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Alternative Constant-Quality Price Indexes for Modest Houses and Condominiums in Kitchener-Waterloo

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ALTERNATIVE CONSTANT-QUALITY PRICE INDEXES FOR MODEST HOUSES AND CONDOMINIUMS IN KITCHENER WATERLOO

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Executive Summary

The need for quality-adjusted house price indexes

The house price booms and busts of the last two decades have stimulated interest in quality-adjusted house price indexes for existing houses. Indexes are needed for a modest house, a "starter home" in order to construct a home ownership affordability index for renters. Price indexes are also needed to allow analysts to determine the extent to which markets are overheated or depressed. Existing indicators cannot be depended to fill these needs. The average Multiple Listing Price is not quality adjusted. The Royal LePage prices of various house types are appraisal-based, subject to the excessive smoothing characteristic of appraisals. The Statistics Canada New House Price Index covers new houses, not existing ones. In addition, most of these are not specifically indicators for *starter* homes.

This study estimates an array of alternative price indexes, some based on methods well known in the house price index literature and some based on variants of these methods. All estimates produced in this study are based on non-arbitrary statistical procedures, so that they are reproducible by other investigators, unlike estimates which are based on judgment.

Theory and modelling for the construction of house price indexes

This study uses the well-known hedonic method for constructing a price index. The basic element of this method is a regression in which the dependent variable is the price of a house (in this study in logarithm form) and the independent variables are characteristics of the house, such as number of rooms and whether or not there is a fireplace. The price of a house of given characteristics is then estimated by plugging the given characteristics into the estimated regression.

Price indexes based on hedonic regressions in the past have been constructed by housing analysts with little regard for underlying index number theory. This study does consider the theory, and specifically the "index number problem" arising from the fact that a specific package of characteristics has to be priced. It concludes that a chain index, which allows the priced bundle to change from period to period, is most appropriate. A chain index based on the Fisher index (the geometric mean of the Laspeyres and Paasche indexes) is preferred. The study estimates Quasi Fisher Chain, Quasi Laspeyres and Quasi Paasche indexes. We call these three indexes flexible relative price indexes, because the relative imputed price of characteristics is allowed to vary over time; for example the imputed price of an additional bathroom relative to that of a recreation room is allowed to vary. The flexible relative price indexes use as inputs regressions and sets of mean characteristics estimated by quarter.

This study also estimates fixed relative price indexes. These require only a single regression for the whole time period, but have strong restrictive assumptions. The first method, the constrained hedonic procedure, assumes that all characteristics of a house change in price at the same rate, so that index number problems are assumed away. The second method, the repeat sales procedure, uses as raw data the prices of only those properties transacting twice during the sample period. It eliminates the index number problem by assuming that all properties change in price at the same rate. It has the great advantage that it does not require knowledge of house characteristics. A major disadvantage is that repeat sales properties may be a biased sample of all properties transacted.

Because the major aim of the study is the estimation of indexes for starter homes, the study estimates many indexes using only transactions of properties broadly fitting into the starter home category. This is consistent with the Consumer Price Index method of pricing only goods which are purchased by households within a limited income range.

The base data, the starter subsamples and characteristics of outliers

This study uses an extraordinarily rich dataset, with information on a large array of structural variables augmented by neighbourhood and accessibility information. The time period is short but is rich in variety, including quarters in the late 1980s boom, the peak of the boom, and the downturn. The base sample, for semi and single-detached houses (sometimes referred to below simply as "houses") consists of 9856 transactions, all sold in Kitchener Waterloo in 1988 to 1990 through the Kitchener-Waterloo Real Estate Board's Multiple Listing Service (MLS). The base sample for condominiums--many of which are townhouse units--consists of 1616 transactions.

The subsample used for the starter home and starter condominium indexes was not selected on the basis of price, to avoid sample selection bias. Instead, the Royal LePage specifications for a standard bungalow and standard condominium were used as starting guides. These specifications were then amended in view of the particular characteristics of Kitchener-Waterloo properties and of the imputed characteristics prices, as estimated in hedonic regressions on the total sample. Houses were eliminated if they were less than five years old, had a den, a family room, a two or three-car garage, an inground pool, or more than one fireplace. Houses with two full bathrooms were not eliminated but those with one full bath and two half baths were. The maximums for lot area and living area were set somewhat higher than the Royal LePage standard, in part because finished basement rooms were included in the total living area in this study. The prices of houses in the starter subsample reflect their modest quality: more than 80 per cent have a real value (first quarter 1988 dollars) at or below $115,000, while more than two-thirds of the non-starters have a real value above this amount.

