal older houses are estimated to be worth less than new ones for the whole range of years (1 to 75 years of age), while old houses in Toronto and Vancouver--those built in the 1920s and earlier--are worth *more* than new ones. All three cities show houses built in the 1970s (and therefore quite likely to be subsidized under AHOP) to be worth less than those built just before or after. The second vintage variable, built before 1941--included in the specification because of the limitations of the HIFE year built classifications-- has a large negative effect in Montreal.

The positive depreciation rates estimated here for old houses in Toronto and Vancouver cannot be taken at face value. True physical depreciation rates are likely greater than even the Montreal estimates. The values estimated here suggest that old houses are located in neighbourhoods close to the core which are more valuable relative to suburban locations in Toronto and Vancouver than in Montreal. It is also possible that the estimates in Toronto and Vancouver reflect a high rate of renovation and gentrification. In Montreal owner-occupied housing is remarkably new, on average, which suggests that the few old owner-occupied houses located in core areas may not be concentrated enough to make desirable enclaves, and instead may be scattered among rental properties with negative externalities.

An increase in the number of "other" rooms has far more effect on value in Montreal than in Toronto and Vancouver (see Charts 4.2a, b, e). The average number of other rooms is markedly lower in Montreal than in these two cities. Perhaps four or five other rooms is more strongly associated with extra quality when relatively few houses are this large. In any case, a house with six other rooms is estimated to be worth close to about 28 per cent more than one with only two other rooms in Montreal (it is worth only about 14 per cent more in Toronto and about 9 per cent more in Vancouver). This implies that a *large* old house in Montreal would be worth far more than a *small* new one, because the negative age effect would be more than outweighed by the positive size effect. Luxury features, in particular two bathrooms and a washroom or more, central air conditioning and an installed dishwasher, are all estimated to be worth more in Montreal than Toronto (see Chart 4.3). In Vancouver, of this list only luxury bathroom facilities have a substantial positive effect.

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[4] The survey year has to be specified because the charted effect includes both age and vintage effects. For example, the age of a house in 1990, which was built in the 1970s (so that the 1970s vintage dummy variable is one), is different from the age of a house in 1993 which was built in the 1970s.

Halifax

Halifax estimates indicate a depreciation rate of about 0.8 per cent for almost new houses, substantially more than for the national sample, but this rate quickly falls so that the maximum estimated discount for accumulated depreciation (inclusive of vintage effects) is only about 20 per cent (see Chart 4.1a). Halifax has the largest negative effect of any city for houses built before 1941 (about 25 per cent) and this estimate, like that for the depreciation rate of new houses is robust to a change in sample to recent movers only. Gentrification and the advantages of living close to the core are evidently not as strong factors in Halifax as elsewhere. The number of bedrooms does not have a statistically significant effect, but the number of other rooms does, with the value of an additional room falling off substantially after three other rooms are attained. Perhaps because in Halifax relatively fewer dwellings than in other cities have luxury amenities, their estimated worth is greater. This is true of bathroom facilities--although less so for movers--and for air conditioning and an installed dishwasher. Houses needing major repairs are much more heavily discounted in Halifax than elsewhere, especially by movers, and houses occupied by household heads less than 65 but with an income below the poverty level are also heavily discounted. In sum, the worth of an old house needing major repairs, with only one bathroom, with few rooms in addition to bedrooms, with no installed dishwasher and occupied by an owner living with an income below the poverty line is estimated in Halifax to be worth much less relative to a new house in good repair, especially one with luxury amenities, than in most other cities.

Quebec

In Québec the size of houses, as indicated by the number of other rooms, has much less effect than in Halifax and Montreal, except for very large houses, those with six or more other rooms. The number of bedrooms has little effect. The dummy variable for houses built before 1941 has an implausibly large estimated positive effect for Québec, yielding the unconvincing age and vintage effects graph shown in Chart 4.1a. On the basis of the more plausible results of the mover regression, the Québec depreciation rate is higher than that in Halifax for almost new houses, at 1.3 per cent, and in fact is very similar to that in Montreal. The high rates are probably associated with the massive subsidy programs for first-time home owners in the province of Québec in the 1980s. The average age of houses for recent movers in the City of Québec is a remarkably low 13 years (as compared to 24 years for all city movers).

Unlike in Halifax, old houses (built before 1941) in need of major repair are estimated to be relatively valuable, but houses occupied by those below the poverty line carry a much larger discount than in most other cities. As for Montreal, in Québec luxury bathroom facilities apparently take a back seat to luxury kitchen facilities, with remarkably few having at least two bathrooms and a washroom[5] while remarkably many have an installed dishwasher; the hedonic estimates indicate however that *both* facilities are valued more than in other cities.

Ottawa

In Ottawa, where the variance in the number of other rooms is low relative to that in other cities, the number of bedrooms has larger estimated effects than the number of other rooms.[6] The discount for a semi-detached house is large, about 16 per cent, as is typical of the smaller Ontario CMAs. Ottawa is unique among the CMAs for its estimated "depreciation" pattern--houses are estimated to *appreciate* with age at all ages, even when they are relatively new. This is consistent with a location premium for close-in areas and, perhaps, declining unmeasured quality in the newest houses. Ottawa houses are relatively high quality. They have a much higher proportion of houses with luxury bathroom facilities than any other city east of Calgary except Toronto, and a higher proportion than any other Ontario city of luxury kitchen facilities as indicated by an installed dishwasher. But perhaps because of their relative ubiquity these facilities are not as strong indicators of high value as in most other cities.

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[5] Although many have two bathrooms. Specifically, for all 15 CMAs together and for Quebec, 28 per cent of houses have two bathrooms, but for all CMAs together 17 per cent have at least two bathrooms plus a washroom, while for Québec only 1 per cent have.

[6] Few of the linear spline variables for other rooms and bedrooms reach statistical significance, however.

Kitchener, Hamilton, St. Catharines and Windsor

Kitchener, Hamilton and St. Catharines-Niagara and Windsor are medium-sized CMAs all located in southern Ontario and so it is not surprising that their hedonic coefficients differ rather little. The first three have an estimated depreciation rate for new houses which is about the national average; Windsor has a substantially higher rate. Unlike Toronto, Ottawa and Vancouver, old houses in these cities are not estimated to be worth more than brand new ones. This is consistent with the relatively easy access to the core in smaller places. Old houses in Windsor are discounted more than in almost any other city. In all four cities the discount for a semi-detached house is large, and the premium for luxury bathroom facilities is large and close to the effect estimated in the national sample. Central air conditioning has a large impact on value in Windsor, especially in the mover regression. The need for major repairs is estimated to have virtually no effect on value in the first two cities, a smaller effect than in the national sample in St. Catharines-Niagara, but a larger effect in Windsor. The slight effect in the first two cities--and in Toronto and Ottawa--on the face of it is puzzling. It may be that the need for repairs is in most cities important not so much for its direct effect on value but as a neighbourhood proxy. If so, this suggests that the need for major repairs is a good proxy for a decaying neighbourhood in Windsor, but not in the other Ontario cities.

London

London houses are the largest of those in any CMA in Ontario and points east, using the number of rooms as the measuring stick. A higher valuation is put on size in London than in most other cities.. As can be seen in Chart 4.2c, a house with five other rooms is worth about 20 per cent more than a house with only two other rooms. The depreciation rate is about the same for new houses as in other CMAs in southwestern Ontario, but it declines more rapidly than in most places, so that 40 year old houses are substantially closer to the value of new houses in London than in those cities. Other indications suggest the relative absence of negative neighbourhood effects. For example, the need-for-repair variables have an estimated *positive* (but not statistically significant) effect. The premium placed on indicators of high quality and renovation--luxury bathroom facilities and an installed dishwasher--are notably high in London.

Winnipeg

Winnipeg houses are the smallest of those in any of the 15 CMAs; larger houses are are also estimated to be worth not much more than small ones (see Chart 4.2d) so that there is apparently little investment incentive to enlarge the existing stock. Winnipeg houses are in remarkably poor condition: it is surprising that so many owner-occupied houses are in need of repair-- 12 percent are in need of major repair and 19 per cent are in need of minor repair, an incidence far above that in the national sample rates. The effects of these need-for-repair variables, and the poverty variable, are all substantial and statistically significant. This together with the high estimated depreciation of old houses tells us that old houses in need of repair in poor areas are heavily discounted in Winnipeg; this suggests houses in the core in Winnipeg are worth far less relative to houses on the edge of the city than in most other CMAs.

Calgary and Edmonton

Owner-occupied houses in Calgary and Edmonton, in vivid contrast to those in

Winnipeg, are far above the national average in their size and incidence of luxury attributes, and the implicit value of additional other rooms is much higher in these two cities than in Winnipeg. In both cities the age of a house has less impact on value than in Winnipeg. Calgary houses, as they age, hover remarkably closely to the value of new houses (Chart4.1d). Edmonton houses do drop quite substantially in value with age. The need-for-repair and poverty variables have substantial negative effects in both cities, more so in Edmonton than in Calgary. Core location will be worth less in cities like these with uncongested roads to the suburbs and with concentrations of people with poverty problems. Together, the estimated effects suggest that housing in poor neighbourhoods close to the centre is discounted most in Winnipeg, next in Edmonton and least in Calgary.

Victoria

Victoria's estimated pattern of value for different ages is a muted version of that for Vancouver, with the rate of depreciation declining so that houses are estimated to appreciate substantially in value with age, starting at a quite young age. Vancouver and Victoria each have natural constraints on suburban expansion--mountains and water--which tend to make core land, where most old housing is located, relatively valuable. Victoria's housing prices boomed over the 1990-93, rising by more than a third in the single year from May of 1991 to May of 1992 (as indicated by time coefficients). Luxury kitchen facilities (as indicated by the presence of an installed dishwasher) and bath facilities are estimated to have a greater impact on value than for the national sample. On the other hand, Victoria houses are smaller (as indicated by the number of bedrooms and other rooms) on average than in the national sample and an increase in size is estimated, perversely, to have a negative effect when there are few rooms. In Victoria as in Vancouver, estimated size effects are strongly nonlinear with an additional bedroom estimated to be worth far more in large houses than in small. Most of the size variables are not statistically significant, however.

4. THE EXPLANATION PROVIDED BY MLS AVERAGE PRICE AND MLS PRICE TRENDS

To what extent does the MLS average price constitute a substitute for a pure price index in explaining home owners' estimates of the value of their homes over time? Evidence on this question is given by replacing the price index variables (that is, the year dummy variables) with the MLS average price by city. Another question is, to what extent are errors in home owners' valuations affected by price trends over the past few years? Evidence on this is given by including price trend variables in the regression.[7] Because each city has only four different values for the MLS average[8] (and for any price change variable constructed from MLS averages), multicollinearity considerations dictate that that the regressions be estimated using the "national " sample. We allow for city effects in this regression (with London, Ontario as the default city). It is important to do this because the evidence of Chapter 1 indicates that the ratio of the overall average price of houses to the MLS average price varies by city. This ratio is likely to vary for a number of reasons; for example, the MLS average, but not our HIFE sample, includes condominiums, which tend to be relatively cheap, and their weight in the MLS average varies greatly from city to city, so that they will depress the MLS average in some cities, like Vancouver, more than in others, like St. Catharines-Niagara.

The results of the estimation are shown in Table 4.3. As can be seen the $\bar{R}^2$ in the regressions is slightly--but only slightly--greater than in the national regression with time dummies. This is somewhat disappointing, since the MLS average varies by city and year while the year dummies only vary by year, so that we expected the MLS average to be more powerful. Note however, that the MLS average's t statistic is over 20 in both regressions. Note also that the estimated effects of the characteristics are very similar to those in the regression with time dummies, giving us reassurance that the use of the MLS average as a proxy for a pure price index is not distorting the hedonic coefficients. [9]

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[7] A more formal justification of the specifications is given in Chapter 2.

[8] For example, all observations in Hamilton for 1990 have the same value for the MLS average, that is, the 1990 Hamilton MLS average; for Hamilton observations as a whole there are only four possible values of the MLS average, the value in 1990, the value in 1991, the value in 1992 and the value in 1993.

The MLS average price as a proxy for a pure price index, and city effects

The estimated coefficient of ln MLS in the second and third regressions indicates that a one percentage point increase in the MLS average results in an increase in owner's estimated value of 0.9 per cent. The fact that the coefficient is less than one supports the view that the MLS average is slightly upward biased as a pure price index. The city effects indicate that the HIFE price of the stock of single and semi-detached houses, for a given MLS average price, is slightly higher in Ottawa and in Hamilton than in London, but in other cities is lower, especially in Vancouver and other western cities. This is consistent with the differences between HIFE *average* values (not a quality-adjusted HIFE based price index) and MLS averages, shown in the charts of Chapter 1 and in the appendix. There it can be seen that HIFE averages are typically only slightly higher than MLS averages in the western cities, but are much higher for some Ontario cities. The extent of the differences--the HIFE price for a given MLS price is predicted to be about 13 per cent less in Calgary than in London-- suggests that factors in addition to the variation in the importance of condominium sales are important in affecting the relation of the HIFE price to the MLS average. The coverage of high-end houses in the MLS may be greater in western cities than in London, for example and high coverage of expensive houses would increase the MLS average.

Effects of price trends on home owners' estimates

In Table 4.3 are shown two specifications for price trends. In the first specification, recent change and lagged changes are allowed to have different effects on the HIFE price. The first price change variable is the difference between the price in the current year and that in the previous year.[10] This change has a negative estimated effect, but it is not statistically significant. The lack of statistical significance may reflect timing problems in the variable--the HIFE price is the estimated price in May of year t while MLS change is the second quarter year-over-year difference (between year t and year t-1); if home owners take a few months to learn about prices the year-over-year difference should be for the first quarter. The change lagged one year has a small positive and statistically significant effect, and the change lagged two years is negative and very statistically significant. Accepting the view that a home owner's estimate tends to overstate the value of his/her home, this pattern implies that when the MLS average rises home owners at first do not change their overestimate, then they increase it slightly and then reduce it substantially. In sum, over three years home owners do not translate a rise in the MLS average into a rise in the value of their home which is as great as the MLS rise. In the third specification the three price trend variables are combined into one variable by averaging them. The estimated coefficient of this combined variable, -0.247, implies that a average annual percentage increase in the MLS average of 10 per cent over the previous three years will reduce the HIFE estimate relative to the MLS average by about 2.5 per cent. Remarkably, this is almost precisely the size of the effect found by Goodman and Ittner (1992) using recent American data; it is somewhat smaller than the effect found for Canadian data of two decades ago (Steele and Buckley, 1976). We find this convincing evidence that home owners' estimates are somewhat sticky, so that their overestimate of value will be less when prices are rising and more when prices are falling.

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[9] One coefficient which changes quite substantially is the effect of "built before 1941."

To corroborate the effects of price trend variables, we estimate the effects in an alternative way. First we regress the log of the ratio of the HIFE price to the average MLS price on the characteristics of the house, running a separate regression for each city. The residuals from this regression will partially reflect errors in the home owners' estimates. We then pool residuals from all the cities into a single sample and regress them on the price trend variables.[11] The results of this regression are shown in Table 4.3b. They substantially corroborate the results of the earlier regressions. In particular, the regression coefficient of the combined price trend variable is -0.173, indicating a 1.7 per cent decline in a home owners' error if the MLS price rises at an average annual rate of 10 per cent over the preceding three years. Thus the finding of a dampening effect of a rise in prices on home owners' estimates is robust to a change in specification.

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[10] Strictly, change in the logarithm of price.

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[11] This specification is set out formally in Chapter 2.

Table 4.1
Hedonic regressions, national sample

	All		Recent Movers	
	coef.	t-stat	coef.	t-stat
Intercept	11.612	289.12	11.696	165.62
Age	-0.0048	-11.40	-0.0065	-10.14
Age2	0.000051	8.25	0.000074	7.36
Built in 70s	-0.056	-10.05	-0.073	-7.94
Built before 4	-0.035	-2.91	-0.031	-1.45
No.of Other Rm	0.052	8.39	0.033	2.90
No.of OR if 4+	-0.010	-1.30	0.014	1.00
No of OR if 6+	-0.029	-5.10	-0.033	-3.67
No of Bedrms	-0.013	-0.72	-0.030	-0.94
No of B if 3+	0.066	3.33	0.085	2.45
No of B if 4+	-0.017	-2.25	-0.006	-0.49
Semi-detached	-0.140	-16.97	-0.150	-12.26
Bath+washrm	0.084	14.41	0.066	6.43
2 baths	0.123	21.90	0.131	13.32
Bath+2 washrms	0.143	7.88	0.154	5.31
2 baths+washrm	0.304	39.65	0.310	24.57
Central air	0.074	14.82	0.098	11.39
Installed dish	0.077	17.52	0.087	11.61
Hot w heating	0.108	12.80	0.127	8.17
No of cars	0.014	5.76	0.014	3.24
Major rep need	-0.064	-9.22	-0.048	-4.08
Minor rep need	-0.036	-6.29	-0.047	-4.70
Below povl, <65	-0.053	-5.97	-0.046	-3.26
Halifax	-0.320	-24.18	-0.306	-14.69
Quebec	-0.441	-30.87	-0.435	-18.68
Montreal	-0.174	-14.92	-0.157	-8.43
Ottawa	0.096	7.93	0.061	3.15
Toronto	0.502	45.91	0.478	26.96
Kitchener	0.060	5.25	0.052	2.93
Hamilton	0.152	12.80	0.166	8.40
St.Catharines	-0.093	-8.52	-0.094	-5.16
Windsor	-0.218	-19.38	-0.214	-12.07
Winnipeg	-0.499	-46.27	-0.495	-27.99
Calgary	-0.165	-13.95	-0.175	-9.08
Edmonton	-0.289	-25.20	-0.273	-14.74
Vancouver	0.416	34.83	0.376	19.70
Victoria	0.253	17.68	0.262	10.88
1991	-0.068	-12.42	-0.051	-5.58
1992	0.002	0.45	-0.014	-1.55
1993	-0.010	-1.62	-0.015	-1.50
n	17407		5780	
$\overline{R}^2$	0.693		0.715	

Note: The All sample is the "After DFFITS" sample. To obtain this sample, the specification given in Table 4.2 was estimated for each CMA separately using the edited sample (see p3.1 for editing criteria) and outliers were then removed on the basis of the 5 per cent DFFITS. The "After DFFITS" sample is used for all analysis except that in Chapter 1 or except otherwise indicated. The mover sample is a subsample of the After DFFITS sample.

Table 4.2
Estimated hedonic equations for 15 Census Metropolitan Areas

	Halifax			
	All		Movers	
	coeff.	t stat.	coeff.	t stat.
Intercept	10.950	64.76	10.869	27.97
Age	-0.00811	-3.94	-0.0084	-2.99
Age2	0.00019	5.51	0.00018	3.97
Built in 70s	-0.044	-1.76	-0.104	-2.53
Built before 41	-0.294	-4.31	-0.273	-2.63
No.of Other Rms	0.113	3.79	0.050	0.75
No.of OR if 4+	-0.084	-2.24	-0.021	-0.27
No of OR if 6+	-0.010	-0.36	0.004	0.11
No of Bedrms	0.082	1.11	0.226	1.36
No of B if 3+	-0.095	-1.09	-0.271	-1.51
No of B if 4+	0.015	0.41	0.106	1.86
Semi-detached	-0.139	-3.01	-0.164	-3.02
Bath+washrm	0.072	2.76	0.043	1.04
2 baths	0.179	6.10	0.121	2.61
Bath+2 washrms	0.234	2.68	0.152	1.42
≥2 baths+washrm	0.435	11.19	0.345	6.49
Central air	0.332	4.51	0.320	3.61
Installed dishw	0.144	6.68	0.161	4.90
Hot w heating	0.101	4.77	0.145	4.09
No of cars	0.003	0.24	0.032	1.59
Major rep need	-0.105	-3.20	-0.202	-3.66
Minor rep need	-0.029	-1.02	-0.091	-2.02
Below povl,<65	-0.089	-1.93	0.001	0.02
1991	-0.063	-2.50	-0.041	-1.06
1992	-0.064	-2.53	-0.094	-2.42
1993	-0.015	-0.50	-0.040	-0.95
	n	**Adj.R^2**	**n**	**Adj.R^2**
	747	0.489	279	0.585

	Quebec City				Montreal			
	All		Movers		All		Movers	
	coeff.	t stat.	coeff.	t stat.	coeff.	t stat.	coeff.	t stat.
Intercept	11.123	61.98	11.342	35.95	11.204	62.78	11.077	80.34
Age	-0.00408	-2.11	-0.013	-3.47	-0.0115	-6.40	-0.013	-3.32
Age2	-0.000023	-0.72	0.00011	1.73	0.00016	4.15	0.00018	1.79
Built in 70s	-0.044	-2.04	-0.011	-0.23	-0.065	-3.20	-0.070	-1.80
Built before 41	0.237	2.94	0.094	0.57	-0.197	-2.13	-0.321	-1.19
No.of Other Rms	0.039	1.84	-0.005	-0.14	0.121	5.47	0.080	2.18
No.of OR if 4+	-0.012	-0.37	0.046	0.86	-0.088	-3.14	-0.046	-0.98
No of OR if 6+	0.103	3.26	0.110	2.00	0.026	1.09	0.022	0.59
No of Bedrms	0.010	0.11	-0.020	-0.13	0.019	0.22	0.119	3.57
No of B if 3+	0.031	0.31	0.061	0.37	0.064	0.69	0.000	
No of B if 4+	-0.001	-0.02	0.062	1.04	-0.058	-2.03	-0.087	-1.86
Semi-detached	-0.168	-6.01	-0.112	-2.37	-0.051	-1.94	-0.148	-3.57
Bath+washrm	0.086	3.72	0.072	1.70	0.099	4.90	0.136	3.99
2 baths	0.082	3.60	0.142	3.48	0.107	5.14	0.148	4.33
Bath+2 washrms	0.000		0.000		0.335	2.24	0.478	1.90
≥2 baths+washrm	0.431	5.07	0.000		0.396	12.15	0.392	7.81
Central air	0.037	0.83	0.028	0.33	0.114	5.96	0.181	5.31
Installed dishw	0.093	3.99	0.042	1.02	0.073	4.18	0.078	2.63
Hot w heating	0.096	2.37	-0.043	-0.38	0.097	2.75	0.052	0.70
No of cars	-0.001	-0.08	0.013	0.54	0.014	1.40	0.014	0.83
Major rep need	-0.002	-0.07	0.108	1.65	-0.058	-1.97	0.005	0.10
Minor rep need	-0.053	-1.89	-0.025	-0.43	-0.065	-2.55	-0.069	-1.39
Below povl,<65	-0.158	-3.97	-0.110	-1.58	-0.023	-0.67	0.043	0.81
1991	0.050	2.08	0.030	0.69	-0.009	-0.44	-0.032	-0.97
1992	0.098	3.97	0.061	1.38	0.021	1.04	-0.007	-0.20
1993	0.124	4.59	0.085	1.72	-0.028	-1.27	-0.069	-2.01
	n	**Adj.R^2**	**n**	**Adj.R^2**	**n**	**Adj.R^2**	**n**	**Adj.R^2**
	589	0.406	204	0.410	1248	0.410	449	0.527

Table 4.2 (cont'd)