For the condominium starter subsample, bathroom and living area constraints were stricter, and new dwellings were not eliminated. For this subsample, the living area is on average 78 per cent of that for non-starters, in contrast with the analogous ratio for houses of 72 per cent.

Because of concern about outliers, prices much higher or lower than predicted, indexes were also estimated for a second subsample, one with outliers systematically eliminated. The most striking characteristic of outlier properties is their age: 56 per cent are over 50 years of age, as compared to only 16 per cent of non-outliers.

The hedonic regression results

The hedonic regressions include as independent variables virtually every structural characteristic available from the MLS records, on the grounds that listing real estate agents have a clear incentive to include information which will affect the price of the property. In addition, neighbourhood and accessibility variables generated through a matching of MLS and Census maps are included. As a consequence, for starter houses there are 39 regressors in each quarterly regression and 50 in the single regression for the whole period (the constrained hedonic). The proportion of variance explained was high.

The regression specification assumes that a unit change in a characteristic has a constant *percentage* effect on value rather than a constant dollar effect. This nonlinearity is consistent with the view that, when a bathroom is added to an expensive house, it is likely to be of higher quality than if it is added to an inexpensive house. The specification holds up well in the estimation. Most coefficients other than the neighbourhood and accessibility variables are statistically significant and overall the coefficient values are highly plausible. For a starter houses, on the basis of the constrained hedonic regression, an additional bedroom *carved out of a given floor space* adds 3 per cent to value, a full bathroom 4 per cent, and a half bathroom 3 per cent, while a recreation room *reduces* value by 0.4 per cent. Adding a recreation room by adding finished space--typically by finishing a basement--is estimated to *add* about 2.5 per cent to value. These effects are less than the percentage effects estimated in the all houses regression. The estimated proportional negative effect of UFFI is, however, greater for starter houses than for all houses.

The estimated effect of age on the value of houses is striking. Taken together the regression results for all houses and starter houses indicates that the rate of depreciation is highly nonlinear--it is higher than commonly assumed for recently built houses and far lower than commonly assumed for houses older than 15 years.

The price index results

The various price indexes generated using hedonic regressions for starter houses show strikingly similar results: all show a strong rise in 1988 (which steepens from the end of 1988 to the end of 1989), a peak in the first quarter of 1990 and a substantial fall over the rest of 1990. Single and semi-detached houses, overall, rose in price slightly faster than did starter houses in 1988 but more slowly in 1989, so that starter houses peaked at a slightly higher value. We emphasize that the difference between the starter house price index and the all house index is *slight*. Starter condominiums are estimated to have risen by about 5 percentage points more than starter houses at the peak.

In general, among indexes for all houses and starter houses which used the hedonic regressions as their basis, there was little variation. In the case of condominiums, however, there were quite substantial differences, with the quasi Fisher Chain index--which is preferred on theoretical grounds--several percentage points below the constrained hedonic index at the peak and also below it at the end of the period.

The repeat sales indexes were substantially higher than the preferred hedonic-based indexes at the peak for both houses and condominiums (see Chart 4.3, 4.6). There is some suspicion that repeat sales indexes will tend, in general, to overstate price peaks, a reason to be cautious in the use of this kind of index.

Comparisons to other indicators of the prices of starter houses and condominiums

As Chart 4.3 shows, the MLS average price (in index version) is surprisingly similar to the quasi Fisher Chain index--somewhat higher in the early quarters but virtually the same in the peak quarters and during the downturn. The average price of National Housing Act existing houses is also substantially similar, overall, but it reaches a later and strikingly higher peak than the quasi Fisher Chain index. The Royal LePage index, reflecting the smoothing characteristic of appraisal-based indexes cuts off the final run-up, peak and early downturn of the boom, ending the period a little higher than the other indicators. Statistics Canada's New House Price Index severely undershoots both actual price increases for new houses (as estimated using a constrained hedonic regression on the subsample of new houses in our total sample (see Chart 4.4)), and our estimated price increases for starter houses. For condominiums the story is similar (Chart 4.5), except that the NHA existing average here is much less useful than it is for houses. The NHA average indicates a price level much higher at the end of the period than that indicated by other indexes.