	Ottawa				Toronto			
	All		Movers		All		Movers	
	coeff.	t stat.	coeff.	t stat.	coeff.	t stat.	coeff.	t stat.
Intercept	11.851	68.14	12.073	49.91	12.160	69.22	12.617	31.00
Age	0.0020	1.32	0.0011	0.52	-0.0020	-1.41	-0.0065	-2.71
Age2	0.000018	0.79	0.000020	0.61	0.000065	3.33	0.00015	4.33
Built in 70s	-0.057	-2.49	-0.092	-2.83	-0.081	-4.23	-0.114	-3.49
Built before 41	-0.083	-1.75	-0.094	-1.33	-0.081	-2.28	-0.173	-2.55
No.of Other Rms	0.046	1.76	0.002	0.06	0.002	0.07	-0.051	-0.94
No.of OR if 4+	-0.006	-0.19	0.044	0.90	0.061	1.98	0.140	2.28
No of OR if 6+	-0.037	-1.60	-0.070	-2.17	-0.061	-3.43	-0.082	-2.55
No of Bedrms	-0.157	-1.77	-0.180	-1.36	0.032	0.40	-0.130	-0.69
No of B if 3+	0.225	2.33	0.234	1.60	0.040	0.46	0.200	1.00
No of B if 4+	0.030	1.02	0.053	1.13	-0.014	-0.53	0.011	0.20
Semi-detached	-0.179	-6.85	-0.156	-4.57	-0.115	-6.65	-0.124	-3.83
Bath+washrm	0.127	6.15	0.069	2.04	0.060	2.97	0.073	1.79
2 baths	0.122	5.45	0.065	1.76	0.134	7.12	0.160	4.23
Bath+2 washrms	0.172	3.00	0.160	1.99	0.150	3.08	0.236	2.78
≥2 baths+washrm	0.295	11.23	0.303	7.16	0.334	13.78	0.324	7.19
Central air	0.058	3.79	0.050	2.07	0.075	5.24	0.089	3.31
Installed dishw	0.054	3.39	0.061	2.32	0.066	4.74	0.087	3.33
Hot w heating	0.078	2.09	0.100	1.77	0.116	5.15	0.173	3.44
No of cars	0.009	0.91	0.002	0.13	-0.006	-0.81	-0.004	-0.26
Major rep need	-0.007	-0.25	-0.040	-0.87	-0.041	-1.63	-0.000	-0.00
Minor rep need	-0.053	-2.75	-0.052	-1.72	-0.022	-1.15	-0.025	-0.64
Below povl,<65	-0.074	-1.86	-0.094	-1.49	-0.029	-1.04	-0.060	-1.15
1991	-0.079	-4.04	-0.047	-1.59	-0.189	-10.80	-0.178	-5.27
1992	0.015	0.78	-0.003	-0.10	-0.137	-8.20	-0.153	-4.84
1993	0.004	0.18	0.017	0.53	-0.205	-10.59	-0.258	-7.38
	n	Adj.R^2	n	Adj.R^2	n	Adj.R^2	n	Adj.R^2
	943	0.439	330	0.524	1651	0.417	493	0.499

	Kitchener				Hamilton			
	All		Movers		All		Movers	
	coeff.	t stat.	coeff.	t stat.	coeff.	t stat.	coeff.	t stat.
Intercept	12.142	94.51	12.364	65.75	12.245	88.54	12.273	40.23
Age	-0.00543	-4.85	-0.0075	-4.30	-0.00510	-3.18	-0.0042	-1.60
Age2	0.000047	2.86	0.000065	2.61	0.000013	0.60	0.0000057	0.16
Built in 70s	-0.047	-3.00	-0.060	-2.28	-0.071	-2.71	-0.027	-0.56
Built before 41	-0.008	-0.26	0.026	0.49	0.006	0.15	-0.019	-0.25
No.of Other Rms	-0.010	-0.47	-0.042	-0.96	0.021	0.88	0.007	0.13
No.of OR if 4+	0.051	2.12	0.087	1.80	0.026	0.90	0.068	1.10
No of OR if 6+	-0.042	-2.87	-0.052	-2.27	-0.037	-1.61	-0.054	-1.18
No of Bedrms	-0.090	-1.55	-0.141	-1.88	-0.131	-2.05	-0.167	-1.17
No of B if 3+	0.128	2.01	0.169	1.92	0.211	2.89	0.272	1.68
No of B if 4+	0.032	1.51	0.041	1.13	-0.043	-1.43	-0.074	-1.24
Semi-detached	-0.178	-9.21	-0.180	-6.43	-0.229	-5.11	-0.222	-3.58
Bath+washrm	0.062	4.10	0.065	2.38	0.059	2.84	0.054	1.33
2 baths	0.055	3.49	0.050	1.78	0.066	3.17	0.006	0.14
Bath+2 washrms	0.190	3.41	0.193	2.19	0.196	2.16	0.204	1.79
≥2 baths+washrm	0.309	14.50	0.299	8.69	0.285	8.88	0.294	5.25
Central air	0.034	2.92	0.048	2.47	0.049	3.04	0.070	2.25
Installed dishw	0.088	7.19	0.102	5.29	0.076	4.74	0.075	2.43
Hot w heating	0.091	3.17	0.006	0.11	0.052	1.48	0.014	0.17
No of cars	0.003	0.44	0.001	0.10	0.030	3.24	0.027	1.36
Major rep need	-0.017	-0.84	-0.019	-0.51	-0.014	-0.55	0.055	1.22
Minor rep need	-0.060	-3.50	-0.058	-1.96	0.000	0.02	-0.036	-0.83
Below povl,<65	-0.037	-1.11	0.011	0.19	-0.021	-0.61	-0.061	-0.94
1991	-0.071	-4.50	-0.058	-2.09	-0.169	-8.22	-0.125	-3.51
1992	-0.091	-6.02	-0.114	-4.34	-0.153	-7.46	-0.155	-3.88
1993	-0.121	-7.43	-0.127	-4.58	-0.188	-8.32	-0.159	-3.63
	n	Adj.R^2	n	Adj.R^2	n	Adj.R^2	n	Adj.R^2
	1294	0.586	490	0.650	1035	0.450	300	0.610

	St.Catharines				London			
	All		Movers		All		Movers	
	coeff.	t stat.	coeff.	t stat.	coeff.	t stat.	coeff.	t stat.
Intercept	11.578	98.65	11.609	70.2	11.786	54.98	11.711	34.24
Age	-0.0050	-4.24	-0.0032	-2.005	-0.0068	-4.27	-0.0075	-3.05
Age2	0.000018	1.13	-0.000014	-0.584	0.000091	4.09	0.000076	2.10
Built in 70s	-0.005	-0.28	-0.008	-0.29	-0.046	-2.05	-0.079	-2.31
Built before 41	-0.022	-0.72	0.078	1.562	-0.137	-3.22	0.009	0.12
No.of Other Rms	0.035	2.23	0.026	0.886	0.119	4.08	0.134	2.34
No.of OR if 4+	0.009	0.46	0.023	0.62	-0.082	-2.40	-0.104	-1.61
No of OR if 6+	-0.075	-4.57	-0.068	-2.723	-0.029	-1.43	-0.005	-0.15
No of Bedrms	0.006	0.10	-0.034	-0.433	-0.203	-2.06	-0.174	-1.13
No of B if 3+	0.082	1.35	0.159	1.864	0.264	2.55	0.229	1.39
No of B if 4+	-0.052	-2.46	-0.110	-3.264	-0.007	-0.25	-0.007	-0.14
Semi-detached	-0.197	-8.84	-0.213	-7.282	-0.209	-4.47	-0.194	-3.09
Bath+washrm	0.073	5.09	0.103	4.138	0.050	2.20	0.029	0.75
2 baths	0.116	8.29	0.101	4.205	0.126	5.49	0.100	2.63
Bath+2 washrms	0.361	3.05	0.362	1.994	0.225	2.91	0.192	1.80
≥2 baths+washrm	0.257	8.58	0.300	7.381	0.353	11.40	0.352	6.97
Central air	0.042	3.60	0.078	3.807	0.052	3.18	0.087	3.39
Installed dishw	0.055	4.65	0.041	2.062	0.092	5.44	0.099	3.71
Hot w heating	0.032	1.53	0.094	2.591	0.057	1.54	0.123	1.96
No of cars	0.011	1.56	0.013	1.002	0.018	1.90	0.017	1.20
Major rep need	-0.044	-2.18	-0.011	-0.348	0.038	1.44	0.029	0.73
Minor rep need	-0.043	-2.70	-0.046	-1.659	0.027	1.23	0.041	1.25
Below povl,<65	-0.028	-1.09	-0.001	-0.015	-0.043	-0.99	-0.081	-1.36
1991	-0.040	-2.80	-0.012	-0.515	-0.060	-2.92	-0.057	-1.83
1992	0.033	2.28	0.005	0.199	0.005	0.25	-0.027	-0.85
1993	-0.006	-0.34	-0.027	-0.967	0.002	0.07	-0.015	-0.43
	n	Adj.R^2	n	Adj.R^2	n	Adj.R^2	n	Adj.R^2
	1553	0.431	433	0.568	839	0.545	332	0.633

	Windsor				Winnipeg			
	All		Movers		All		Movers	
	coeff.	t stat.	coeff.	t stat.	coeff.	t stat.	coeff.	t stat.
Intercept	11.421	89.19	11.333	49.98	11.042	139.45	10.953	82.87
Age	-0.008	-6.24	-0.0090	-4.51	-0.005	-3.72	-0.0043	-2.33
Age2	0.000037	1.97	0.000041	1.25	0.0000020	0.12	-0.0000039	-0.14
Built in 70s	-0.063	-2.84	-0.067	-1.84	-0.027	-1.58	0.005	0.20
Built before 41	0.047	1.35	0.074	1.10	-0.030	-0.98	0.052	1.01
No.of Other Rms	0.038	1.89	0.013	0.38	0.037	2.63	0.034	1.41
No.of OR if 4+	-0.002	-0.07	0.036	0.84	0.004	0.19	-0.007	-0.21
No of OR if 6+	-0.011	-0.63	-0.036	-1.34	0.009	0.39	-0.012	-0.34
No of Bedrms	0.014	0.25	0.058	0.54	0.067	2.01	0.089	1.69
No of B if 3+	0.067	1.05	0.033	0.29	0.019	0.48	-0.025	-0.41
No of B if 4+	-0.010	-0.39	0.022	0.51	-0.073	-3.49	-0.046	-1.25
Semi-detached	-0.236	-5.18	-0.245	-3.84	-0.289	-12.08	-0.259	-7.47
Bath+washrm	0.083	4.22	0.039	1.16	0.102	6.52	0.092	3.34
2 baths	0.121	6.63	0.150	5.12	0.103	6.47	0.154	5.58
Bath+2 washrms	0.260	1.86	0.000		0.172	3.46	0.162	2.15
≥2 baths+washrm	0.331	9.96	0.324	7.05	0.236	10.46	0.295	7.80
Central air	0.085	5.49	0.116	4.37	0.031	2.59	0.049	2.24
Installed dishw	0.053	3.57	0.039	1.60	0.114	8.96	0.159	7.54
Hot w heating	0.019	0.52	0.033	0.45	0.161	6.13	0.153	3.63
No of cars	0.021	2.61	0.039	2.72	0.022	3.03	0.029	2.19
Major rep need	-0.065	-3.09	-0.035	-0.99	-0.064	-3.50	-0.001	-0.03
Minor rep need	-0.069	-3.30	-0.005	-0.13	-0.029	-2.05	-0.040	-1.62
Below povl,<65	-0.021	-0.74	-0.063	-1.26	-0.092	-4.03	-0.093	-2.44
1991	0.018	0.97	0.012	0.41	-0.019	-1.22	-0.022	-0.86
1992	0.071	3.85	0.055	1.89	0.034	2.23	-0.008	-0.30
1993	0.098	4.92	0.125	3.84	-0.011	-0.63	0.001	0.03
	n	Adj.R^2	n	Adj.R^2	n	Adj.R^2	n	Adj.R^2
	1343	0.540	483	0.649	1754	0.529	517	0.607

Table 4.2 (cont'd)

	Calgary				Edmonton			
	All		Movers		All		Movers	
	coeff.	t stat.	coeff.	t stat.	coeff.	t stat.	coeff.	t stat.
Intercept	11.348	77.57	11.159	35.38	11.182	72.93	10.965	41.19
Age	-0.0021	-1.01	0.0025	0.74	-0.0060	-3.92	-0.0078	-2.94
Age2	0.000057	1.86	0.0000044	0.09	0.000044	1.77	0.00011	2.20
Built in 70s	-0.053	-2.85	-0.067	-2.26	0.0052	0.34	0.004	0.16
Built before 41	-0.143	-2.29	-0.080	-0.76	0.069	1.19	-0.093	-0.85
No.of Other Rms	0.072	3.13	0.119	2.50	0.092	5.10	0.102	3.00
No.of OR if 4+	-0.040	-1.45	-0.100	-1.78	-0.048	-2.15	-0.052	-1.25
No of OR if 6+	-0.029	-1.64	-0.011	-0.39	-0.006	-0.34	-0.040	-1.31
No of Bedrms	-0.010	-0.16	0.004	0.03	-0.001	-0.02	0.103	0.81
No of B if 3+	0.053	0.74	0.024	0.16	0.101	1.26	-0.002	-0.01
No of B if 4+	-0.011	-0.42	0.000	0.00	-0.094	-4.01	-0.100	-2.44
Semi-detached	-0.207	-6.06	-0.198	-4.34	-0.252	-5.99	-0.267	-4.57
Bath+washrm	0.093	3.79	0.033	0.73	0.022	1.02	0.019	0.51
2 baths	0.079	3.83	0.072	1.96	0.078	4.29	0.064	1.95
Bath+2 washrms	0.176	3.69	0.135	1.53	0.104	2.24	0.094	1.32
≥2 baths+washrm	0.291	11.50	0.277	6.43	0.192	8.81	0.243	6.39
Central air	0.131	3.97	0.098	1.46	0.052	2.06	0.014	0.31
Installed dishw	0.072	4.67	0.097	3.37	0.078	6.18	0.048	2.19
Hot w heating	-0.060	-0.90	0.046	0.43	0.088	1.79	-0.004	-0.04
No of cars	0.005	0.64	-0.003	-0.23	0.023	3.56	0.008	0.66
Major rep need	-0.055	-2.41	-0.047	-1.08	-0.074	-4.07	-0.079	-2.47
Minor rep need	-0.048	-2.63	-0.061	-1.96	-0.044	-2.65	-0.059	-2.10
Below povl,<65	-0.060	-2.49	-0.086	-2.17	-0.067	-2.68	-0.066	-1.85
1991	-0.031	-1.64	-0.045	-1.36	-0.042	-2.64	0.017	0.60
1992	0.044	2.42	0.039	1.16	0.049	3.13	0.059	2.19
1993	0.029	1.43	-0.014	-0.37	0.088	5.18	0.102	3.43
	n	Adj.R^2	n	Adj.R^2	n	Adj.R^2	n	Adj.R^2
	1248	0.365	405	0.383	1482	0.456	486	0.443

	Vancouver				Victoria			
	All		Movers		All		Movers	
	coeff.	t stat.	coeff.	t stat.	coeff.	t stat.	coeff.	t stat.
Intercept	11.850	58.73	11.981	32.49	12.333	64.55	12.312	41.26
Age	-0.0029	-1.33	-0.0072	-2.06	-0.010	-3.34	-0.012	-3.10
Age2	0.00013	3.85	0.00019	2.88	0.00016	4.15	0.00020	3.58
Built in 70s	-0.061	-2.08	-0.041	-0.88	-0.048	-1.23	-0.068	-1.25
Built before 41	-0.087	-1.24	-0.038	-0.24	-0.126	-1.93	-0.231	-2.01
No.of Other Rms	0.014	0.36	-0.043	-0.66	-0.045	-1.02	-0.055	-0.73
No.of OR if 4+	0.023	0.52	0.109	1.41	0.078	1.49	0.083	0.94
No of OR if 6+	-0.042	-1.52	-0.040	-0.88	0.004	0.10	-0.034	-0.63
No of Bedrms	0.077	0.92	0.059	0.38	-0.159	-2.14	-0.171	-1.43
No of B if 3+	-0.154	-1.63	-0.129	-0.73	0.099	1.13	0.026	0.18
No of B if 4+	0.115	3.23	0.114	1.76	0.075	1.61	0.118	1.63
Semi-detached	-0.143	-1.28	-0.187	-1.12	-0.161	-2.01	-0.085	-0.98
Bath+washrm	0.082	2.31	0.037	0.54	0.165	3.83	0.192	2.69
2 baths	0.194	6.32	0.222	4.03	0.207	4.96	0.325	4.73
Bath+2 washrms	0.079	1.17	0.036	0.30	0.106	1.33	0.163	1.02
≥2 baths+washrm	0.420	11.26	0.376	5.78	0.312	6.20	0.359	4.47
Central air	-0.081	-1.35	-0.237	-2.39	0.008	0.14	0.100	0.75
Installed dishw	0.028	1.26	0.047	1.26	0.096	3.29	0.079	1.75
Hot w heating	0.194	5.34	0.261	4.57	0.058	1.18	-0.152	-1.55
No of cars	0.032	2.79	0.052	2.45	0.022	1.40	0.084	2.93
Major rep need	-0.122	-3.29	-0.193	-2.85	-0.037	-0.85	-0.048	-0.67
Minor rep need	-0.004	-0.12	-0.078	-1.41	-0.082	-2.14	-0.032	-0.56
Below povl,<65	0.024	0.57	0.023	0.41	-0.040	-0.57	-0.088	-0.94
1991	-0.171	-6.25	-0.101	-2.29	-0.041	-1.15	0.070	1.24
1992	0.063	2.33	0.109	2.28	0.251	6.99	0.280	5.05
1993	0.161	5.39	0.245	5.24	0.305	7.06	0.351	5.60
	n	Adj.R^2	n	Adj.R^2	n	Adj.R^2	n	Adj.R^2
	1146	0.382	413	0.471	534	0.407	166	0.504

Table 4.3
National sample regressions with and without MLS effects

(a) Dependent variable: log of price

	coef.	t-stat.	coef.	t-stat	coef.	t-stat
Intercept	11.612	289.12	0.840	1.68	0.401	0.81
Age	-0.0048	-11.40	-0.0050	-12.06	-0.0051	-12.34
Age2	0.000051	8.25	0.000054	9.01	0.000056	9.39
Built in 70s	-0.056	-10.05	-0.052	-9.58	-0.054	-10.01
Built before 41	-0.035	-2.91	-0.041	-3.56	-0.048	-4.10
No.of Other Rms	0.052	8.39	0.051	8.31	0.050	8.09
No.of OR if 4+	-0.010	-1.30	-0.009	-1.15	-0.007	-0.96
No of OR if 6+	-0.029	-5.10	-0.030	-5.29	-0.029	-5.07
No of Bedrms	-0.013	-0.72	-0.012	-0.70	-0.012	-0.70
No of B if 3+	0.066	3.33	0.065	3.30	0.064	3.27
No of B if 4+	-0.017	-2.25	-0.017	-2.24	-0.016	-2.19
Semi-detached	-0.140	-16.97	-0.140	-17.21	-0.139	-17.11
Bath+washrm	0.084	14.41	0.083	14.37	0.083	14.49
2 baths	0.123	21.90	0.124	22.16	0.124	22.11
Bath+2 washrms	0.143	7.88	0.139	7.76	0.140	7.83
2 baths+washrm	0.304	39.65	0.300	39.47	0.301	39.51
Central air	0.074	14.82	0.076	15.48	0.076	15.38
Installed dishwsr	0.077	17.52	0.077	17.78	0.077	17.74
Hot w heating	0.108	12.80	0.104	12.45	0.104	12.41
No of cars	0.014	5.76	0.014	5.88	0.014	5.74
Major rep need	-0.064	-9.22	-0.064	-9.27	-0.063	-9.10
Minor rep need	-0.036	-6.29	-0.035	-6.08	-0.034	-5.89
Below povl, <65	-0.053	-5.97	-0.053	-6.06	-0.054	-6.17
Halifax	-0.320	-24.18	-0.053	-2.85	-0.029	-1.58
Quebec	-0.441	-30.87	-0.030	-1.23	-0.004	-0.16
Montreal	-0.174	-14.92	-0.027	-2.02	-0.018	-1.35
Ottawa	0.096	7.93	0.028	2.24	0.032	2.55
Toronto	0.502	45.91	-0.005	-0.17	-0.027	-1.04
Kitchener	0.060	5.25	-0.035	-2.80	-0.042	-3.45
Hamilton	0.152	12.80	0.025	1.86	0.016	1.19
St.Catharines	-0.093	-8.52	-0.072	-6.57	-0.073	-6.67
Windsor	-0.218	-19.38	-0.022	-1.48	-0.009	-0.65
Winnipeg	-0.499	-46.27	-0.081	-3.62	-0.054	-2.44
Calgary	-0.165	-13.95	-0.139	-11.65	-0.132	-11.19
Edmonton	-0.289	-25.20	-0.087	-5.66	-0.070	-4.70
Vancouver	0.416	34.83	-0.112	-4.23	-0.130	-4.91
Victoria	0.253	17.68	-0.010	-0.56	-0.015	-0.83
1991	-0.068	-12.42				
1992	0.002	0.45				
1993	-0.010	-1.62				
log MLS			0.912	21.57	0.949	22.69
log MLS - log MLS(-1)			-0.015	-0.30		
log MLS(-1) - log MLS(-2)			0.068	2.32		
log MLS(-2) - log MLS(-3)			-0.316	-9.93		
(log MLS - log MLS(-3))/3					-0.247	-5.17
n		17407		17407		17407
$\bar{R}^2$		0.693		0.699		0.698

Table 4.3 (cont'd)

b) Residual regression (Dependent variable is the residual defined by (log HIFE price - log MLS) - estimated (log HIFE price - log MLS))

	coef.	t-stat	coef.	t-stat
Intercept			0.008	3.31
log MLS - log MLS(-1)	-0.028	-0.81		
log MLS(-1) - log MLS(-2)	0.075	2.84		
log MLS(-2) - log MLS(-3)	-0.257	-9.49		
(log MLS - log MLS(-3))/3			-0.173	-5.35
n		17407		17407
$\overline{R}^2$		.005		0.002

Chart 4.1a

Effect of age and vintage, by CMA

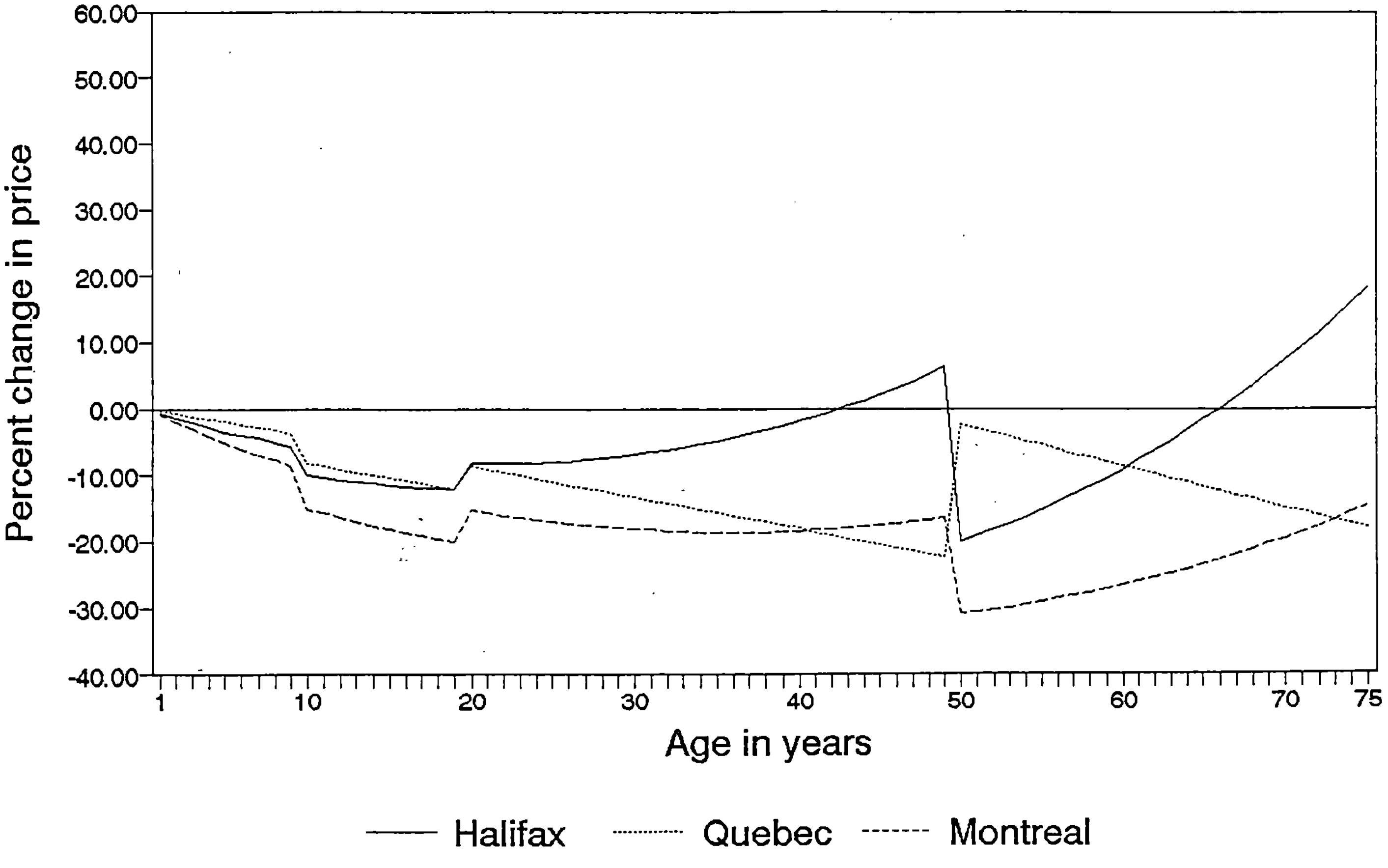


Chart 4.1b

Effect of age and vintage, by CMA

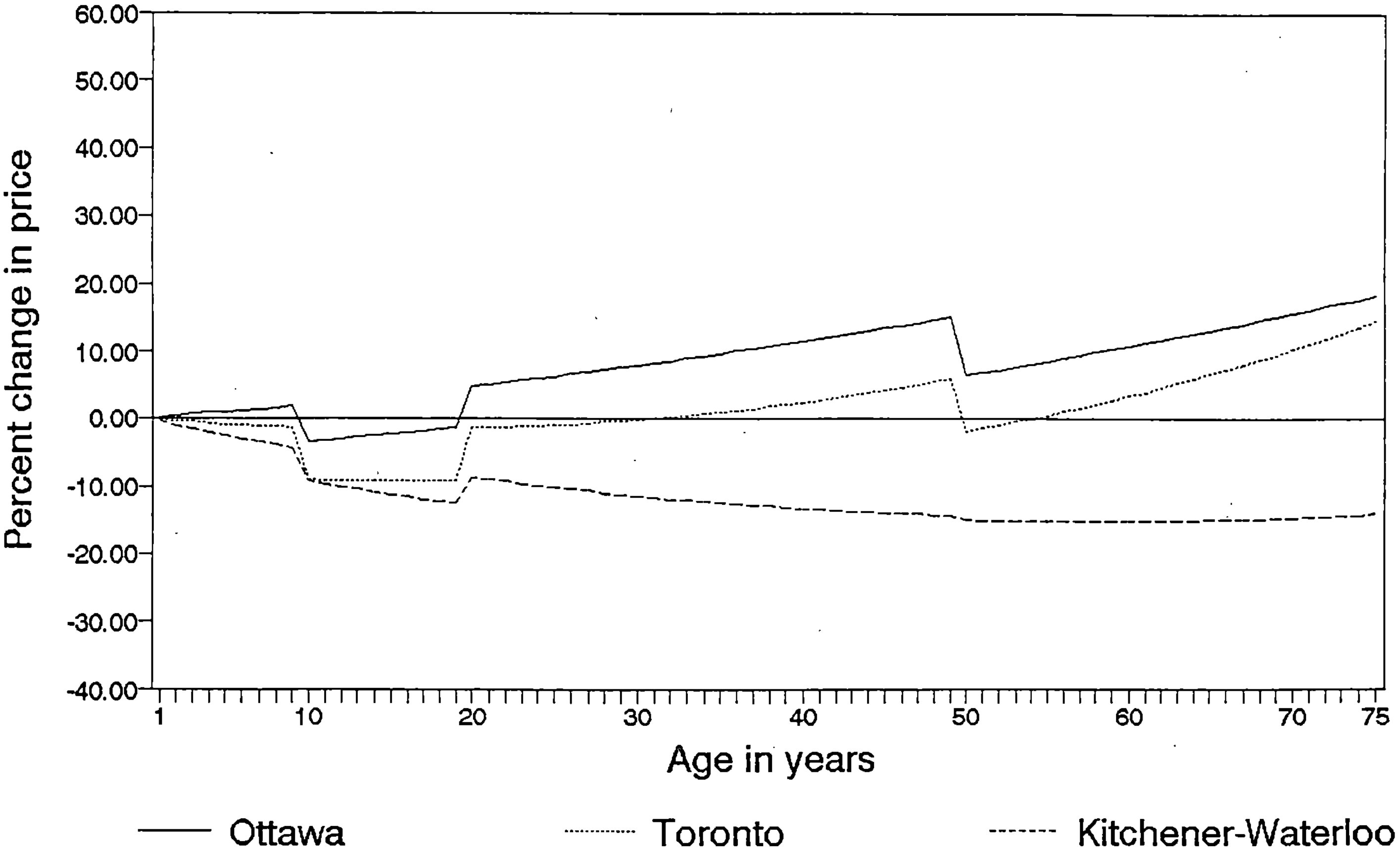


Chart 4.1c

Effect of age and vintage, by CMA

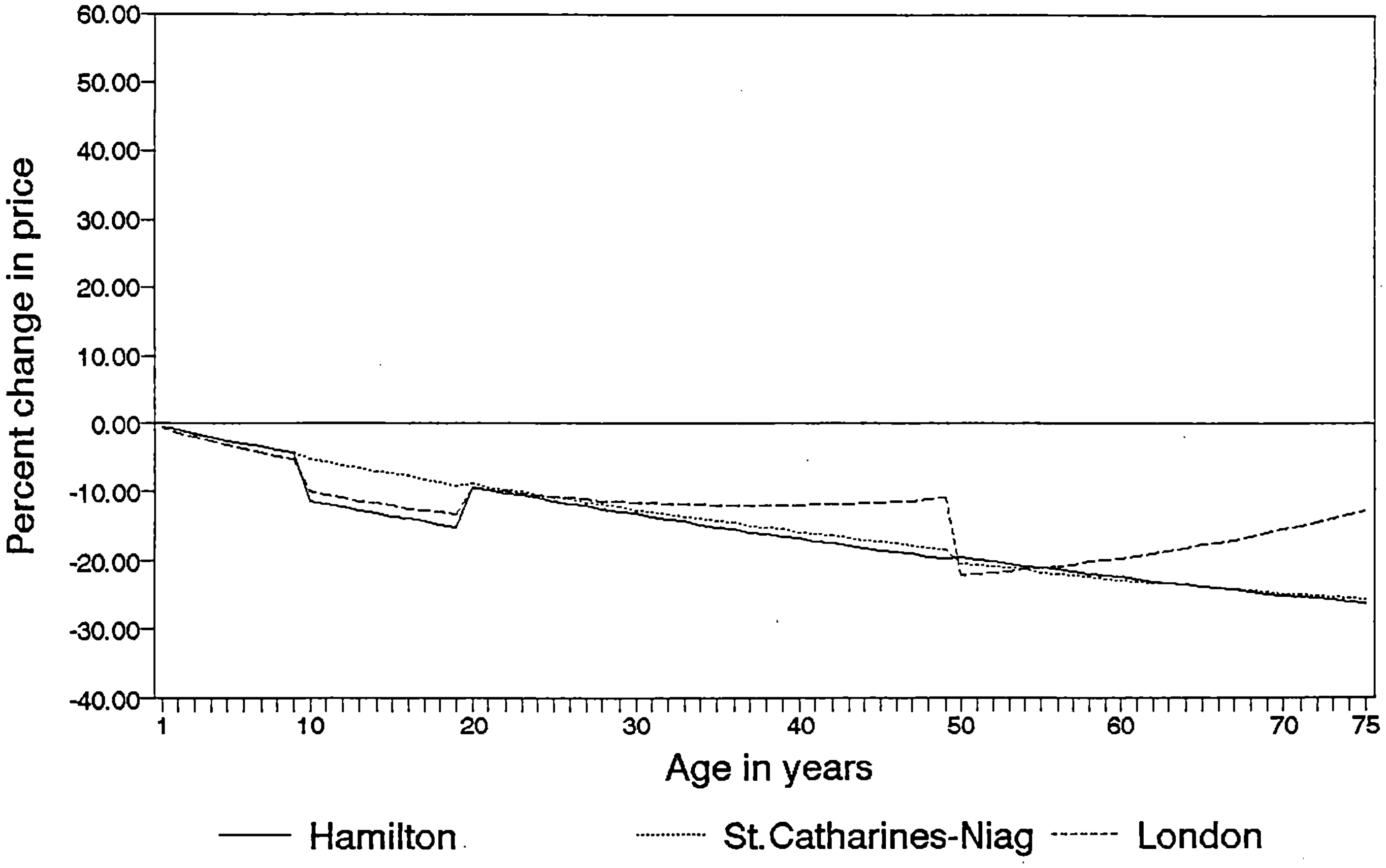


Chart 4.1d

Effect of age and vintage, by CMA

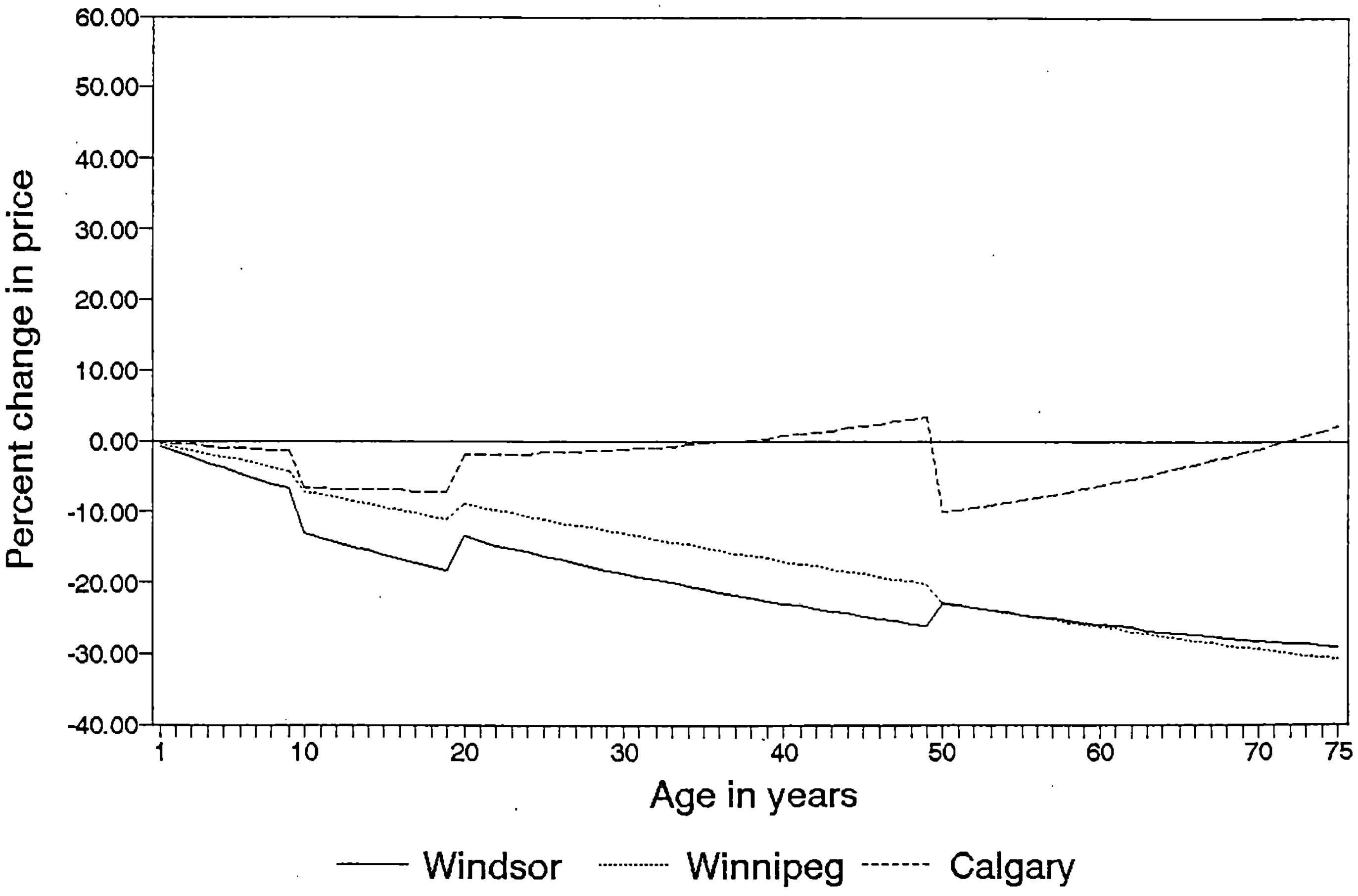


Chart 4.1e

Effect of age and vintage, by CMA

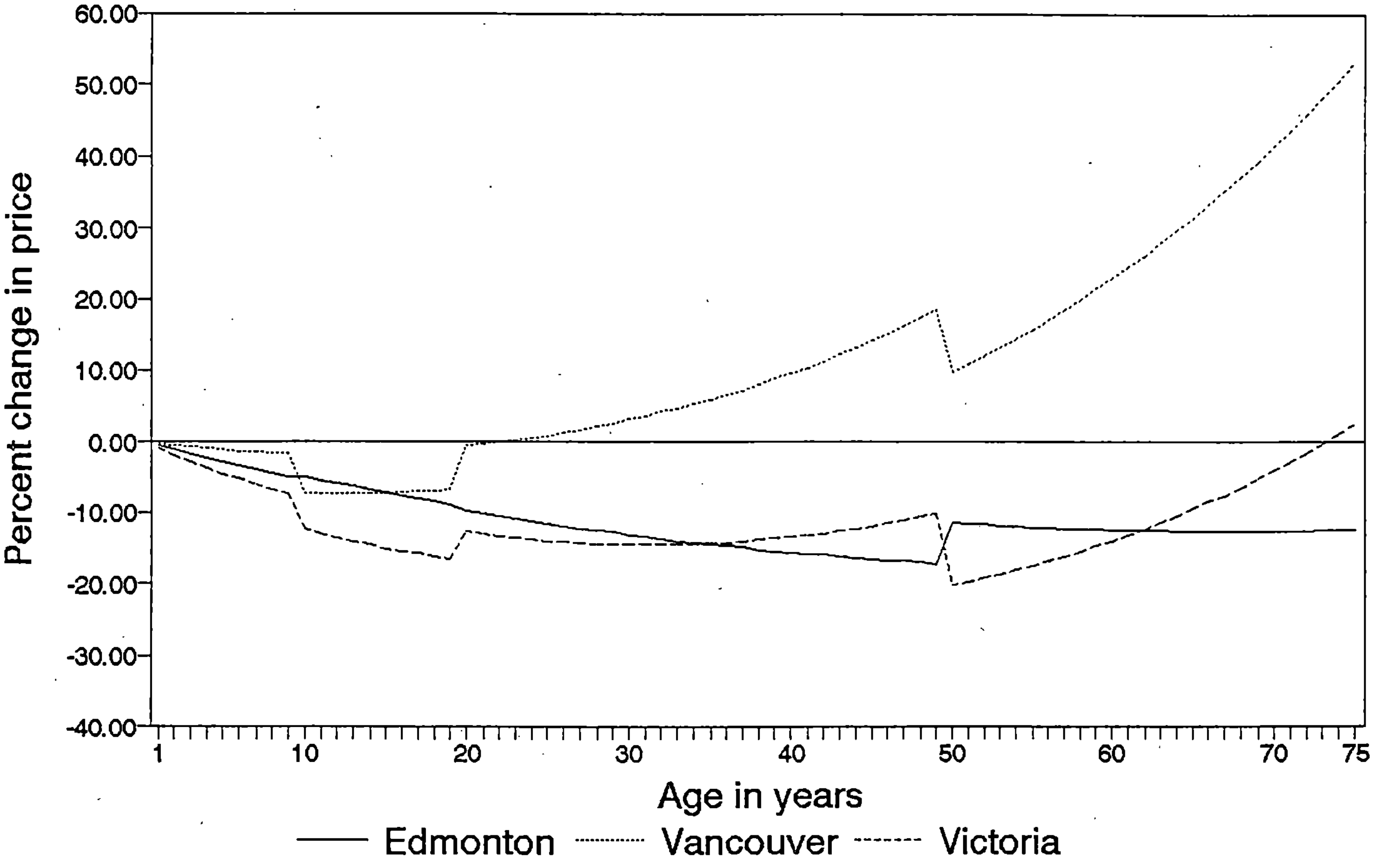
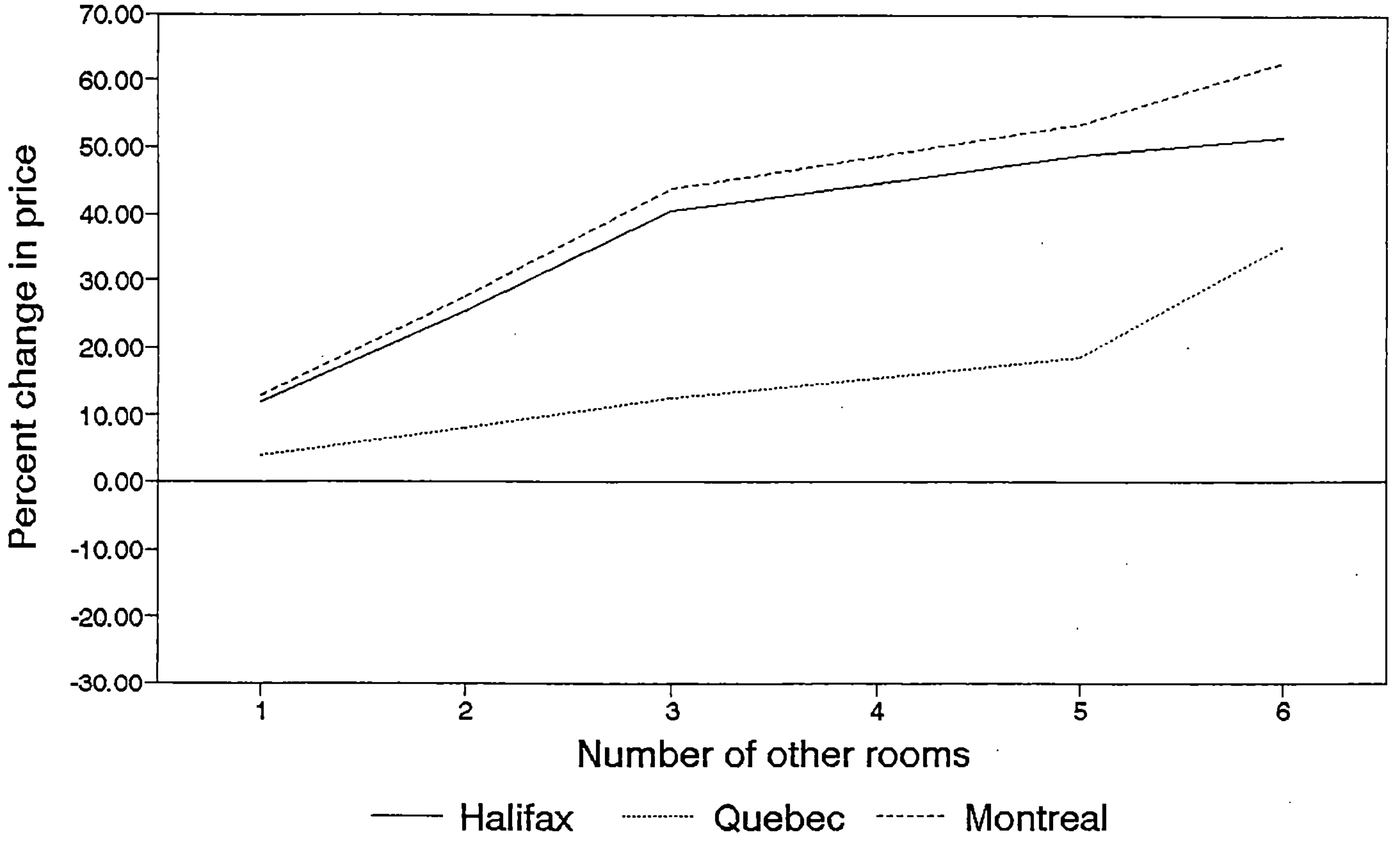