Implications of this study

The results of this study suggest that the quasi Fisher Chain Index estimated using the starter subsample is the best choice of index for starter houses, when funds and data are available. The quasi Fisher Chain is preferable on theoretical grounds to the two alternative flexible relative price indexes, the quasi Laspeyres and quasi Paasche indexes because it is weighted to reflect current and previous choices of purchasers.

While for houses there is little difference among indexes computed using the three flexible relative price methods, for all condominiums differences are quite large. Note that computerization means that computing the quasi Fisher Chain is no more troublesome than computing the quasi Laspeyres and quasi Paasche.

The choice of method when resources are constrained depends on the nature of the constraint. When limited *data* are the constraint--typically because there are very few observations for downturn quarters--the constrained hedonic is an appropriate method. Because a single regression is used for all periods, this method places little demand on the data. When limited *funds* are the constraint, the repeat sales method should be considered. Its basic regression requires no information about property characteristics. Some information is required, however, to determine whether or not a property should be eliminated because it changed between sales. Further, the repeat sales index results should be used with some caution for a few quarters at the beginning and end of the sample period, and at peaks.

The empirical results of this study indicate that the expense undergone to delineate starter houses separately from all houses was not warranted for Kitchener-Waterloo for these years. The price indexes for starter houses are very similar to those for all houses. Some literature suggests that this may not be true in general, however.

We believe that the results in this study probably generalize beyond Kitchener-Waterloo. At the least, negative results must be taken seriously. For example, the poor performance of the New House Price index means that in general it is suspect; and the high value of NHA averages at the 1990 peak suggests that NHA averages should be used gingerly at peaks.

«Nouveaux indices des prix à qualité constante pour les maisons et logements en copropriété à caractère modeste à Kitchener-Waterloo»

Résumé

Pourquoi des indices des prix des maisons en fonction de la qualité

Les fluctuations des prix des maisons ces deux dernières décennies ont stimulé l'intérêt pour des indices des prix tenant compte de la qualité pour les maisons en revente. On a besoin d'indices portant sur une maison modeste, une maison «d'accédant à la propriété», afin de calculer un indice d'abordabilité de la propriété pour les locataires. Ces indices permettraient aussi aux analystes de déterminer dans quelle mesure ces marchés sont en surchauffe ou en dépression. Les indicateurs actuels ne correspondent pas vraiment à ces besoins. Le prix moyen du service interagences (MLS) ne tient pas compte de la qualité. Quant aux prix Royal LePage pour les divers types de maisons, ils se fondent sur des évaluations et en subissent par conséquent un lissage excessif. L'indice du prix des maisons neuves de Statistique Canada porte uniquement sur les maisons neuves, non sur les maisons existantes. En outre, il ne s'agit pas dans la plupart des cas d'indices portant expressément sur les maisons d'accédants à la propriété.

Nous évaluons ici un éventail d'autres indices, dont certains se fondent sur des méthodes bien connues dans la documentation sur les indices des prix des maisons et d'autres sur des variantes de ces méthodes. Toutes les estimations produites ici utilisent des méthodes statistiques non arbitraires et peuvent donc être reproduites par d'autres chercheurs, à la différence des estimations fondées sur le jugement.

Théorie et modèles pour la construction d'indices des prix des maisons

Nous utilisons ici la méthode hédonistique bien connue pour la construction de l'indice des prix des maisons. L'élément fondamental de cette méthode est une régression où la variable dépendante est le prix d'une maison (ici sous forme logarithmique) et les variables indépendantes sont les caractéristiques de la maison, comme le nombre de chambres et la présence de foyer. On calcule ensuite le prix d'une maison possédant des caractéristiques données en insérant les caractéristiques dans la régression estimative.