Chart 4.2a

Effect of number of rooms other than bedrooms, by CMA



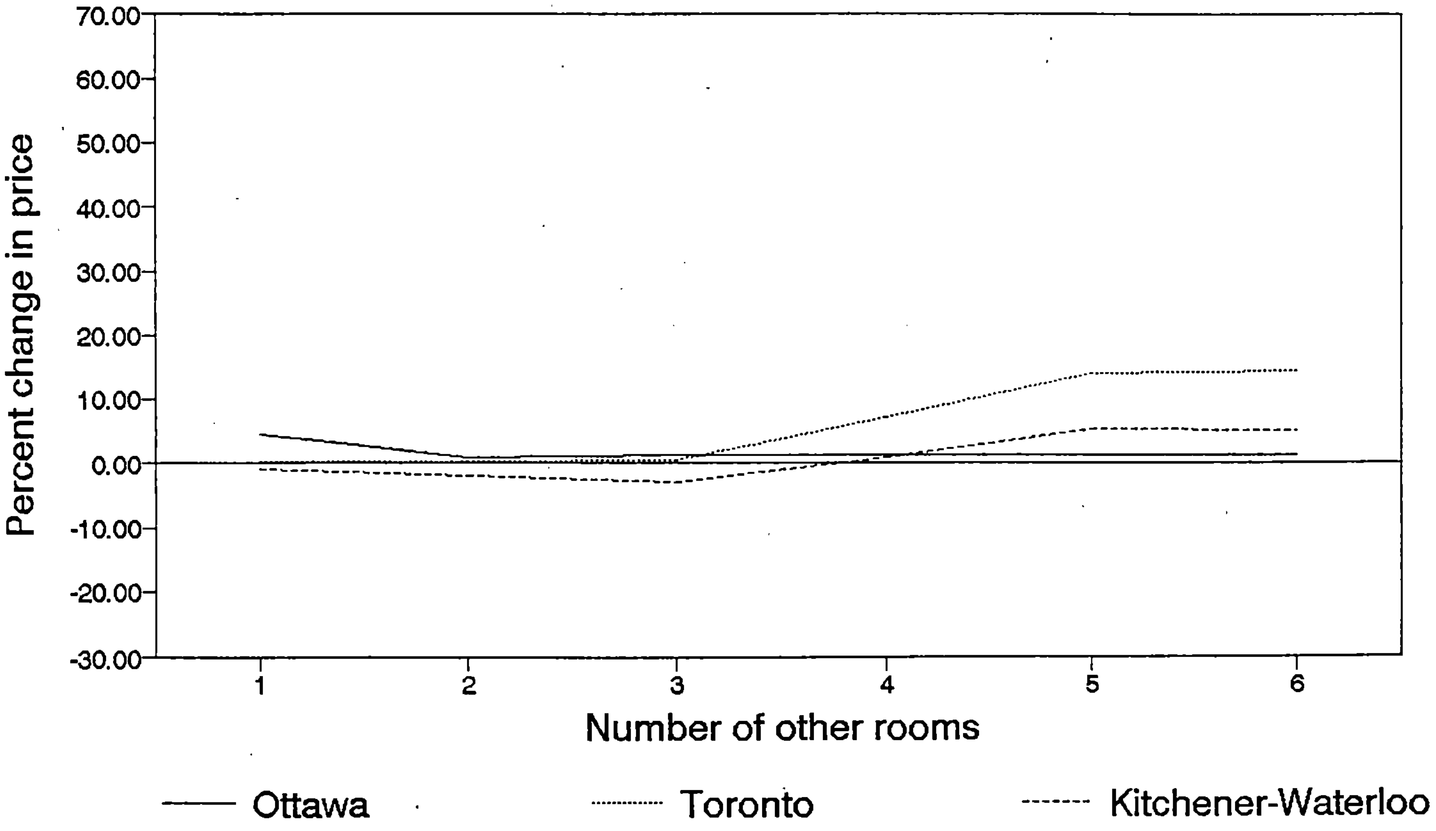


Chart 4.2b

Effect of number of rooms other than bedrooms, by CMA

Chart 4.2c

Effect of number of rooms other than bedrooms, by CMA

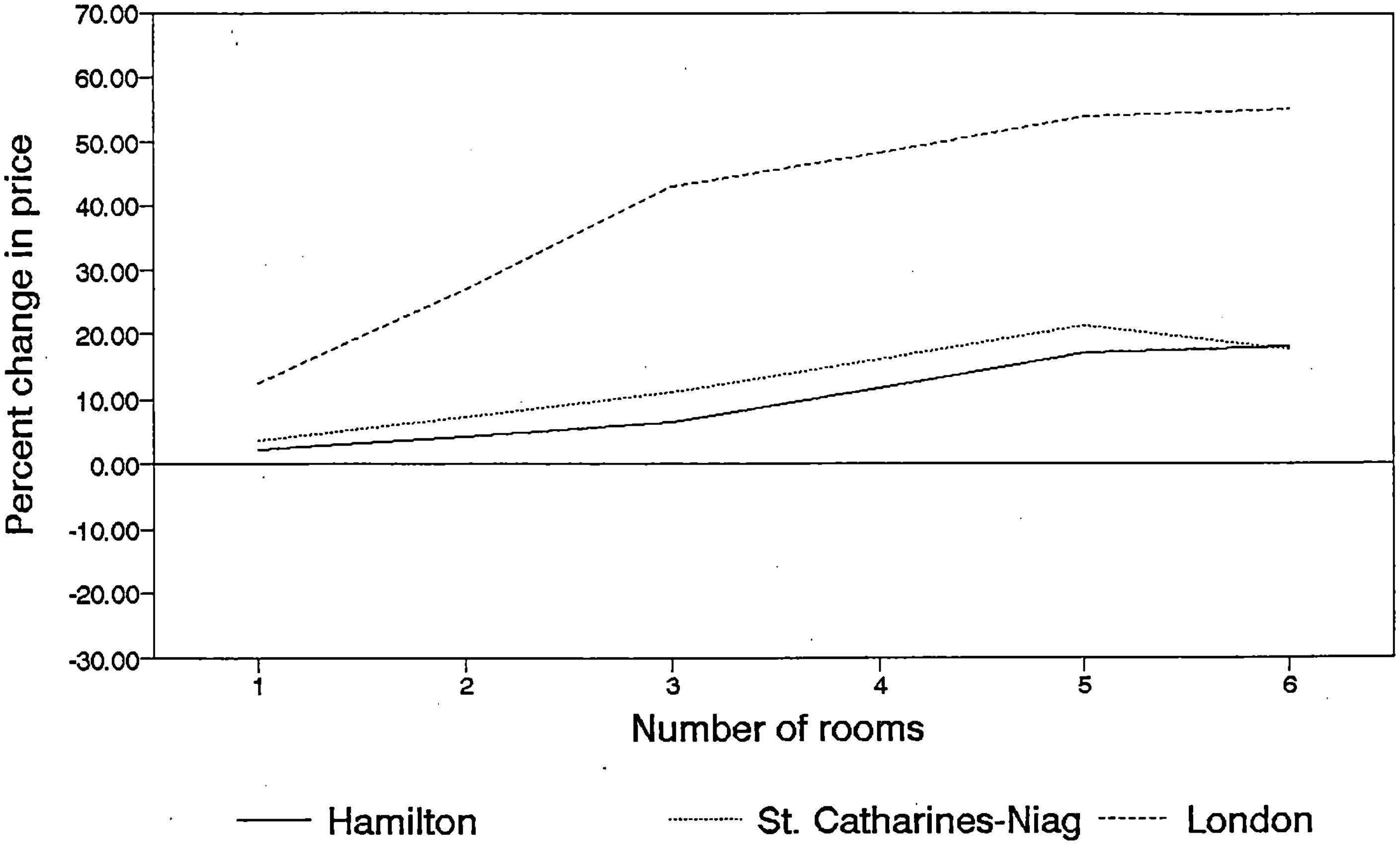


Chart 4.2d

Effect of number of rooms other than bedrooms, by CMA

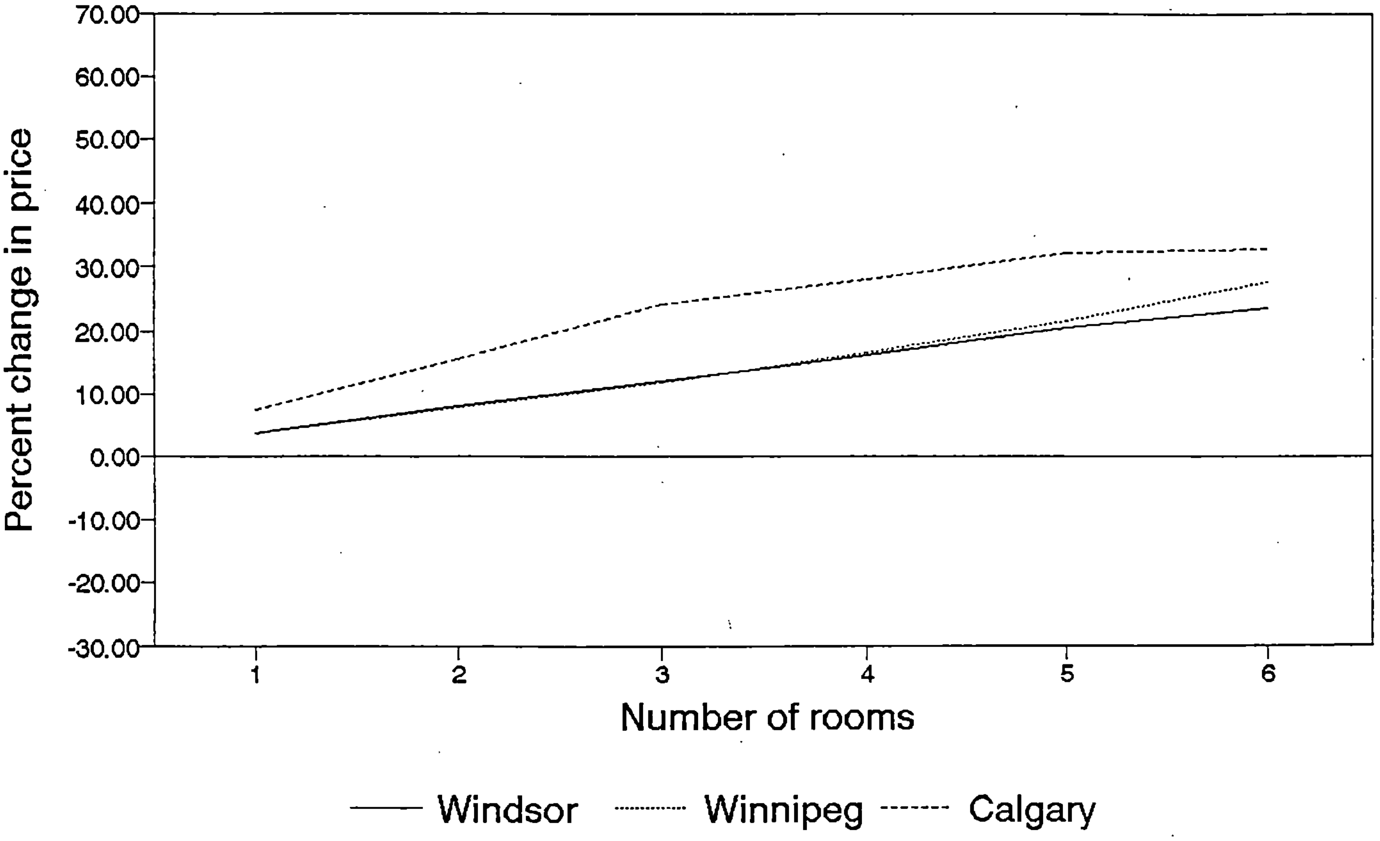


Chart 4.2e

Effect of number of rooms other than bedrooms, by CMA

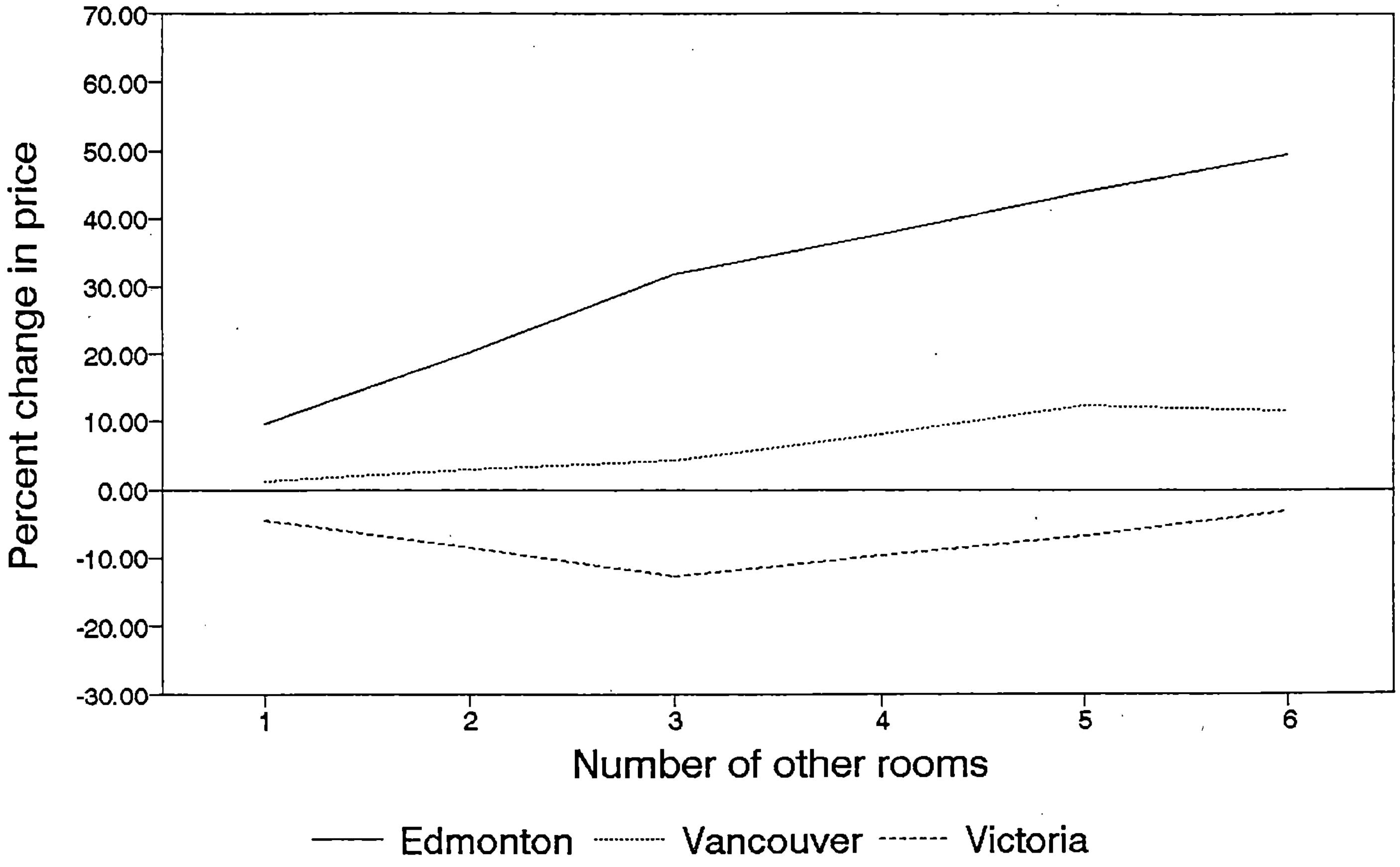
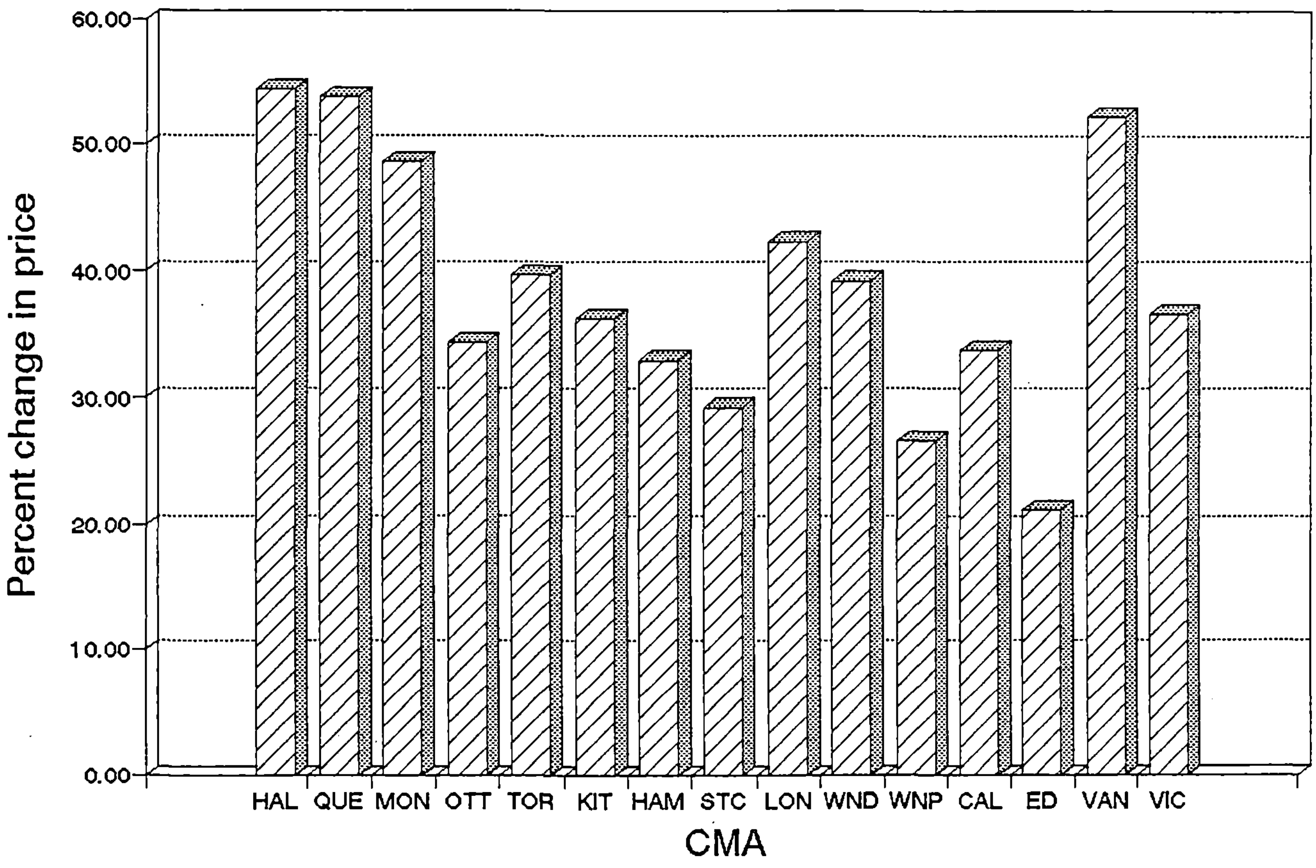


Chart 4.3

Effects on price of at least two bathrooms and a washroom



CHAPTER 5

HEDONIC INDEX RESULTS

I. INTRODUCTION

Overall, what are the price index results of this study? Over the period 1990 to 1993 our results show extraordinary variation in price movements between different regions of the country (Charts 5.1a-5.1n). We classify CMAs into four major categories of price change on the basis of our estimated standard hedonic indexes . The first is a substantial fall in price. Into this category fall Toronto and the two CMAs in its shadow, Hamilton and Kitchener. The second category is very little change in price over the period as a whole, and no large change in any single year. This fits most CMAs east of Calgary and outside the Toronto shadow-- Halifax, Montreal, Ottawa, St. Catharines-Niagara, London and Winnipeg. The third category is a distinct, but not large, upward trend in price; this pattern characterizes Québec, Windsor, and the two Alberta CMAs. The final category is a strong upward trend. The British Columbia CMAs fit here; in fact, "boom" is a better description of the market in Vancouver and Victoria, especially from May 1991 to May 1992. In sum, while in most CMAs quality-adjusted house prices, as indicated by our hedonic index, changed little, in two narrowly defined regions they moved sharply, down in the Toronto area and up in the lower B. C.

In the next section we assess the overall hedonic results technically and by comparing them to other indexes. We also assess the MLS average and the HIFE weighted average value as indicators of overall price movement.

II. ASSESSING THE PERFORMANCE OF THE HEDONIC AND OTHER INDEXES

Confidence intervals for the standard hedonic index

In Table 5.1 are given the estimated indexes and their confidence intervals. The focus of the assessment in this chapter is on the hedonic indexes on the whole sample, movers plus non-movers, after outliers have been removed using the DFFITS criterion. We refer to these indexes as the standard indexes. For all indexes we set 1990 = 100.

About half the 45 values [1] of the standard indexes have a standard error of under two percentage points, and less than a quarter (various years in Halifax, Québec, Vancouver and Victoria) have standard errors of more than 2.5 percentage points. Thus we have 95 per cent confidence for three quarters of the values, that the true index lies within 5 percentage points of the point estimate; the upper and lower bounds as well as the point ("middle") estimate are given in Table 5.1.

The size of the standard error depends on sample size as well as on the standard error of the regression.[2] In the smaller CMAs, like Kitchener, there are a large number of owner-occupiers living in semi and single-detached houses, yielding us a relatively large sample. The large sample size contributes to keeping standard errors low: they average under 1.6 percentage points for Kitchener and about 1.5 percentage points for St. Catharines-Niagara.

Confidence intervals for the mover hedonic index

There is some reason to believe that recent movers will more accurately assess the value of their homes than will other home owners, because they have relatively recently engaged in the search process, scrutinizing alternative houses on the market. For this reason indexes are estimated for mover subsamples. These are less than half the size of the base samples and accordingly, confidence intervals for the mover indexes are considerably wider than those for the standard indexes. Reassuringly, the mover indexes are on the whole similar to the standard indexes, with 80 percent of their values within the relevant 95 per cent confidence interval of the standard index.

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[1] That is, 15 CMAs each for three years.

[2] Note that all estimates use the sample after outliers were removed on the basis of the 5% level DFFITS, so that strictly speaking the 95 per cent confidence intervals are unknown. Virtually all literature in this area deals with samples after outliers have been removed by some criterion or other, however, so that this point about confidence intervals applies to most of the literature.

Assessing the MLS indexes

A major purpose of this study is to assess the worth of the MLS residential price average (here transformed to index form) as an indicator of quality-adjusted house price change. At a narrowly technical level, its performance is only fair--for only slightly less than half of the 45 values is it within the 95 per cent confidence interval of the standard index. At a more qualitative level, however, its performance is good. Consider the question: does the pattern of the MLS average over the period tell essentially the same story about house prices as does the hedonic indexes? The answer, in almost all cities, is yes. Specifically, consider the four categories set out in the introduction--substantial decline, little change, small upward trend and strong upward trend. If the MLS were used to determine the placement of each CMA, in our judgment only two CMAs would change categories, and in each case the change would be a small one. First, St. Catharines would leave the no-change category and join Toronto, Hamilton and Kitchener in the substantial decline category--although it had a milder decline than these had. Second, Windsor would leave the small upward trend category and move to the no change category--although its MLS index does show a *slight* rise.

The uniformity of the placement of CMAs in the three categories using the two indexes also constitutes, in general, an endorsement of the standard hedonic index.

One difference deserves comment, however. The standard index shows a dip, or at least a kink, in 1991 in almost every city (Quebec is a notable exception), while the MLS index rarely does (see Charts 5.1a-5.1n). The divergence between the MLS and hedonic is especially marked in Toronto, Hamilton, Edmonton and Vancouver. In Toronto, the hedonic index indicates a price crash in 1991 --a drop of 17 per cent--while the MLS average falls only 8 per cent. In Hamilton the contrast is even greater--16 per cent vs 3 per cent. In Edmonton, the hedonic fell 4 per cent while the MLS *rose* 6 per cent. In Vancouver the hedonic fell 16 per cent while the MLS fell but 2 per cent. From 1991 to 1992 the gap largely closed, with the MLS falling more (in, for example, Toronto), or rising less (in Vancouver) than the hedonic.[3]

It seems possible that in 1991 many home owners who were potential vendors perceived a fall in the value of their home value, but refused to sell unless they "got their price." This reservation price, while less than they would have accepted at the peak, was still higher than they would expect to be able to get if they had to sell within a few months. Houses which actually sold would be those purchased by optimistic potential buyers or by those with a high opportunity cost of waiting (such as households moving from another city).

Qualitative assessment of the mover indexes

Comparisons of the mover indexes--the hedonic specification using samples of households who had moved within the previous five and a half years--with the standard indexes does not support the proposition that they are superior to the standard indexes. It is true that slightly over half the 45 index values, are closer than the standard index to the MLS index, so that on these grounds alone the choice of which is better slightly favours the mover indexes. The results for Vancouver and Victoria--and to a lesser extent Edmonton and Windsor--however, suggest that when prices are rising, recent movers exaggerate the rise. For instance, on the basis of the mover sample, Victoria prices in the 1990-93 boom rose by 42 per cent, while the standard index rises just 36 per cent and the MLS index 31 per cent. It seems possible that recent movers are more affected by price bubble psychology than nonmovers.

One striking result is that the mover indexes for almost all cities show a lesser price drop in 1991 than the standard index (although for Toronto the two are very similar). This may reflect an unwillingness of some who bought in the boom years to face the unpalatable fact of negative equity. Or the standard indexes may exaggerate the true 1991 drop.

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[3] These differences are reduced if the MLS index is computed using the MLS average for the first quarter of the year rather than for the year as a whole, so that the drop in the MLS index in 1991 is taken as the drop from the first quarter 1990 to first quarter 1991. Year over year changes in the MLS index for the second quarter give about the same percentage change as those for the year as a whole, however. Households were surveyed for HIFE in the second quarter.

It is also possible that differences between the mover indexes and the standard indexes for this period reflect differences in price movements for different types of houses. Movers' houses in Quebec and Montreal were more likely to be new and to be semis, less likely to have luxury bath facilities. In Quebec they also were on average distinctly smaller. Thus, the greater fall in the mover house price index than the standard index may simply reflect a less favourable price experience for modest houses than for more luxurious ones. The "all" hedonic may reflect the price movements for the whole single and semi market in Quebec and Montreal while the mover index reflects just movements in the modest house submarket.

Assessing the HIFE average price as an index

An alternative to computing hedonic indexes would be to simply compute the HIFE weighted average price and convert it to index form. This would give an index conceptually similar to the MLS index. It would have the advantage of using values of houses representative of the whole stock rather than only those selling through the MLS system, although it would have the disadvantage of using homeowners' estimates. In Charts 5.1a to 5.1n HIFE averages computed in this way are given.[4]

It can be seen that for most cities the movement of the weighted average HIFE price is very similar to that of the hedonic index (e.g. consider Vancouver), although the latter is quality-adjusted and the former is not. Close conformity of the two indexes is not surprising over such a short period because the average quality of the stock changes only slowly. There are some quite notable differences, however. For example for Halifax the percentage increase of the average, 1992 to 1993, is about twice that of the hedonic index. For Quebec, average price rises more in 1991 than the hedonic, and then falls over the next two years while the hedonic rises. On the face of it this implies a drop in average quality in the latter two years. This may reflect subsidy programs in Quebec in those years.

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[4] Outliers are not excluded from the sample used to compute these averages because the use of the DFFITS criterion for outliers requires the computation of hedonic indexes. The total size of sample for the 15 CMAs is the number in the "edited" sample (see Chapter 2), 18,482. Weights are the HIFE final universal weights.

The greatest divergence between the pattern shown by the average price and by the hedonic is for Kitchener-Waterloo. The hedonic, like the MLS index, falls substantially over the 1990-93 period while the average HIFE price rises slightly. The divergence seems too great to explain on the basis of quality change alone. In fact a large part of the divergence is explained by the impact of the HIFE weights. Computing the HIFE average on an unweighted basis yields price movements much more like the hedonic (for example this average is two per cent less in 1993 than 1990 while the weighted average is four per cent *more*). It is not clear why the HIFE weighted average is so unsatisfactory here but one possible mechanism which would produce this result is the following: suppose that an extremely inaccurate house price (one which would get rejected by the outlier criterion) or an unusual high, although accurate, price happens to have a high HIFE weight. Then the use of a weighted average will magnify the inaccuracy.[5]

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[5] Consider the following numerical example. Suppose the true value of four houses is $120,000, $180,000, $215,000, $100,000, so that the true mean is $153,750.. Suppose home owners value these houses at respectively $140,000, $250,000, $210,000, $110,000. Suppose weights are respectively 2 15, 2, 3. . Then the unweighted average is $177,500 and the weighted average is $217,300.

Table 5.1
MLS index and hedonic indexes, national and by CMA, 1990=100

Halifax		Estimated hedonic indexes					
		All			Movers		
Year	MLS index	Lower bound	Middle	Upper bound	Lower bound	Middle	Upper bound
1991	102.15	89.44	93.94	98.66	89.07	96.01	103.50
1992	102.81	89.23	93.78	98.57	84.30	90.99	98.21
1993	105.41	92.88	98.51	104.48	88.60	96.12	104.27

Number of years MLS index is within 95% confidence interval of "all" hedonic index: 0
Number of years movers middle index is within 95% confidence interval of "all" hedonic index: 3

Quebec City		Estimated hedonic indexes					
		All			Movers		
Year	MLS index	Lower bound	Middle	Upper bound	Lower bound	Middle	Upper bound
1991	104.64	100.28	105.10	110.16	94.67	103.02	112.11
1992	103.82	105.07	110.26	115.71	97.50	106.25	115.79
1993	106.14	107.39	113.24	119.41	98.81	108.83	119.87

Number of years MLS index is within 95% confidence interval of "all" hedonic index: 1
Number of years movers middle index is within 95% confidence interval of "all" hedonic index: 3

Montreal		Estimated hedonic indexes					
		All			Movers		
Year	MLS index	Lower bound	Middle	Upper bound	Lower bound	Middle	Upper bound
1991	102.16	95.12	99.08	103.20	90.86	96.87	103.28
1992	101.55	98.13	102.14	106.31	93.18	99.34	105.91
1993	102.09	93.23	97.28	101.50	87.33	93.37	99.83

Number of years MLS index is within 95% confidence interval of "all" hedonic index: 2
Number of years movers middle index is within 95% confidence interval of "all" hedonic index: 3

Ottawa		Estimated hedonic indexes					
		All			Movers		
Year	MLS index	Lower bound	Middle	Upper bound	Lower bound	Middle	Upper bound
1991	101.28	88.91	92.39	96.00	89.98	95.38	101.11
1992	101.63	97.69	101.56	105.58	93.96	99.71	105.82
1993	102.87	96.37	100.37	104.54	95.38	101.76	108.57

Number of years MLS index is within 95% confidence interval of "all" hedonic index: 2
Number of years movers middle index is within 95% confidence interval of "all" hedonic index: 3

Table 5.1 (cont'd)

Toronto		Estimated hedonic indexes					
		All			Movers		
Year	MLS index	Lower bound	Middle	Upper bound	Lower bound	Middle	Upper bound
1991	91.93	79.95	82.74	85.64	78.39	83.74	89.45
1992	84.34	84.42	87:23	90.12	80.62	85.79	91.28
1993	81.01	78.42	81.46	84.61	72.10	77.22	82.71

Number of years MLS index is within 95% confidence interval of "all" hedonic index: 1
Number of years movers middle index is within 95% confidence interval of "all" hedonic index: 2

Kitchener/Waterloo		Estimated hedonic indexes					
		All			Movers		
Year	MLS index	Lower bound	Middle	Upper bound	Lower bound	Middle	Upper bound
1991	96.87	90.29	93.13	96.06	89.35	94.36	99.64
1992	90.79	88.69	91.34	94.08	84.71	89.20	93.92
1993	86.96	85.83	88.61	91.49	83.45	88.11	93.02

Number of years MLS index is within 95% confidence interval of "all" hedonic index: 2
Number of years movers middle index is within 95% confidence interval of "all" hedonic index: 3

Hamilton		Estimated hedonic indexes					
		All			Movers		
Year	MLS index	Lower bound	Middle	Upper bound	Lower bound	Middle	Upper bound
1991	97.11	81.11	84.45	87.92	82.28	88.24	94.62
1992	91.13	82.42	85.80	89.32	79.15	85.61	92.60
1993	86.54	79.31	82.90	86.64	78.24	85.27	92.94

Number of years MLS index is within 95% confidence interval of "all" hedonic index: 1
Number of years movers middle index is within 95% confidence interval of "all" hedonic index: 2

St. Catharines/Niagara		Estimated hedonic indexes					
		All			Movers		
Year	MLS index	Lower bound	Middle	Upper bound	Lower bound	Middle	Upper bound
1991	100.04	93.36	96.04	98.80	94.45	98.82	103.39
1992	95.69	100.46	103.35	106.33	95.78	100.49	105.43
1993	92.45	96.29	99.44	102.69	92.14	97.33	102.82

Number of years MLS index is within 95% confidence interval of "all" hedonic index: 0
Number of years movers middle index is within 95% confidence interval of "all" hedonic index: 2

Table 5.1 (cont'd)

London		Estimated hedonic indexes					
		All			Movers		
Year	MLS index	Lower bound	Middle	Upper bound	Lower bound	Middle	Upper bound
1991	101.75	90.39	94.13	98.03	88.82	94.44	100.40
1992	102.53	96.54	100.51	104.64	91.49	97.35	103.59
1993	100.50	95.83	100.16	104.68	92.25	98.56	105.30

Number of years MLS index is within 95% confidence interval of "all" hedonic index: 2
Number of years movers middle index is within 95% confidence interval of "all" hedonic index: 3

Windsor		Estimated hedonic indexes					
		All			Movers		
Year	MLS index	Lower bound	Middle	Upper bound	Lower bound	Middle	Upper bound
1991	99.31	98.18	101.83	105.61	95.66	101.19	107.05
1992	102.74	103.56	107.37	111.33	99.80	105.69	111.93
1993	103.53	106.06	110.28	114.67	106.33	113.36	120.85

Number of years MLS index is within 95% confidence interval of "all" hedonic index: 1
Number of years movers middle index is within 95% confidence interval of "all" hedonic index: 3

Winnipeg		Estimated hedonic indexes					
		All			Movers		
Year	MLS index	Lower bound	Middle	Upper bound	Lower bound	Middle	Upper bound
1991	100.19	95.27	98.16	101.13	92.99	97.81	102.88
1992	100.31	100.42	103.46	106.60	94.22	99.21	104.47
1993	101.61	95.53	98.89	102.37	94.42	100.08	106.09

Number of years MLS index is within 95% confidence interval of "all" hedonic index: 2
Number of years movers middle index is within 95% confidence interval of "all" hedonic index: 2

Edmonton		Estimated hedonic indexes					
		All			Movers		
Year	MLS index	Lower bound	Middle	Upper bound	Lower bound	Middle	Upper bound
1991	105.98	93.47	96.98	100.61	89.62	95.60	101.99
1992	108.47	100.87	104.50	108.30	97.35	103.97	111.03
1993	110.67	98.95	102.91	107.03	91.86	98.65	105.94

Number of years MLS index is within 95% confidence interval of "all" hedonic index: 2
Number of years movers middle index is within 95% confidence interval of "all" hedonic index: 2

Table 5.1 (cont'd)

Calgary		Estimated hedonic indexes					
		All			Movers		
Year	MLS index	Lower bound	Middle	Upper bound	Lower bound	Middle	Upper bound
1991	99.82	92.89	95.85	98.91	96.20	101.74	107.60
1992	100.80	101.86	105.06	108.37	100.62	106.09	111.86
1993	104.29	105.63	109.21	112.91	104.46	110.71	117.33

Number of years MLS index is within 95% confidence interval of "all" hedonic index: 1
Number of years movers middle index is within 95% confidence interval of "all" hedonic index: 2

Vancouver		Estimated hedonic indexes					
		All			Movers		
Year	MLS index	Lower bound	Middle	Upper bound	Lower bound	Middle	Upper bound
1991	98.00	79.85	84.25	88.90	82.94	90.41	98.55
1992	108.33	101.01	106.51	112.32	101.52	111.48	122.41
1993	123.57	110.82	117.53	124.63	116.56	127.73	139.96

Number of years MLS index is within 95% confidence interval of "all" hedonic index: 2
Number of years movers middle index is within 95% confidence interval of "all" hedonic index: 1

Victoria		Estimated hedonic indexes					
		All			Movers		
Year	MLS index	Lower bound	Middle	Upper bound	Lower bound	Middle	Upper bound
1991	105.46	89.58	96.01	102.90	96.04	107.26	119.79
1992	121.10	119.79	128.53	137.91	118.65	132.25	147.42
1993	131.05	124.61	135.60	147.57	125.63	142.03	160.57

Number of years MLS index is within 95% confidence interval of "all" hedonic index: 2
Number of years movers middle index is within 95% confidence interval of "all" hedonic index: 2