Jusqu'ici, les analystes n'ont guère tenu compte de la théorie du nombre indice dans l'élaboration d'indices des prix fondés sur des régressions hédonistiques. Nous en tenons compte ici, et particulièrement du «problème du nombre indice» découlant du fait qu'il faut calculer le prix d'un ensemble donné de caractéristiques. Nous concluons qu'un indice en chaîne, qui permet de modifier le faisceau d'une période à l'autre, est celui qui convient le mieux. Un indice en chaîne fondé sur l'indice de Fisher (la moyenne géométrique des indices de Laspeyres et de Paasche) a été retenu. Nous calculons une chaîne quasi Fisher et des indices quasi Laspeyres et quasi Paasche. Nous appelons ces trois indices des indices flexibles des prix relatifs, parce que le prix relatif imputé des caractéristiques peut varier avec le temps; par exemple, le prix imputé d'une salle de bain supplémentaire par rapport à celui d'une salle de loisirs peut varier. Les indices flexibles des prix relatifs utilisent comme intrants des régressions et des ensembles de caractéristiques moyennes estimées par trimestre.

Nous calculons aussi des indices fixes des prix relatifs. Ceux-ci n'exigent qu'une seule régression pour toute la période visée, mais comportent des hypothèses fortement restrictives. La première méthode, la méthode hédonistique restrictive, suppose que le prix de toutes les caractéristiques de la maison évolue au même rythme, de sorte que les problèmes de nombre indice sont éliminés par hypothèse. La seconde méthode, celle des ventes à répétition, utilise comme seules données brutes les prix des propriétés faisant l'objet de deux transactions au cours de la période. On élimine ainsi le problème de nombre indice en supposant que le prix de toutes les propriétés évolue au même rythme. Le grand avantage est qu'il n'est pas nécessaire de connaître les caractéristiques des maisons, tandis que cette méthode présente le grand désavantage que les propriétés vendues plus d'une fois peuvent constituer un échantillon biaisé de l'ensemble des propriétés ayant fait l'objet d'une transaction.

Puisque l'étude vise surtout les indices pour les maisons d'accédants à la propriété, nous calculons plusieurs indices utilisant uniquement des transactions portant sur des propriétés appartenant en gros à cette catégorie. Ceci est conforme à la méthode de l'indice des prix à la consommation, qui porte uniquement sur les biens achetés par les ménages appartenant à une fourchette restreinte de revenu.

Les données de base, les soue-échantillons de maisons d'accédants à la propriété et lee caractéristiques des cas extrêmes

L'étude utilise un ensemble extraordinairement riche de données, l'information sur un vaste éventail de variables structurales étant augmentée par des renseignements sur le quartier et l'accessibilité. La période visée est brève, mais riche de variété, comprenant des trimestres du boom de la fin des années 80, le sommet du boom et la baisse. L'échantillon de base pour les maisons individuelles et jumelées (parfois désignées ci-après tout simplement «maisons») comprend 9 856 transactions, toutes faites à Kitchener-Waterloo entre 1988 et 1990 par l'entremise du service MLS de la chambre d'immeuble locale. L'échantillon des logements en copropriété souvent des maisons en rangée comprend 1 616 transactions.

Le sous-échantillon utilisé pour les indices des maisons et des logements en copropriété pour accédants à la propriété n'a pas été choisi en fonction du prix, pour éviter de biaiser la sélection de l'échantillon. On a plutôt utilisé comme guide de départ les normes de Royal LePage pour la maison et le logement en copropriété standards. Ces normes ont ensuite été modifiées en fonction des caractéristiques particulières des propriétés de Kitchener-Waterloo et des prix des caractéristiques imputées, selon les régressions hédonistiques sur l'ensemble de l'échantillon. On a éliminé les maisons de moins de cinq ans, possédant une pièce de détente, une salle familiale, un garage pour deux ou trois voitures, une piscine creusée ou plus d'un foyer. Les maisons possédant deux salles de bains complètes ont été retenues, mais non celles qui comptent une salle de bain complète et deux demies. Le maximum de la superficie habitable et de la superficie du terrain a été fixé un peu plus haut que la norme Royal LePage, en particulier parce que les pièces finies du sous-sol étaient comptées dans la superficie habitable. Le prix des maisons du sous-échantillon des accédants à la propriété reflète leur caractère modeste : plus de 80 p. 100 ont une valeur réelle (en dollars du premier trimestre de 1988) qui ne dépasse pas 115 000 $, tandis que plus des deux tiers des autres ont une valeur réelle supérieure à cette somme.