Chart 5.1a

Alternative house price indexes, Halifax

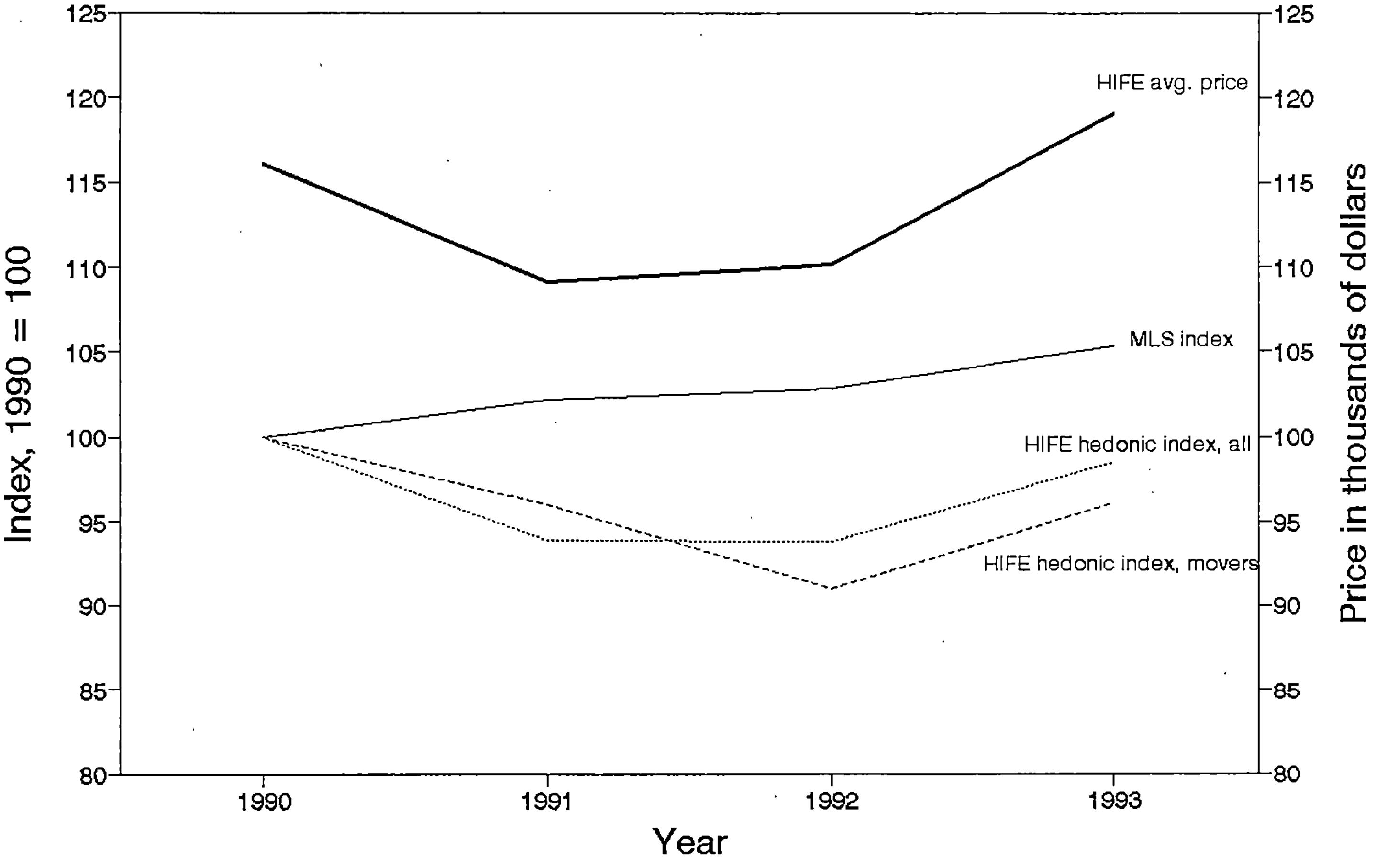


Chart 5.1b

Alternative house price indexes, Quebec

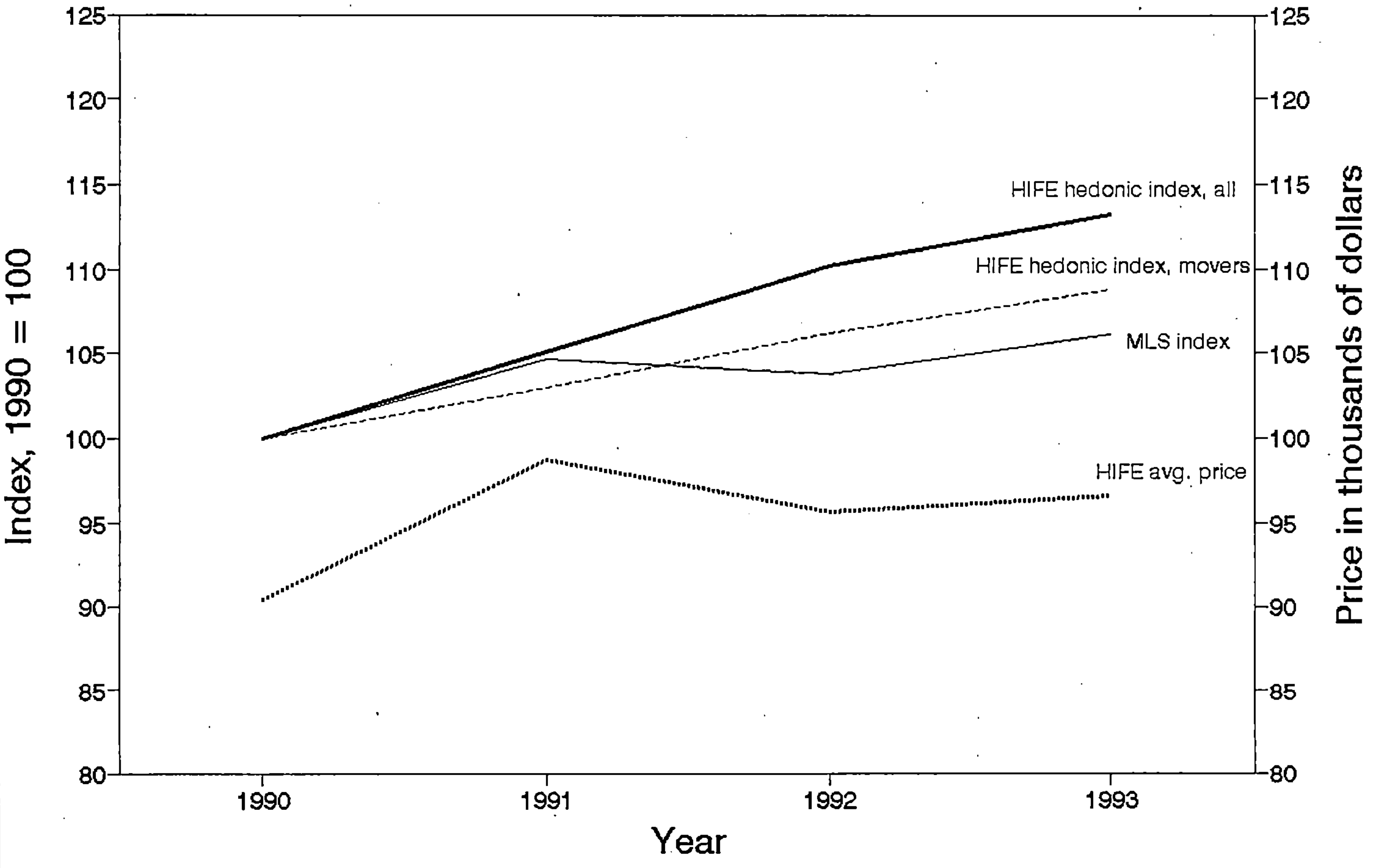


Chart 5.1c

Alternative house price indexes, Montreal

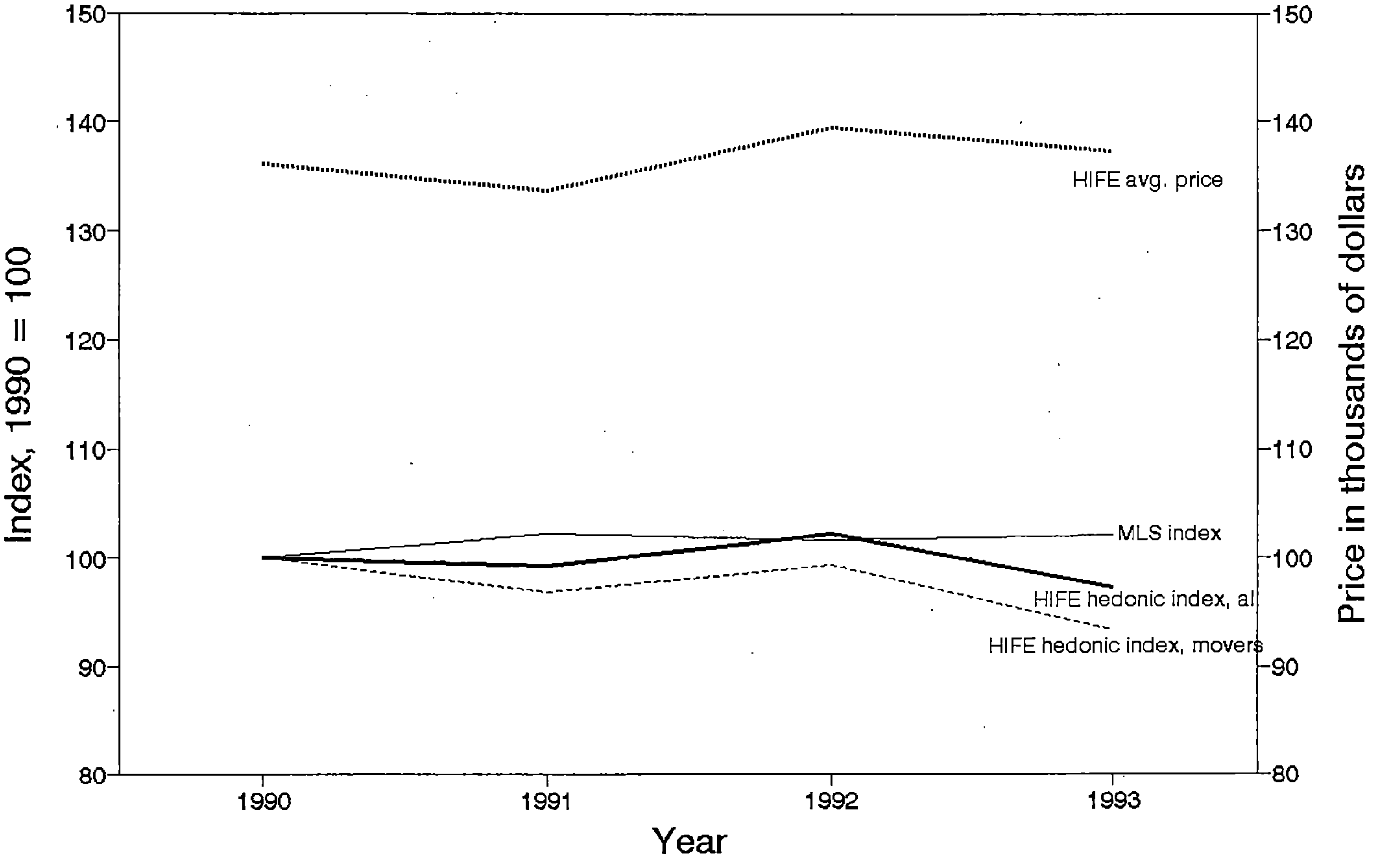


Chart 5.1d

Alternative house price indexes, Ottawa

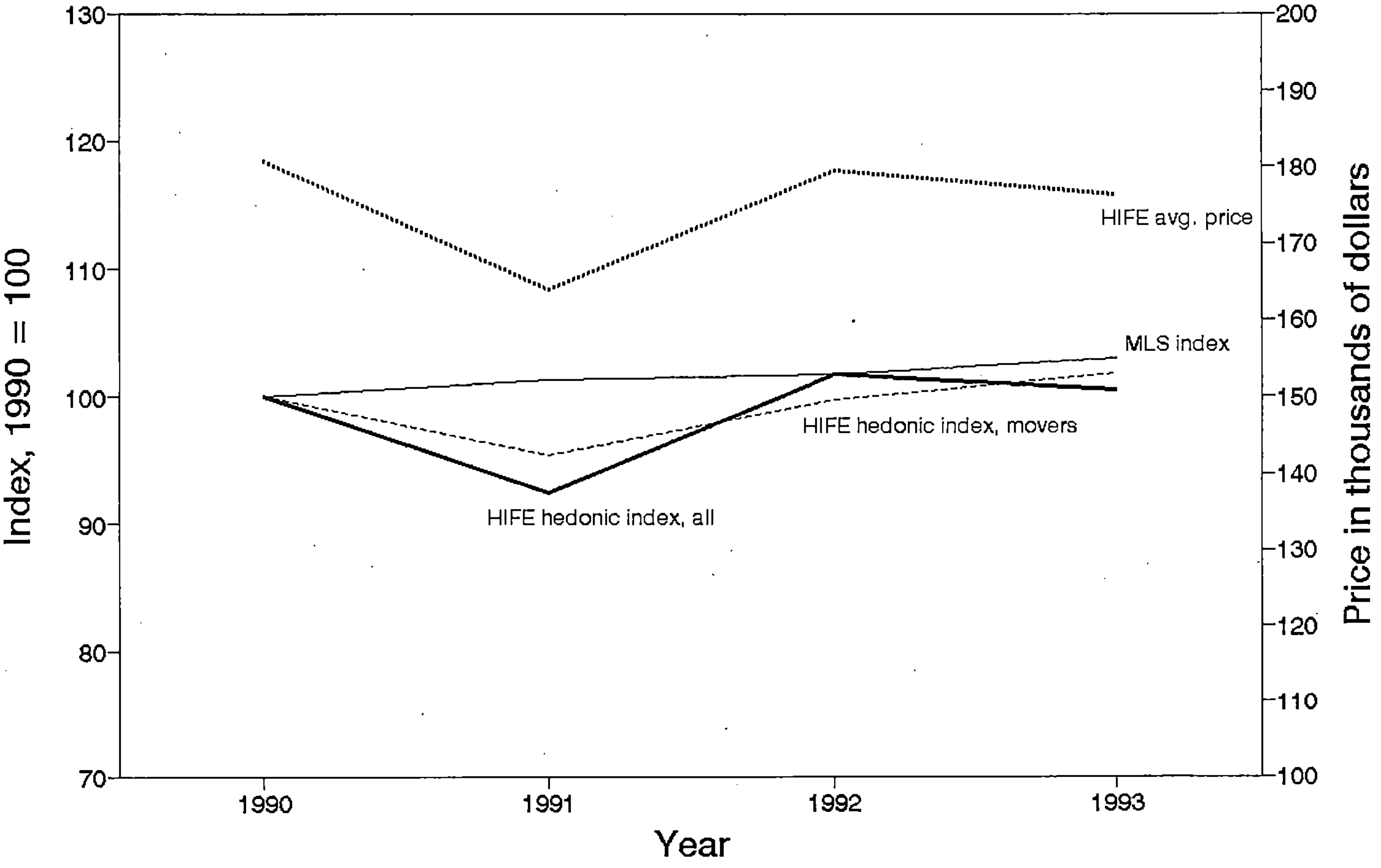


Chart 5.1e

Alternative house price indexes, Toronto

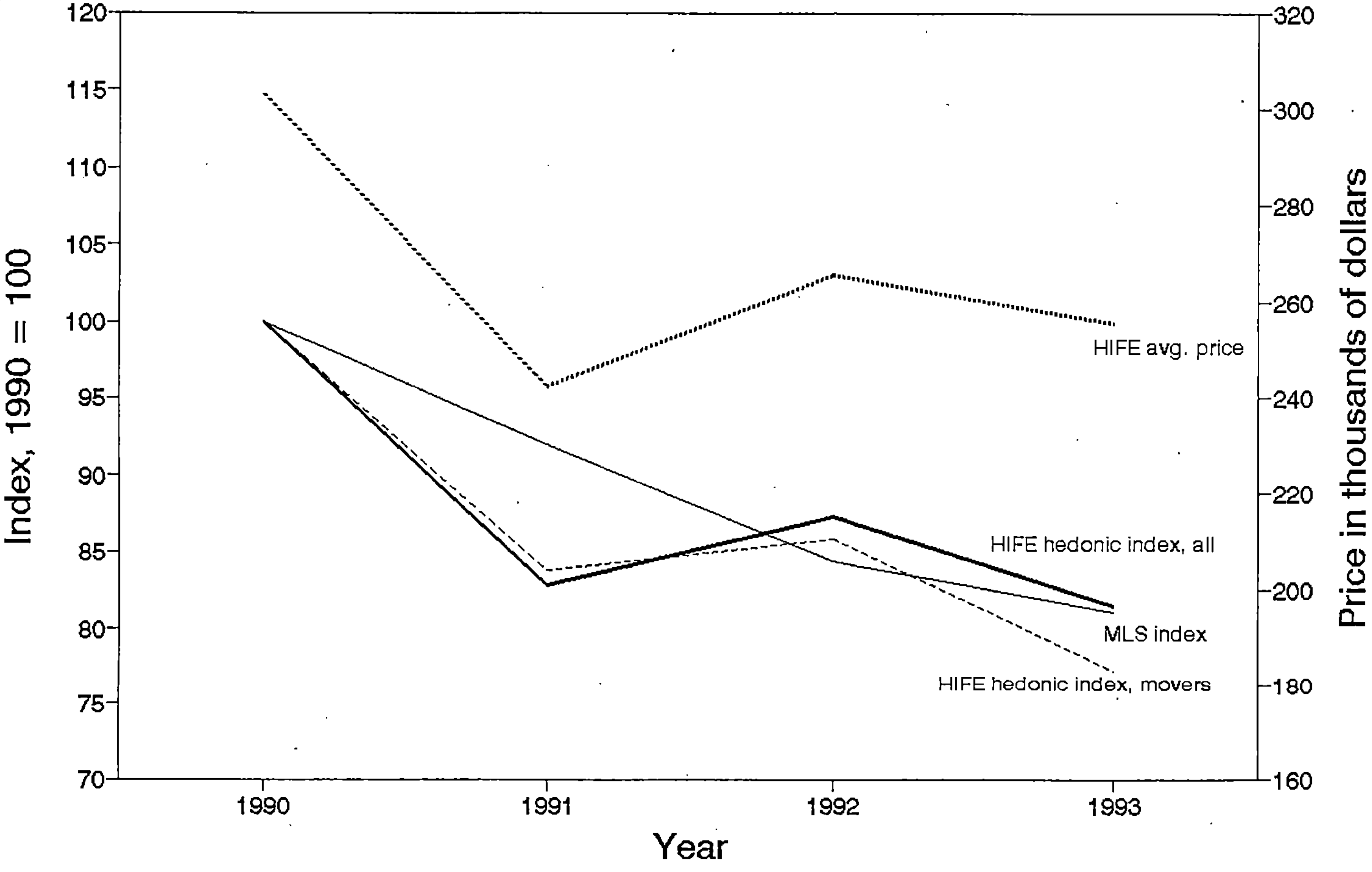


Chart 5.1f

Alternative house price indexes, Kitchener-Waterloo

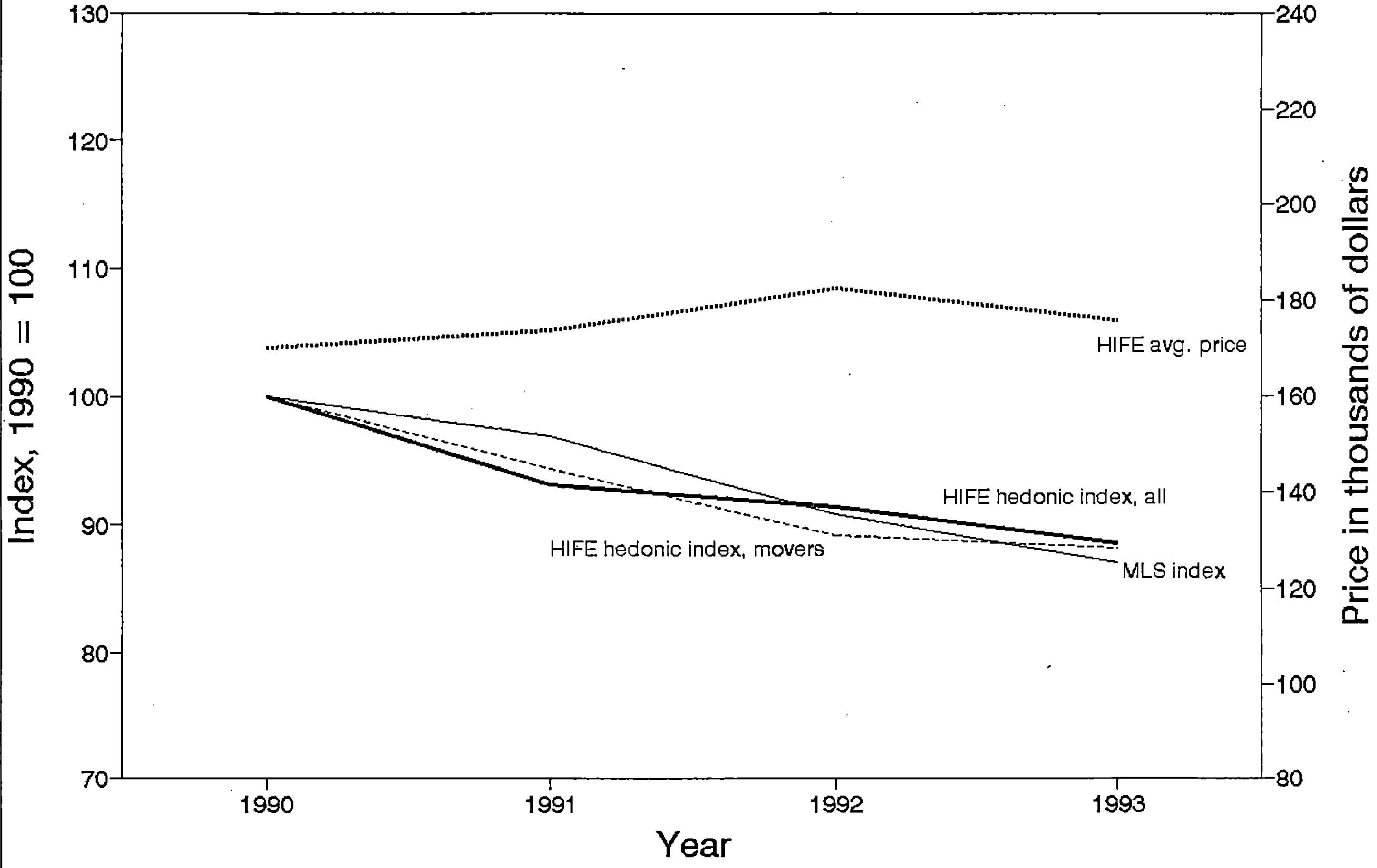


Chart 5.1g

Alternative house price indexes, Hamilton

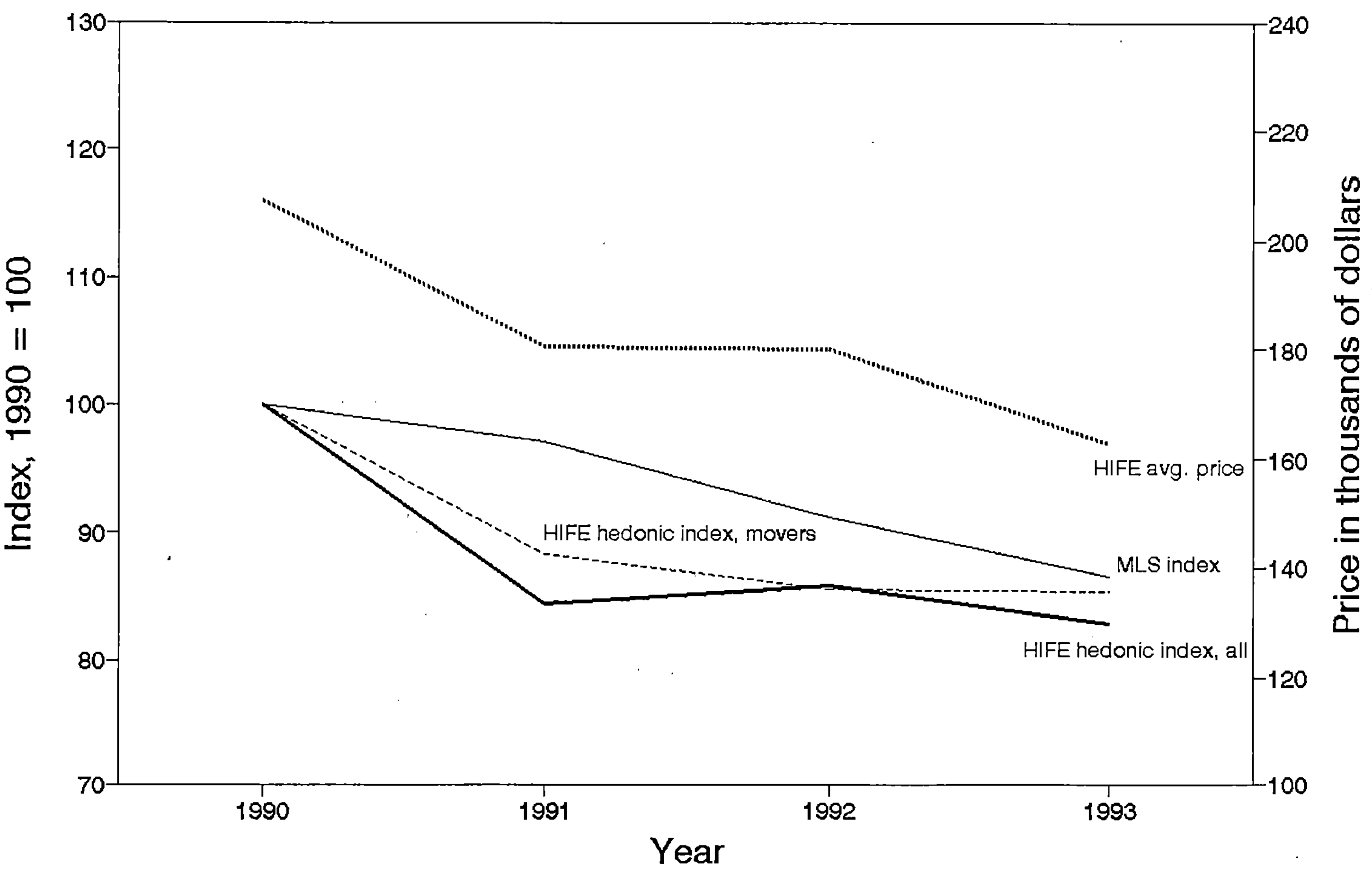


Chart 5.1h

Alternative house price indexes, St. Catharines-Niagara

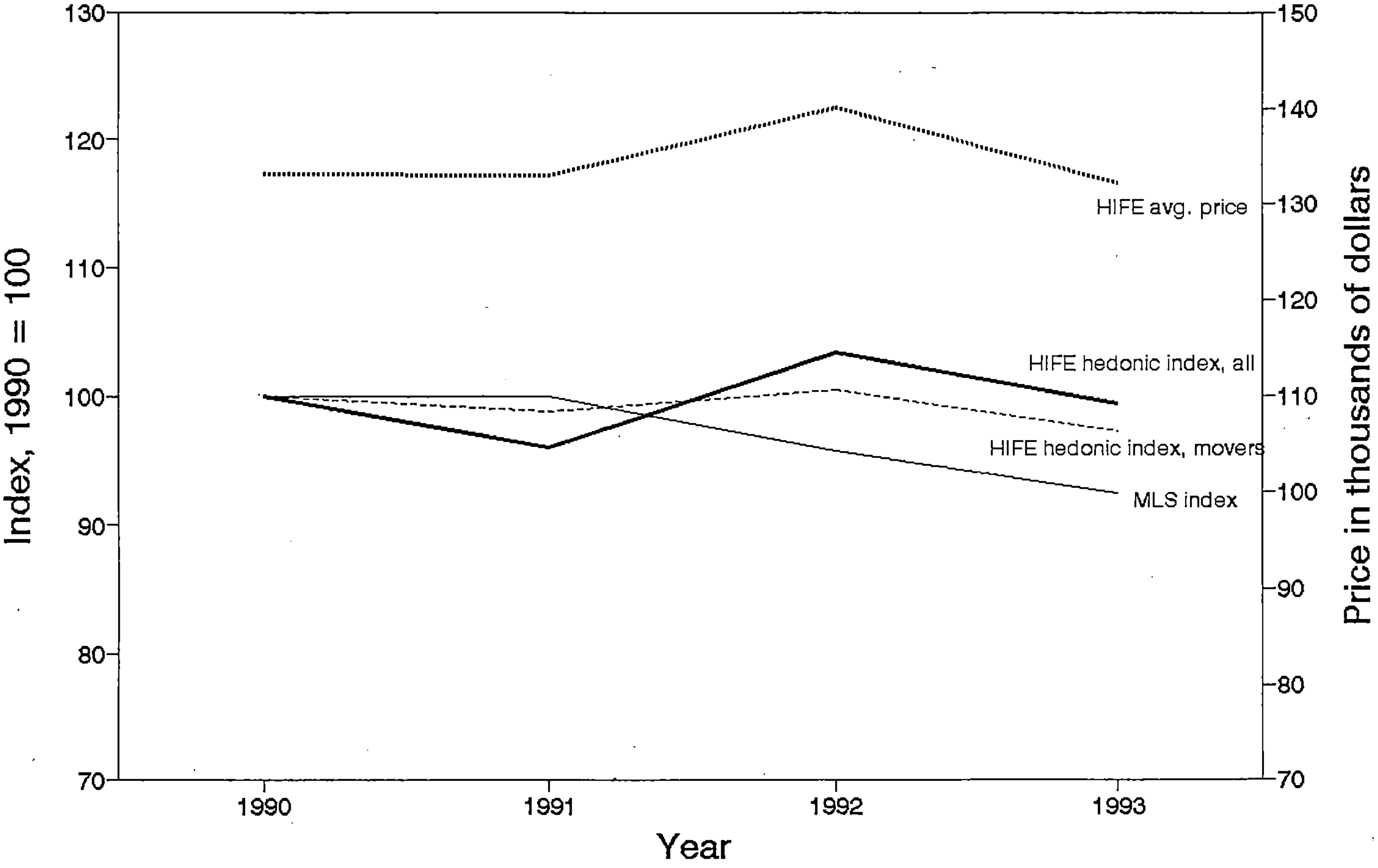


Chart 5.1i

Alternative house price indexes, London

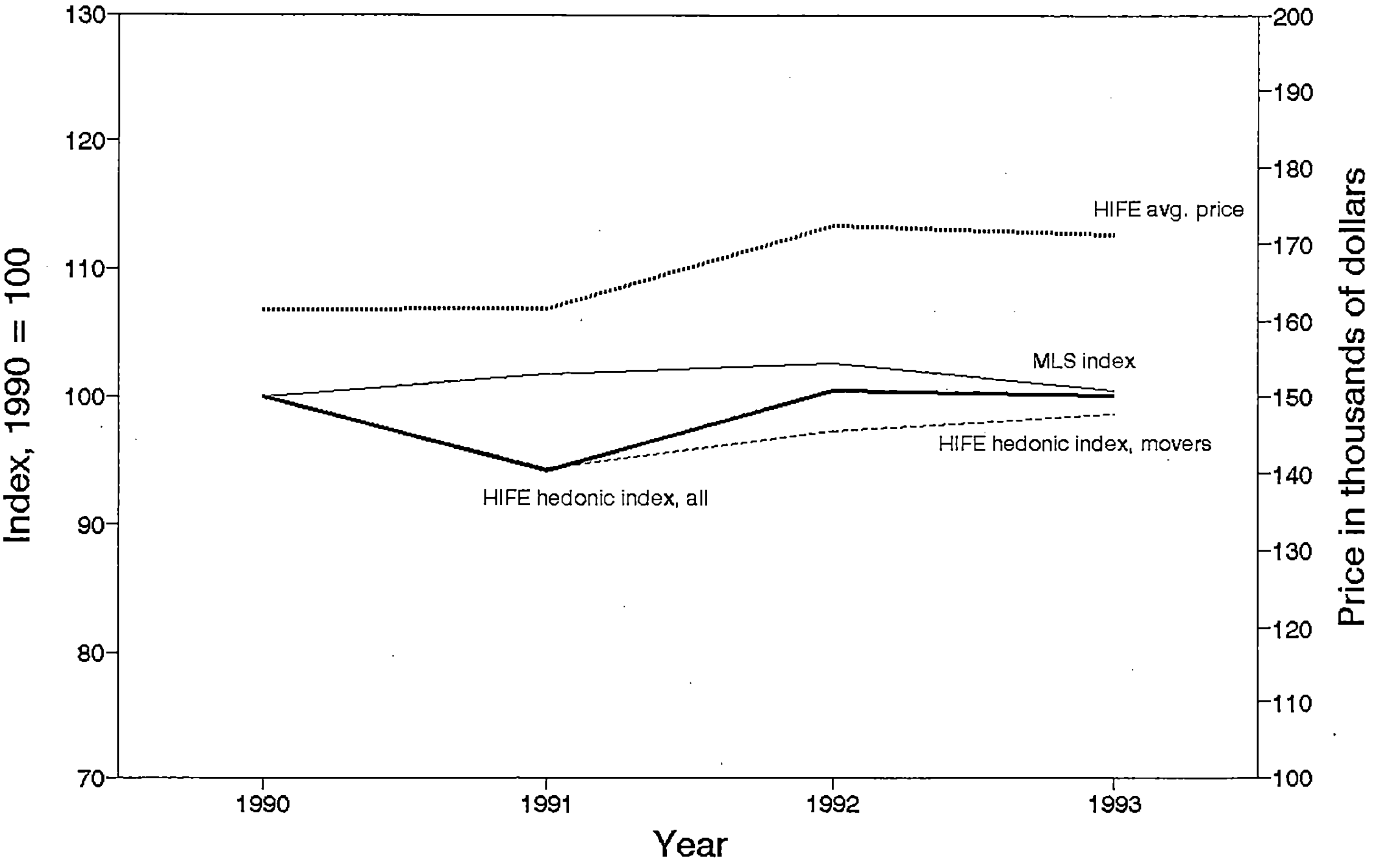


Chart 5.1j

Alternative house price indexes, Windsor

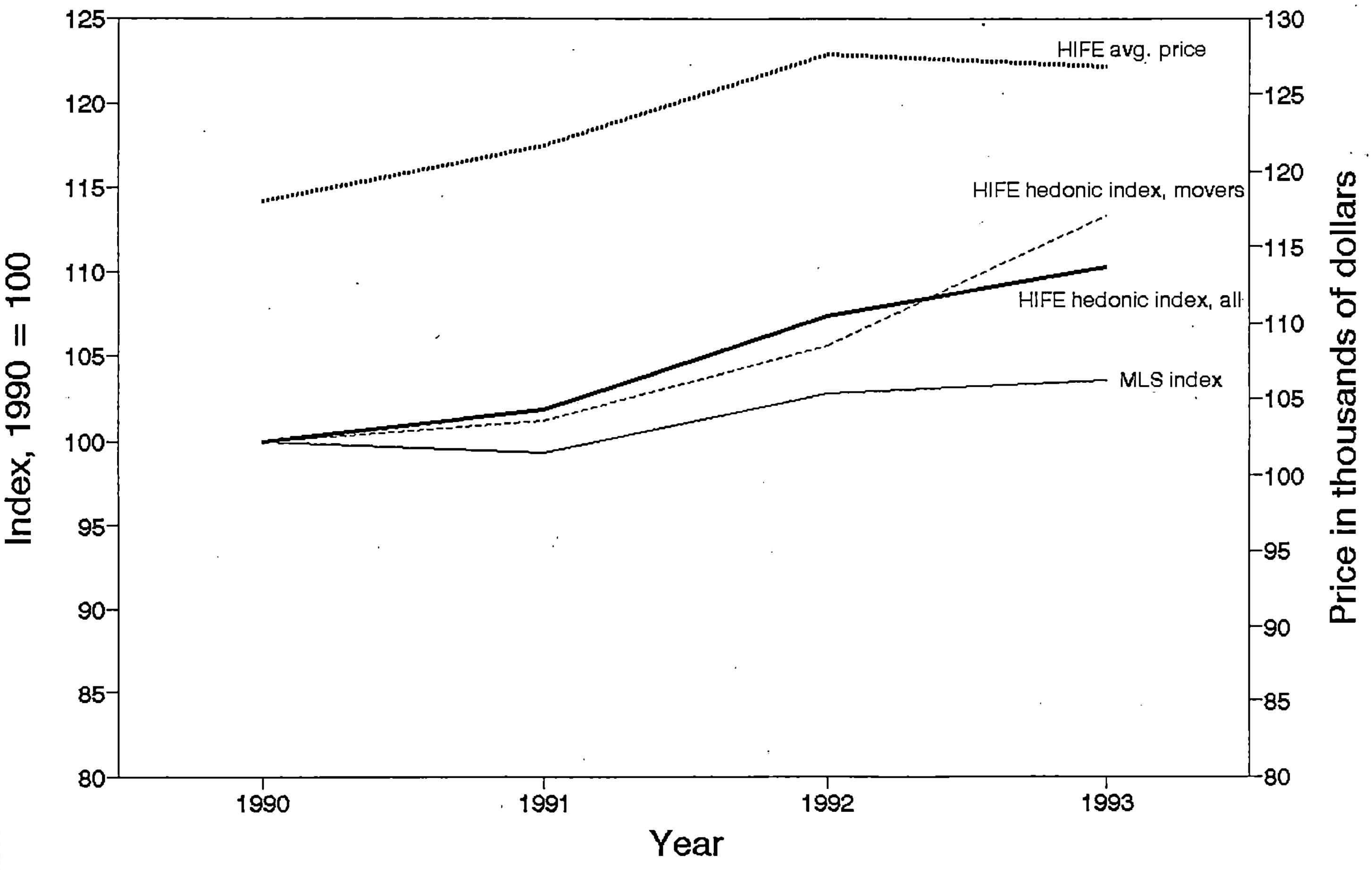


Chart 5.1k

Alternative house price indexes, Winnipeg

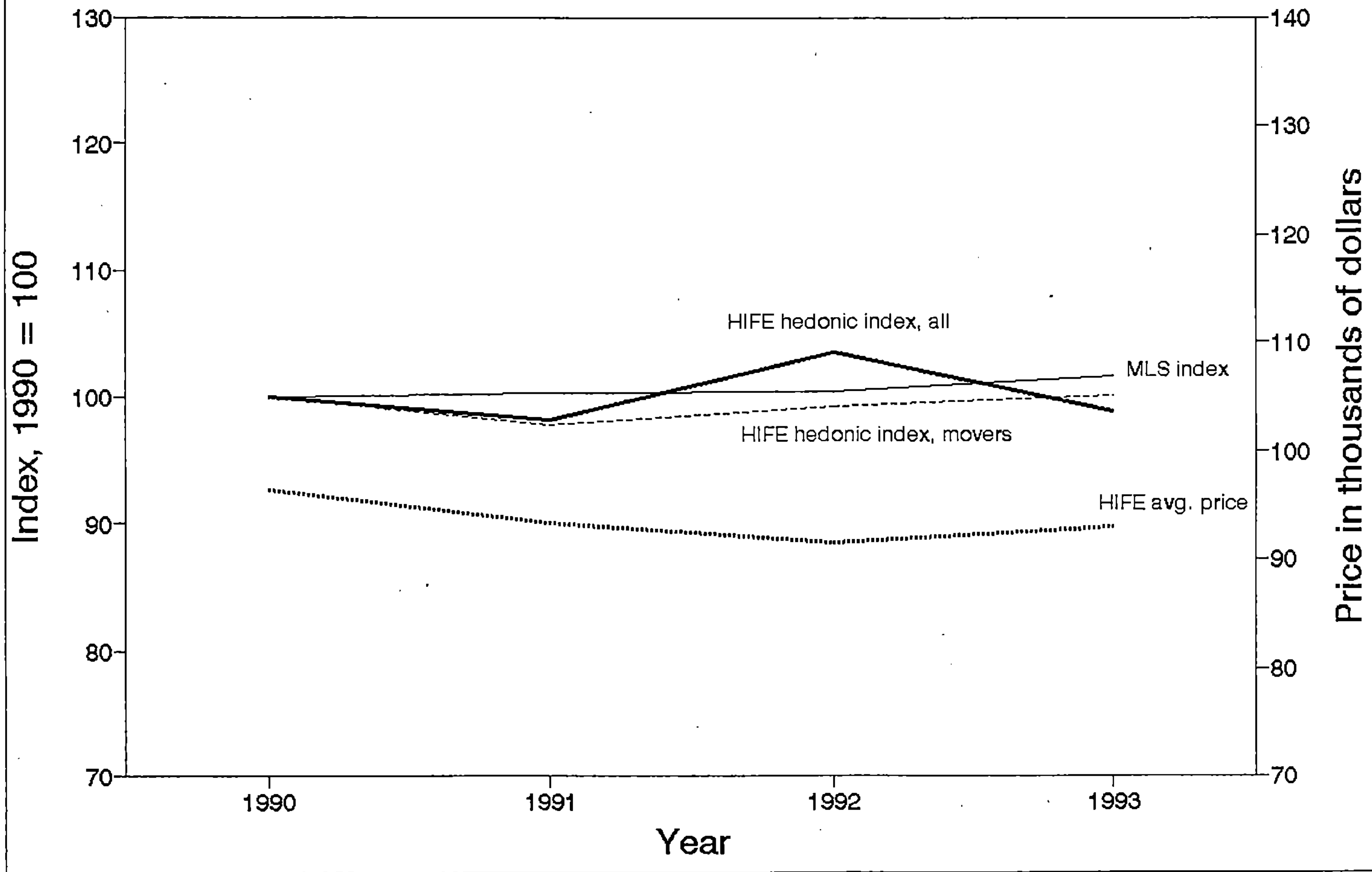


Chart 5.1l

Alternative house price indexes, Calgary

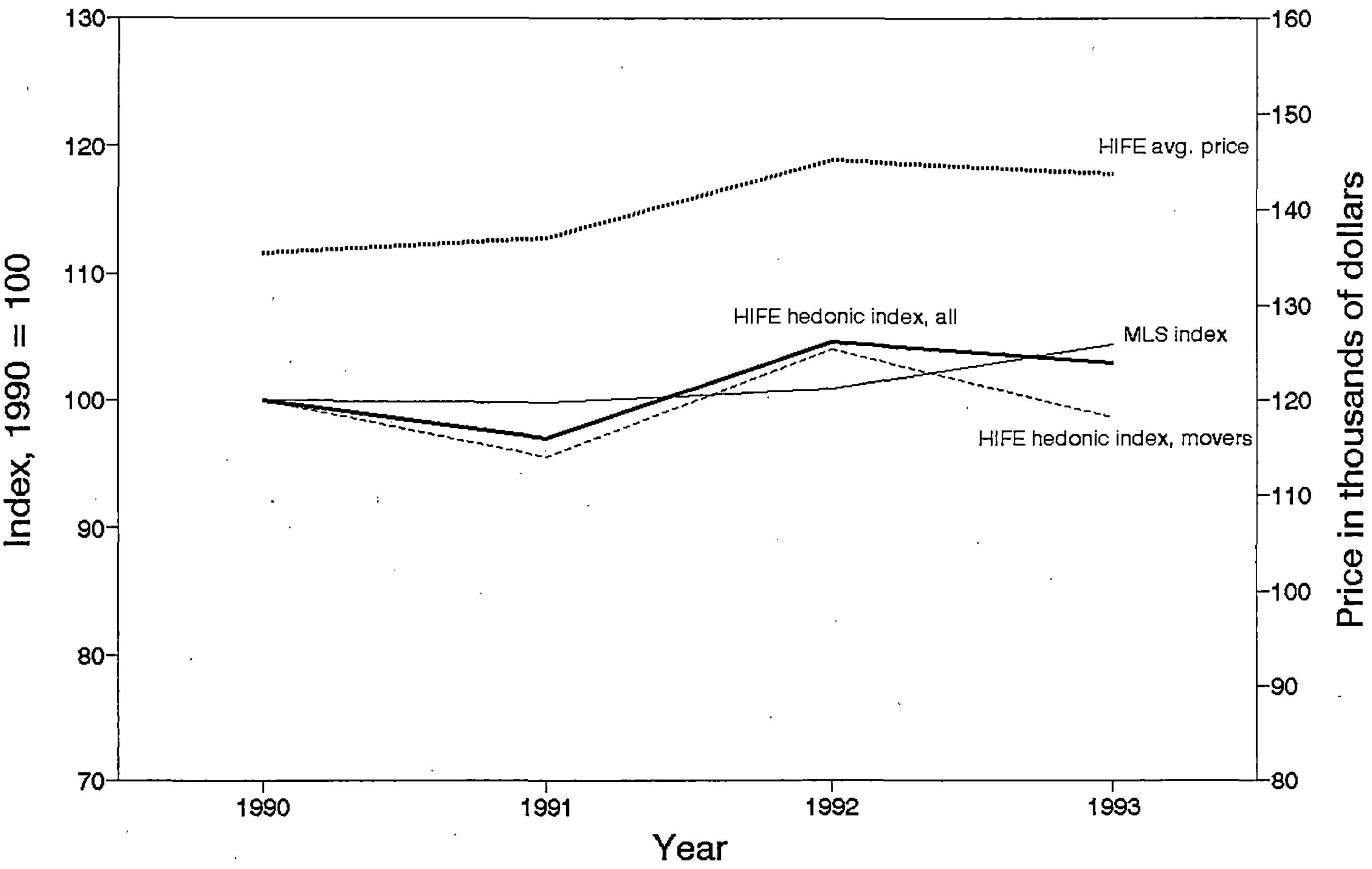


Chart 5.1m

Alternative house price indexes, Edmonton

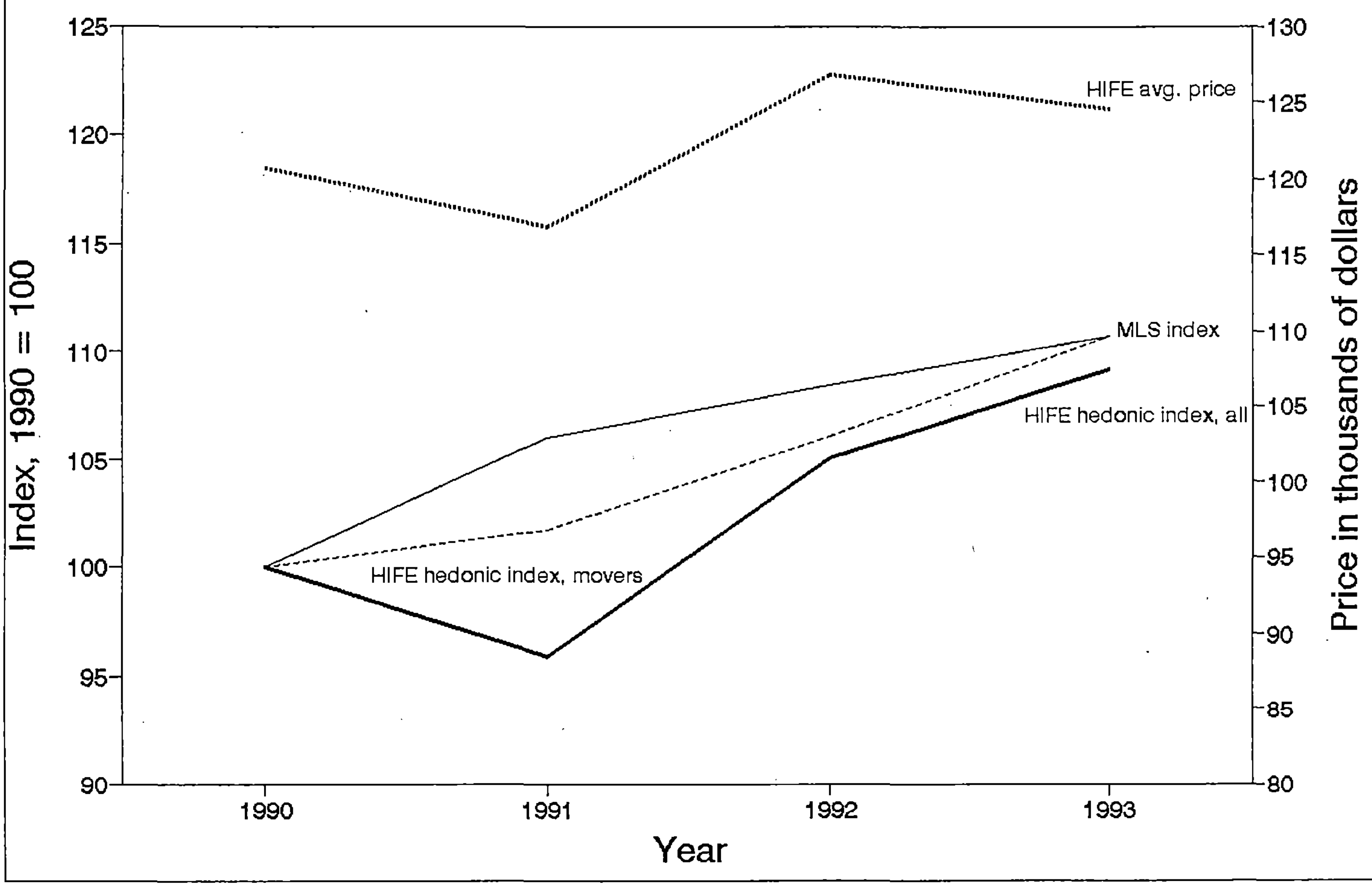


Chart 5.1n

Alternative house price indexes, Vancouver

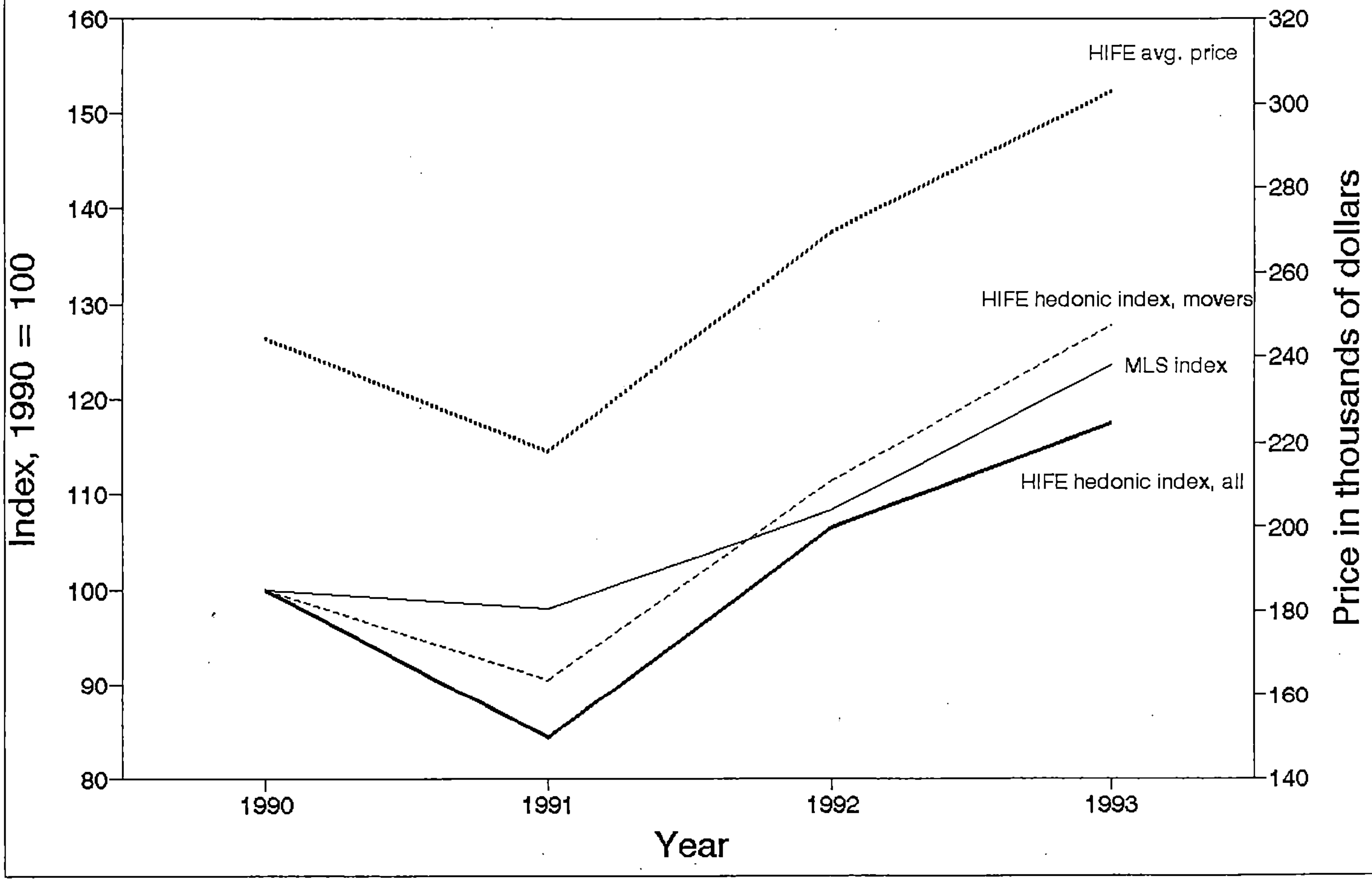
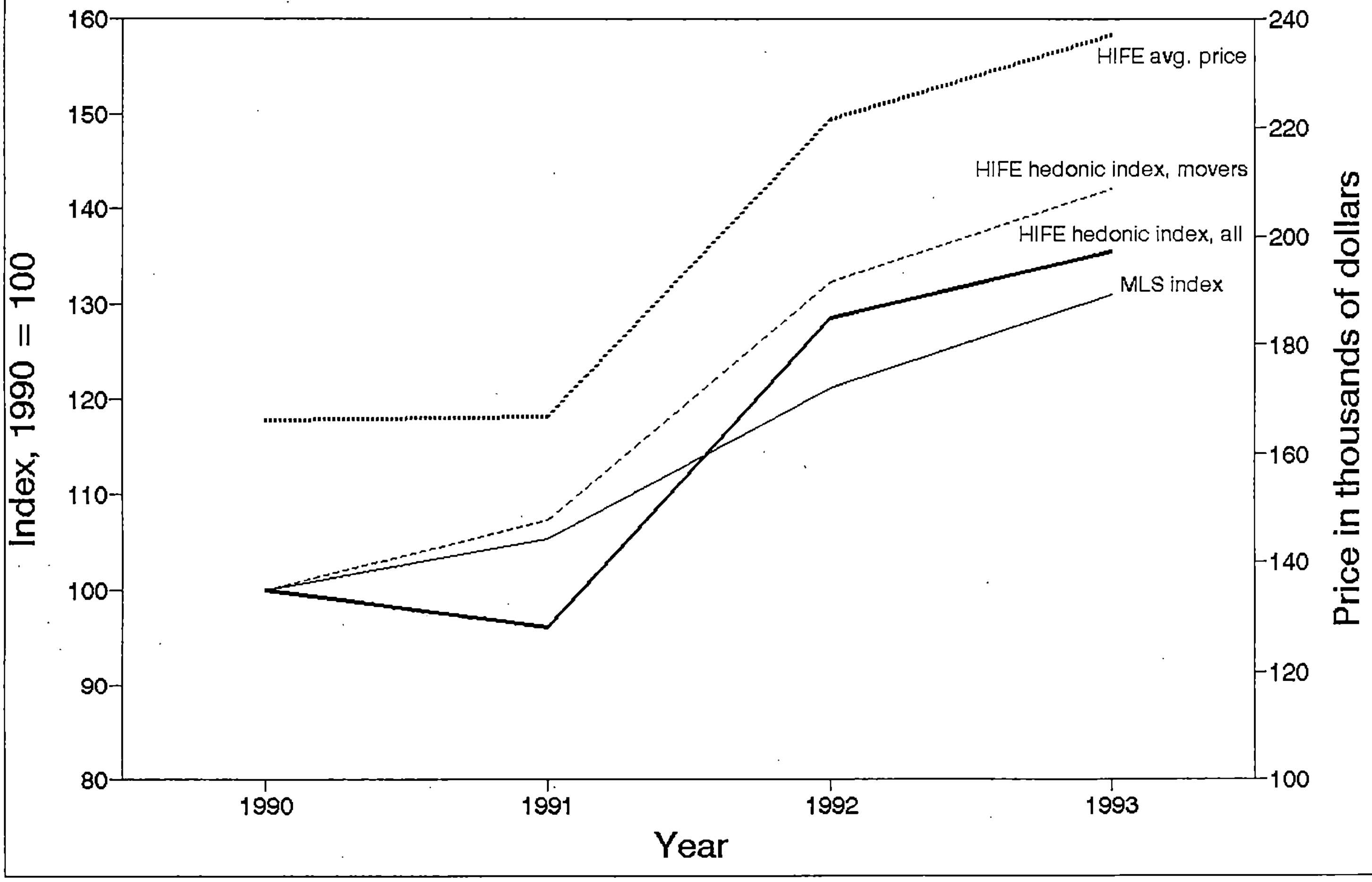


Chart 5.1o

Alternative house price indexes, Victoria



CHAPTER 6

NOTEWORTHY RESULTS, LESSONS AND IMPLICATIONS

1. WHAT AFFECTS THE VALUE OF HOUSES IN CANADIAN CITIES?

This study shows that what affects values most reliably are not the basic variables of size and age but variables indicating quality per room and the existence of amenities. These have relatively consistent effects from city to city, and have high t statistics, Age and vintage effects are quite strong, but they are complex. We now give more details.

Age

The hedonic results (Chapter 4) show that age has a substantial effect on value, but the pattern of effects varies greatly from city to city. It is clear that age is not merely an indicator of the state of obsolescence and physical deterioration of the house. While in practically all cities the effect of age, in the first few years of its life, is negative--that is the house depreciates--the rate of depreciation declines with age and in many cities eventually reverses, becoming *appreciation*. In some of the largest cities--Vancouver, Toronto and Ottawa are examples--old houses are found to be worth *more* than new ones with the same number of rooms and other characteristics. This almost certainly reflects the fact that old houses tend to be located close to the centre where land commands a large premium relative to land in the suburbs. Another factor contributing to the positive impact of age on value is the extent of renovation in recent years. It is of some interest to note which large cities are the ones where old houses are worth *less* than otherwise new ones: Montreal, Winnipeg, and Edmonton. In the latter two cities central locations are relatively unattractive because access to downtown from the suburbs is very quick, and core areas have concentrations of poverty problems.

Number of bedrooms and other rooms

The size of houses in terms of number of rooms differs substantially in its effects from one city to another. Additionally, in some cities one more bedroom add more to value than one more other room and in some cities the opposite is true. Quite uniformly, however, the effect of another room declines quite markedly as the number of rooms increases.

Need for repair

The need for repair variables have the expected negative effect in almost all cities. For the national (all cities) sample, the need for minor repairs reduces value by an estimated 3.5 per cent and the need for major repairs has almost twice that effect. The discount for needed major repairs is estimated to be distinctly greater in western cities than elsewhere. It may be, however, that this discount is in part the consequence of negative neighbourhood effects in places where these houses are located. For example, houses in need of major repair may in western cities typically be situated in decaying areas close to the core.

Extra bathroom facilities and other amenities

The variables having the greatest quantitative effects--and ones that are highly consistent from city to city--are the amenity variables. The first is the set of bathroom categories. A second bathroom adds around 10 per cent to value in most cities. Having at least two baths and a washroom is estimated to make a house worth at least 25 per cent more than a house with one bath, in almost every city. Usually the bathroom variables have very high levels of statistical significance. The presence of an installed dishwasher--taken to indicate high quality kitchen facilities--adds not much less than 10 per cent to value in most cities, and central air conditioning usually adds almost as much.

2. MEAN VALUES AND OUTLIERS: HOW GOOD ARE HOME OWNERS' ESTIMATES?

The average of home owners' estimates of values as compared with market averages

A recent U. S. study comparing home owners' estimates with subsequent sales prices of the same home found that home owners overestimate by about five per cent (Goodman and Ittner, 1992). Steele and Buckley (1976), quite remarkably, found an overestimate very similar to this for 1971 Canadian data. The results of this study are consistent with the presence of an upward bias. MLS averages are always less than HIFE averages with the notable exceptions of Vancouver in 1991 and St. Catharines Niagara in 1990 and 1991. Included in the MLS average are condominiums duplexes and triplexes, while the HIFE sample we use is confined to single and semi-detached houses and so this will depress the MLS relative to the HIFE average, especially in Vancouver in this period when condominium sales were important. It must also be remembered that the value of houses which transact is not the same as the value of houses in the stock. Still, the size of the HIFE-MLS difference in most cities suggests strongly that home owners are overoptimistic in their valuation. Further, the data suggest that recent movers are more overoptimistic than nonmovers, especially in boom conditions like those prevailing in Vancouver and Victoria during the 1990-1993 period.

The results of this study provide some evidence on the effect of price trends on bias in home owners' estimates.. We use MLS average price data for this purpose. The results of the regressions in Table 4.3 indicate that home owners' estimates of value are somewhat sticky so that when prices have been have been rising for a few years their valuation does not fully reflect this rise. We estimate that if current prices were reached following a rise of 10 per cent a year for three years, home owners' valuations would be between 1.7 and 2.4 per cent lower than if past prices were the same as current levels.

The effect of outliers

Studies which make direct comparisons of home owners' estimates and sales prices or appraised values find that while the error in home owners' values is *on average* slight (and in some studies no worse on average than professional appraisals) there are a substantial number of observations for which errors are extremely great.[1] For some purposes the latter problem can be dismissed--for instance, in the computation of unweighted averages--because large negative errors will tend to cancel out large positive ones. In two situations it is not so easy to dismiss the problem. First, when HIFE weights are used to get estimates of the population mean, there is the possibility that values containing an extreme error might be on a household record which has a high HIFE weight. Second, and more important, if the classic regression estimation procedure, Ordinary Least Squares, is used, extreme errors will greatly influence the parameter estimates. This well-known property of OLS procedures is very important in this context.

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[1] More technically, mean error is close to zero but the variance in the error is high.

To deal with the extreme error problem we have eliminated observations which have house values which are very different from those predicted by the house value equation.[2] We found that in certain cases eliminating these outliers made a major difference to the price index estimates. For example the Toronto price crash in 1991 was estimated to be much greater in outlier-included estimates than in the standard hedonic indexes.

The characteristics of outliers

A knowledge of the characteristics of outliers gives us insight into situations where home owners' estimates are apt to be particularly problematic. Outlier houses are generally relatively expensive, but this is certainly not true in all cases. The most striking characteristic of outliers is their age: outliers in every city but one are on average older than other houses--in many cities *much* older.[3] Older houses may be more difficult to appraise than newer ones because of greater heterogeneity, the effects of complete or partial renovation and location value. Indeed it is possible that some of the houses rejected as outliers in our estimation were not valued grossly incorrectly by their owners but instead simply have special characteristics like prime location and architecturally unique renovation which are not accounted for in the HIFE data.

3. HOW WELL DO THE HEDONIC INDEXES AND MLS INDEXES DO?

The major aim of this study is to determine the usefulness of hedonic indexes based on HIFE data and MLS indexes. The MLS indexes is simply the MLS average price converted to index form.

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[2] The hedonic regression used to predict the value uses as its sample all observations *except the one being predicted.* More precisely, we use the DFFITS criterion. See Chapter 2 for more details.

[3] This is consistent with the finding of Goodman and Thibodeau (1995) that heteroscedasticity in hedonic house regressions is associated with the age of house.

The hedonic indexes

The standard hedonic index is estimated using the "all " sample. Technically, the estimates are quite good: most index values have standard deviations of not much more than two percentage points, so that the 95 times out of 100 we have confidence that the true value is within about four percentage points of the estimated value. At a more pragmatic level, we can ask whether the estimated indexes are consistent with our other knowledge of house prices in the various cities. The answer to this is yes: if we use the hedonic index to place cities in four price pattern categories during the period--large decline, little change, small increase and large increase--the hedonic index gives us almost precisely the same answer as the MLS index.