Le sous-échantillon des logements en copropriété pour accédants à la propriété était soumis à des restrictions plus rigoureuses en ce qui touche les salles de bains et la superficie habitable et les logements neufs n'étaient pas éliminés. Pour ce sous-échantillon, la superficie habitable est en moyenne 78 p. 100 de celle des autres logements, tandis que le chiffre comparable pour les maisons est de 72 p. 100.

En raison des problèmes que pouvaient poser les prix de beaucoup supérieurs ou inférieurs aux prévisions, on a aussi calculé des indices pour un second sous-échantillon d'où les cas extrêmes étaient systématiquement éliminés. La caractéristique la plus frappante de ces propriétés est leur âge : 56 p. 100 ont plus de 50 ans, en comparaison de seulement 16 p. 100 des autres propriétés.

Les résultats de la régression hédonistique

Les régressions hédonistiques incluent parmi les variables indépendantes presque toutes les caractéristiques structurales figurant dans les dossiers MLS, pour le motif que les agents vendeurs ont clairement intérêt à inclure toutes les données qui influencent le prix de la propriété. On a aussi inclus des variables de quartier et d'accessibilité générées par la comparaison des cartes du MLS et du recensement. En conséquence, pour les maisons d'accédants à la propriété, chaque régression trimestrielle comporte 39 régresseurs, tandis qu'il y en a 50 dans la régression unique pour toute la période (régression hédonistique restrictive). La proportion de variance expliquée était élevée.

Le devis de régression suppose qu'une modification unitaire d'une caractéristique a un effet constant en pourcentage sur la valeur plutôt qu'un effet constant en dollars. Cette non linéarité concorde avec l'idée que si on ajoute une salle de bain à une maison coûteuse, elle sera vraisemblablement de qualité supérieure à celle qui serait ajoutée à une maison bon marché. Le devis supporte bien l'estimation. La plupart des coefficients autres que les variables de quartier et d'accessibilité sont statistiquement significatifs, et dans l'ensemble, les valeurs des coefficients sont fortement plausibles. Pour les maisons d'accédants à la propriété, d'après la régression hédonistique régressive, une chambre à coucher additionnelle prise sur une superficie donnée ajoute 3 p. 100 à la valeur, une salle de bain complète 4 p. 100, et une demi-salle de bain 3 p. 100 tandis qu'une salle de loisirs réduit la valeur de 0,4 p. 100. On estime qu'ajouter une salle de loisirs par l'augmentation de la superficie finie, d'ordinaire en finissant le sous-sol, ajoute environ 2,5 p. 100 à la valeur. Ces effets sont inférieurs aux effets en pourcentage calculés par la régression sur l'ensemble des maisons. L'effet négatif proportionnel de la MIUF est cependant plus grand pour les maisons d'accédants à la propriété que pour l'ensemble des maisons.

L'effet de l'âge sur la valeur des maisons est frappant. Ensemble, les résultats de régression pour l'ensemble des maisons et pour les maisons d'accédants à la propriété révèlent que le taux de dépréciation est fortement non linéaire, il est plus élevé qu'on ne se suppose d'habitude pour les maisons récentes et de beaucoup inférieur aux hypothèses habituelles pour les maisons de plus de 15 ans.

Les résultats des indices des prix

Les divers indices des prix générés au moyen de régressions hédonistiques pour les maisons d'accédants à la propriété donnent des résultats très semblables : tous indiquent une forte hausse en 1988 (qui s'accélère entre la fin de 1988 et la fin de 1989), un sommet au premier trimestre de 1990 et une chute substantielle au cours du reste de 1990. Les prix des maisons individuelles et jumelées, dans l'ensemble, ont augmenté un peu plus rapidement que les maisons d'accédants à la propriété en 1988, mais plus lentement en 1989, de sorte que le sommet des maisons d'accédants à la propriété se situe à une valeur légèrement plus élevée. Nous soulignons que la différence entre l'indice des prix des maisons d'accédants à la propriété et l'indice des prix de l'ensemble des maisons est légère. Les logements en copropriété pour accédants ont augmenté d'environ 5 points de pourcentage de plus au sommet que les maisons d'accédants.