The hedonic index based on the recent mover sample gives values which are in almost all cases within the 95 per cent confidence interval of the standard estimates. This indicated that valuations are not strongly dependent on how recently the home owner was in the housing market. There is some tendency for mover indexes to be closer to the MLS index than the standard indexes. In the two boom cities, however, movers estimates show a substantially greater price increase than either the standard hedonic or the MLS index, which suggests boom psychology may affect the usefulness of movers' estimates.

The MLS indexes

The MLS indexes in general do remarkably well. Most MLS index values are outside the 95 per cent confidence interval of the standard hedonic, but, as noted above, if an analyst used MLS indexes to place house price movements in one of four qualitative categories, the placements would be almost precisely the same as if the standard HIFE-based hedonic were used.

There is one caveat to this endorsement. It is important to remember that a MLS index is an index of the prices of houses which transact, not all houses in the stock. This may explain the contrast between MLS indexes and hedonic indexes in 1991. In virtually every city, but especially in Toronto, Hamilton, Edmonton and Vancouver the hedonic gives a more negative picture of the price change from 1990 to 1991 than does the MLS average.[4] One scenario is this: vendors hoping for a recovery set a high reservation price, turning off many buyers. Those who do buy are those who are in some sense "distress" buyers, for example a family with several children unable to find a suitable rental house. Or they may be people who believe the slump is only temporary. The lucky vendors whose house happens to appeal to such buyers sells at a price higher than roughly similar houses would sell for if the vendors had to sell within a few months. What matters to mortgage lenders, of course, is the latter price--one can think of it as the "power of sale" price. Under this scenario then, the fall in 1991 indicated by the MLS indexes is too small and the hedonic indexes are better guides.

4. RECOMMENDATIONS

From this assessment comes the following conclusions and recommendations

1. The MLS index is a good enough guide to price movements in all CMAs investigated for most purposes. It is possible that it is better than any alternative available on a timely basis.
2. The MLS index should be used with caution, however, in periods of downturn, especially after the sales-to-listing ratio drops.
3. Because of recommendation 2, HIFE hedonic indexes should be updated as new HIFE data arrives.
4. HIFE data should only be used after outliers have been eliminated using the DFFITS criterion or some other systematic criterion and HIFE weights should not be used in the estimation.
5. Because of timeliness concerns early access--before public release--to HIFE value and house characteristics would be useful.
6. In times of sharp changes in the number of MLS sales consideration should be given to attaching questions on house value and characteristics to a Labour Force Survey in November as an addition to the current May survey.

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[4] The contrast is lessened if the change in the MLS average is computed not from annual MLS average price but from the MLS first quarter average price. The HIFE house value survey takes place in mid second quarter.

Table A1.1
Average Annual MLS Price
and Owner's Estimate of Average House Value in HIFE

Year	Halifax		Quebec		Montreal		Ottawa		Toronto	
	MLS	HIFE	MLS	HIFE	MLS	HIFE	MLS	HIFE	MLS	HIFE
1987	89013	-	68743	-	92292	-	119613	-	189105	-
1988	92309	-	75758	-	103674	-	128256	-	227014	-
1989	93444	-	85057	-	110015	-	137456	-	273698	-
1990	97238	116014	82972	90416	111956	136157	141562	180608	254890	303174
1991	99332	109067	86821	98740	114379	133686	143379	163816	234313	242282
1992	99975	110127	86144	95626	113688	139535	143869	179290	214971	265371
1993	102500	119070	88066	96592	114293	137292	145626	176185	206489	255612

Year	Kitchener/Waterloo		Hamilton		St.Cath./Niag.		London		Windsor	
	MLS	HIFE	MLS	HIFE	MLS	HIFE	MLS	HIFE	MLS	HIFE
1987	112600	-	114626	-	92399	-	97962	-	74307	-
1988	130974	-	134182	-	105710	-	112104	-	84166	-
1989	154713	-	163249	-	125279	-	129087	-	99746	-
1990	159718	169893	165743	207312	134813	133136	134920	161331	106327	118055
1991	154725	173548	160954	180670	134872	132934	137278	161373	105590	121630
1992	145015	182491	151038	180119	129001	140191	138327	172281	109239	127650
1993	138896	175933	143433	162540	124639	132259	135594	171170	110078	126825

Year	Winnipeg		Calgary		Edmonton		Vancouver		Victoria	
	MLS	HIFE	MLS	HIFE	MLS	HIFE	MLS	HIFE	MLS	HIFE
1987	78286	-	93102	-	77373	-	132659	-	102041	-
1988	81903	-	100352	-	82028	-	158756	-	128812	-
1989	84234	-	112837	-	89052	-	209671	-	141909	-
1990	81740	96372	128484	135517	101040	120633	226392	244348	160742	166164
1991	81892	93328	128255	137053	107085	116723	221874	217863	169516	166762
1992	81990	91550	129506	145228	109602	126888	245260	269650	194666	221613
1993	83058	93086	133998	143756	111823	124477	279759	302628	210650	236825

Chart A1.1

Average price, MLS and HIFE
Halifax, Quebec, Montreal

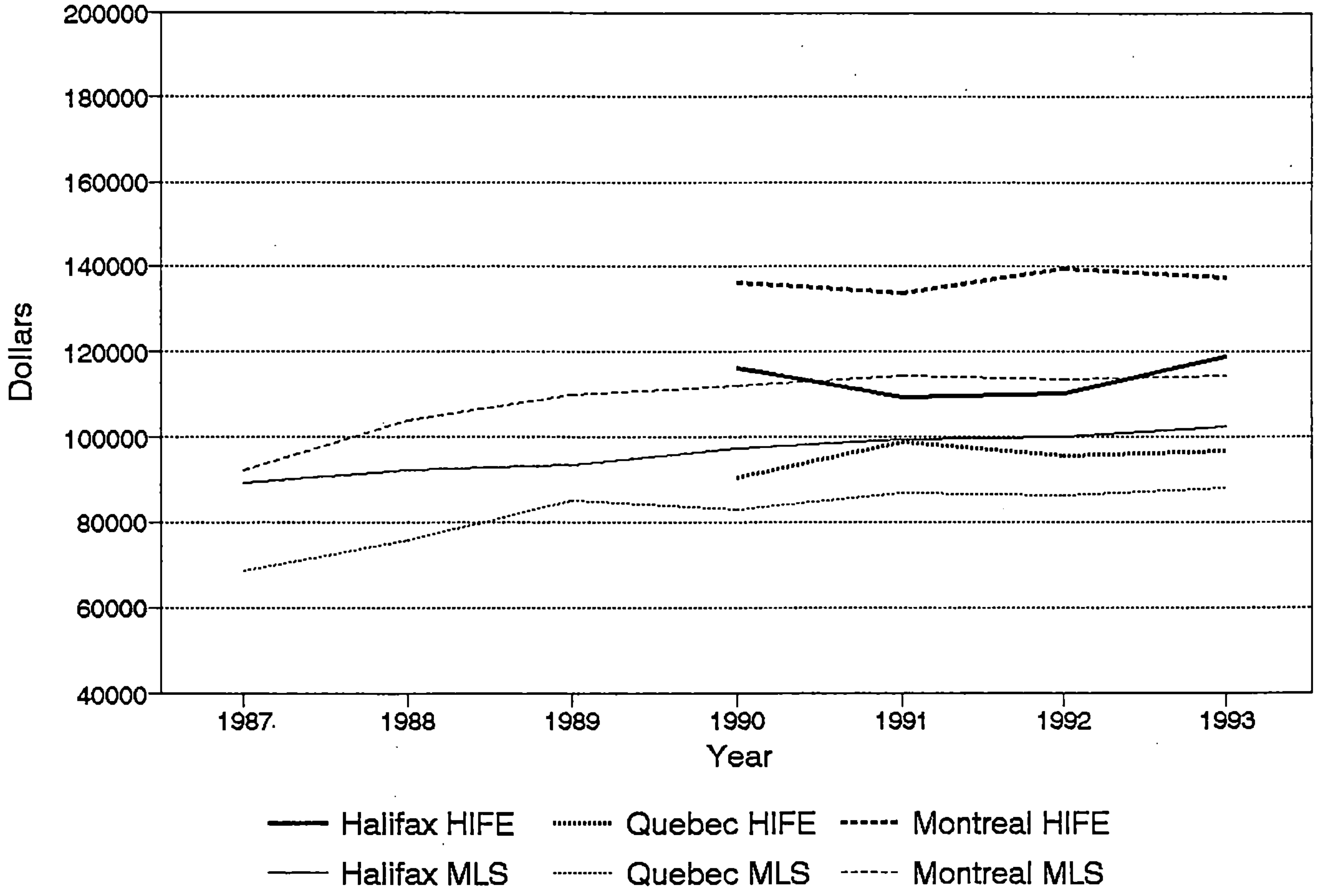


Chart A1.2

Average price, MLS and HIFE Ottawa, Toronto, Kitchener-W.

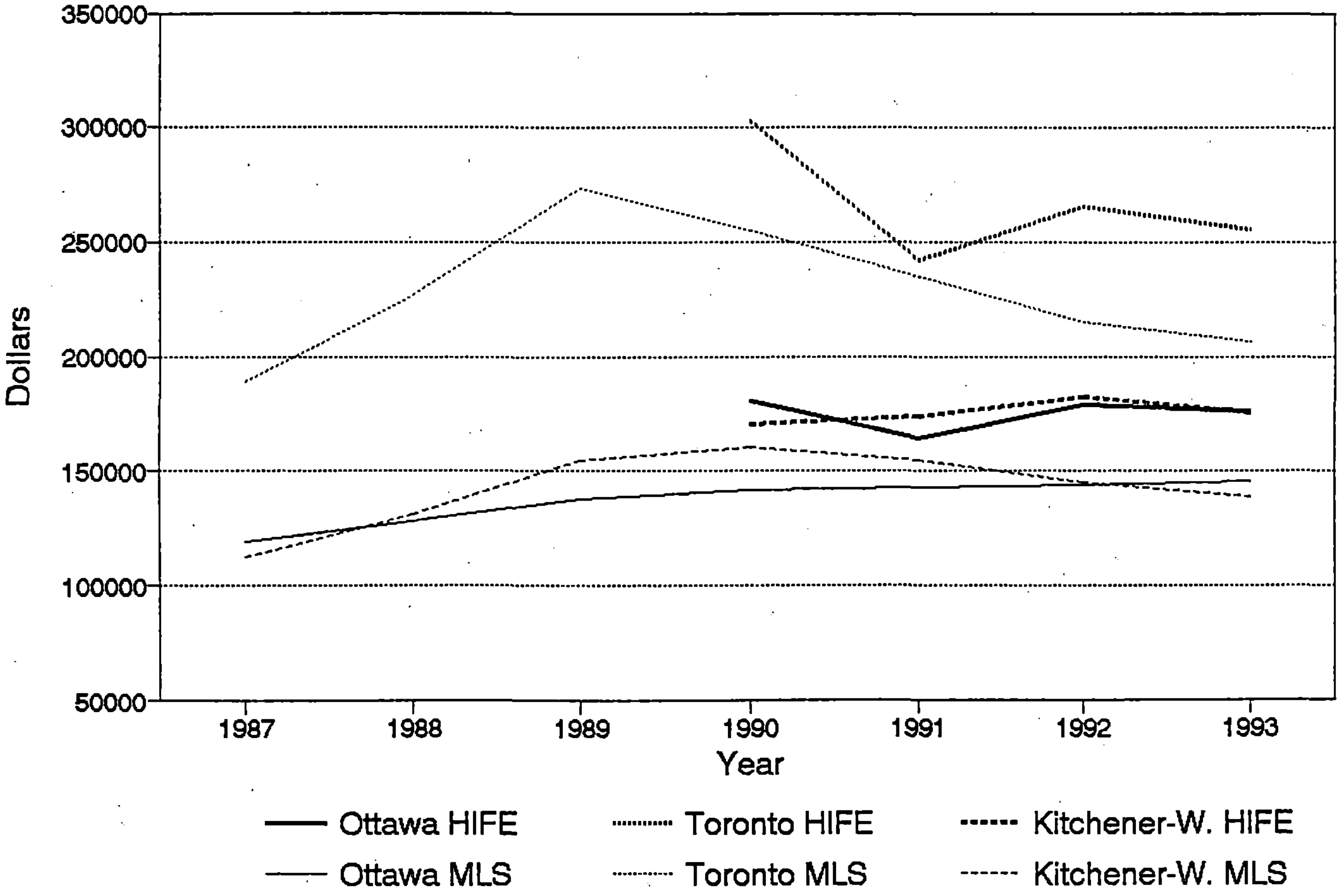


Chart A1.3

Average price, MLS and HIFE
Hamilton, St. Catharines-N, London

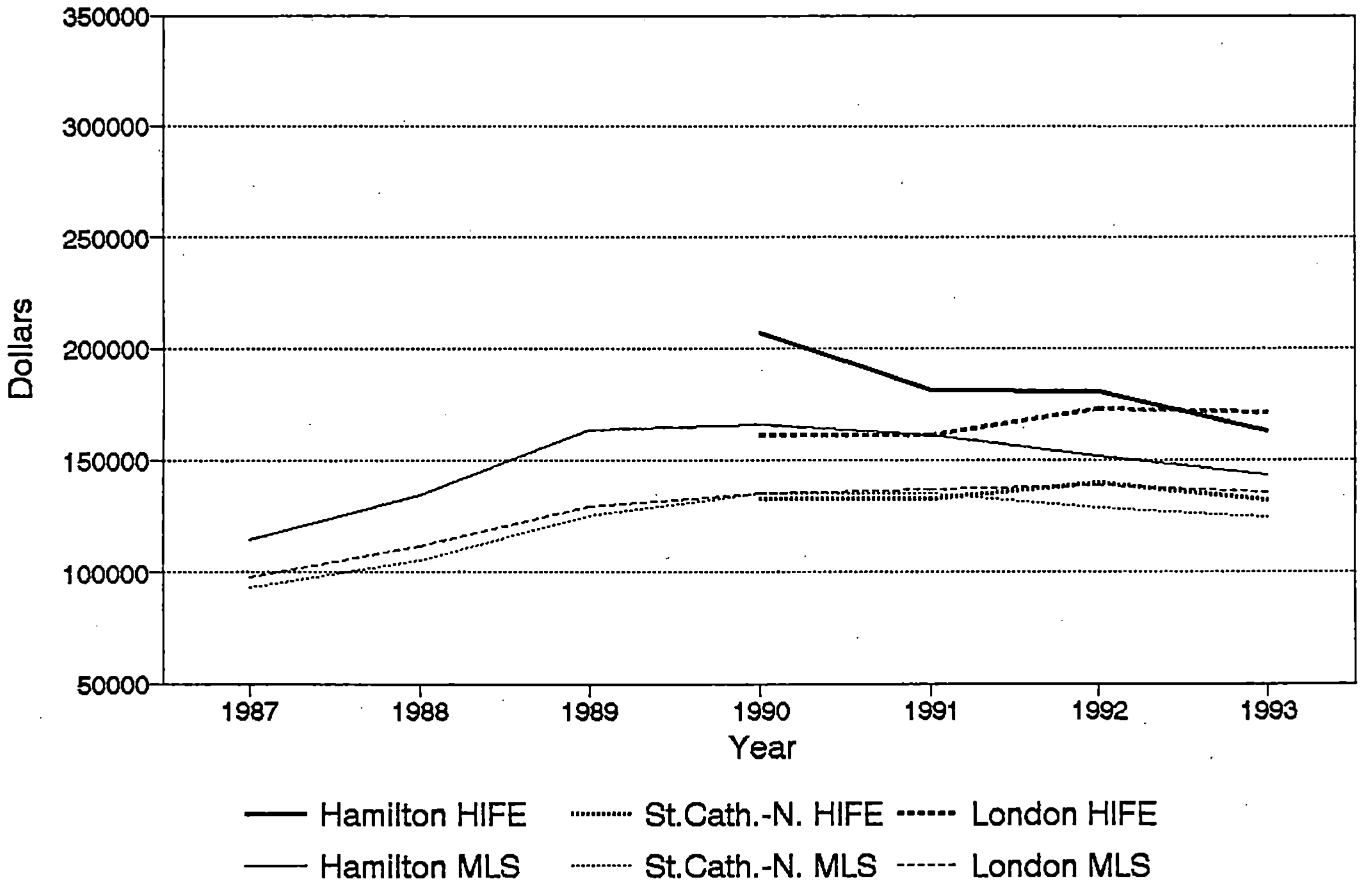


Chart A1.4

Average price, MLS and HIFE
Windsor, Winnipeg, Calgary

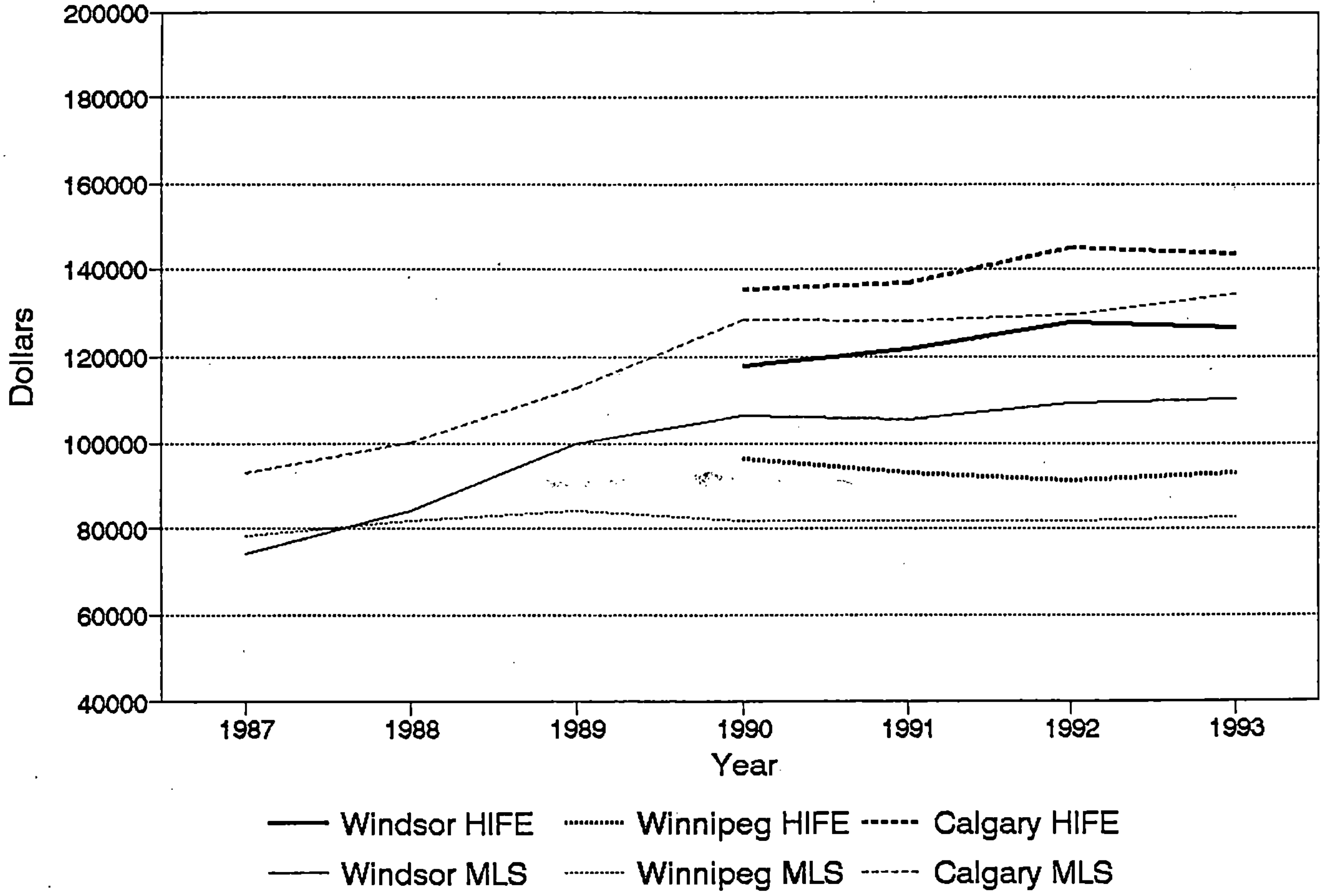
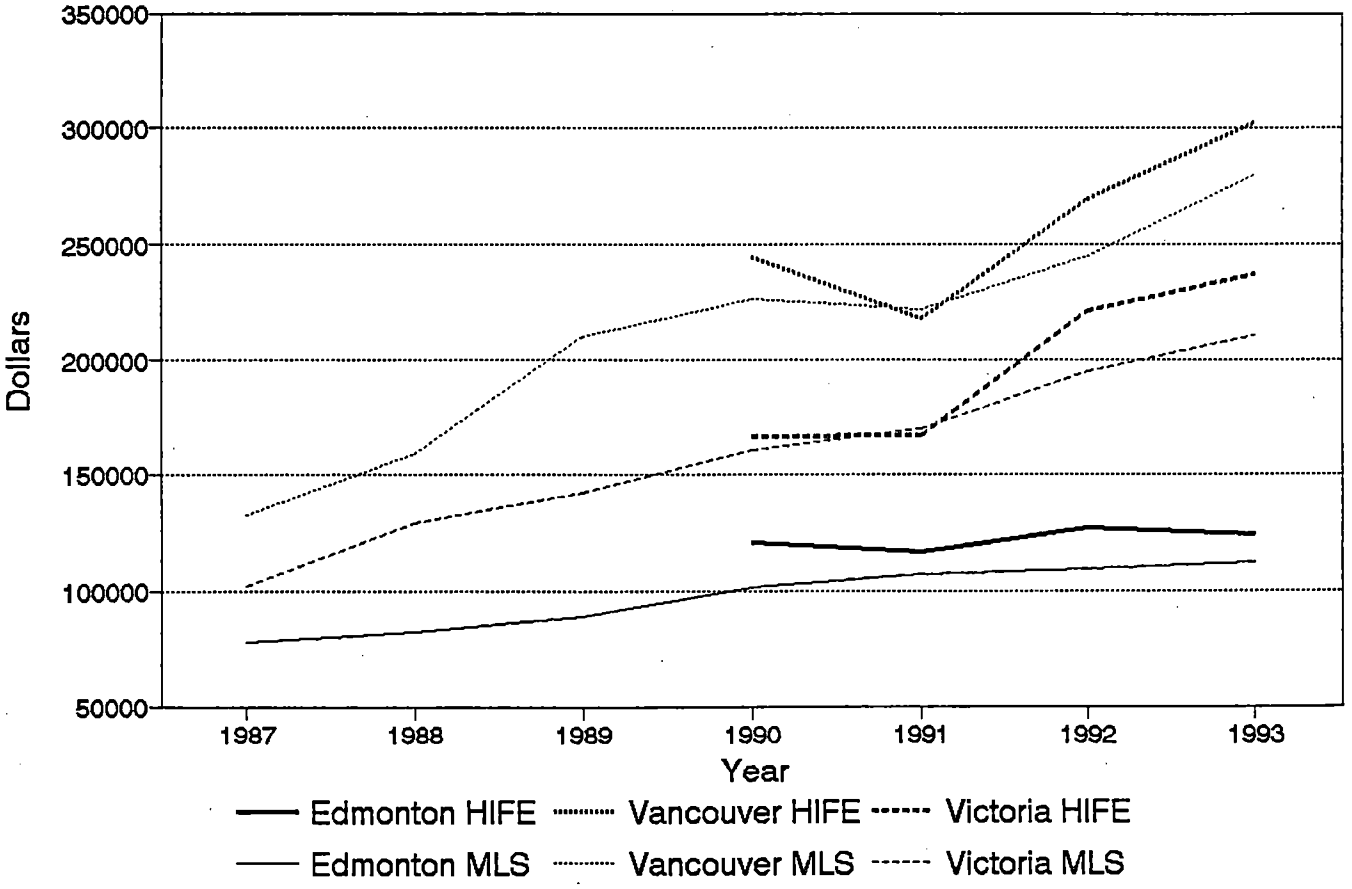


Chart A1.5

Average price, MLS and HIFE
Edmonton, Vancouver, Victoria



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