En général, il n'y avait guère de variation entre les indices fondés sur des régressions hédonistiques pour l'ensemble des maisons et pour les maisons d'accédants à la propriété. Dans le cas des logements en copropriété, toutefois, il y avait des différences assez substantielles, l'indice de la chaîne quasi Fisher préférable pour des motifs théoriques étant inférieur de plusieurs points de pourcentage à l'indice hédonistique restrictif au sommet et aussi à la fin de la période.

Les indices fondés sur les ventes à répétition étaient substantiellement plus élevés au sommet que les indices fondés sur la régression hédonistique, qui sont préférés, tant pour les maisons que pour les logements en copropriété (voir les tableaux 4.3 et 4.6). On soupçonne que les indices des ventes à répétition auront en général tendance à exagérer les sommets, ce qui incite à la prudence dans l'utilisation de ce genre d'indice.

Comparaisons avec d'autres indicateurs des prix des maisons et des logements en copropriété pour les accédants à la propriété

Comme le montre le tableau 4.3, le prix moyen MLS (version indice) est étonnamment semblable à l'indice de chaîne quasi Fisher un peu plus élevé dans les premiers trimestres, mais presque identique dans les trimestres du sommet et au cours de la baisse. Le prix moyen des maisons existantes assurées aux termes de la Loi nationale sur l'habitation est aussi substantiellement semblable dans l'ensemble, mais il présente un sommet beaucoup plus tardif, et beaucoup plus élevé, que l'indice de la chaîne quasi Fisher. L'indice Royal LePage, qui présente le lissage des indices fondés sur l'évaluation, réduit la fin de la hausse, le sommet et le début de la baisse, pour terminer la période un peu plus haut que les autres indicateurs. L'indice du prix des maisons neuves de Statistique Canada reste fortement inférieur à la fois aux augmentations réelles du prix des maisons neuves (d'après une régression hédonistique restrictive sur le sous-échantillon des maisons neuves de l'ensemble de notre échantillon (voir le tableau 4.4)), et nos augmentations estimatives des prix des maisons pour accédants à la propriété. La situation est semblable pour les logements en copropriété (tableau 4.5), si ce n'est que la moyenne des maisons existantes LNH est moins utile que dans le cas des maisons. La moyenne LNH donne un prix beaucoup plus élevé à la fin de la période que les autres indices.

Conclusions de l'étude

Les résultats de l'étude donnent à penser que l'indice de la chaîne quasi Fisher à partir du sous-échantillon des maisons pour accédants à la propriété est le meilleur choix pour les maisons pour accédants, lorsqu'on dispose des fonds et des données nécessaires. Il est préférable aux deux autres indices flexibles des prix relatifs, quasi Laspeyres et quasi Paasche, parce qu'il est pondéré en fonction des choix actuels et antérieurs des acheteurs.

Alors que les indices calculés selon les trois méthodes ne présentent guère de différences pour les maisons, dans le cas de l'ensemble des logements en copropriété les différences sont très considérables. Il faut signaler qu'avec l'informatisation, il n'est pas plus difficile de calculer la chaîne quasi Fisher que les indices quasi Laspeyres et quasi Paasche.

Si les ressources sont rares, le choix de méthode dépend de la nature de la restriction. Si ce sont les données qui manquent d'ordinaire parce qu'il y a peu d'observations pour les trimestres de ralentissement c'est la régression hédonistique restrictive qui convient. En effet, puisqu'elle utilise une seule régression pour toutes les périodes, cette méthode n'est pas exigeante sur le plan des données. Si ce sont les fonds qui manquent, on devrait songer à la méthode des ventes à répétition, car la régression de base n'exige pas de données sur les caractéristiques des propriétés. Il faut toutefois certains renseignements pour déterminer s'il faut éliminer une propriété parce qu'elle a été modifiée entre les ventes. En outre, il faut utiliser avec une certaine prudence les résultats de l'indice des ventes à répétition pendant quelques trimestres au début et à la fin de la période d'échantillonnage et lors des sommets.

Les résultats empiriques de l'étude révèlent que les dépenses engagées pour distinguer les maisons d'accédants à la propriété n'étaient pas justifiées dans le cas de Kitchener-Waterloo pour les années en cause. Les indices des prix pour les maisons d'accédants à la propriété sont très semblables à ceux de l'ensemble des maisons. Certains ouvrages donnent cependant à penser que cette conclusion n'est peut-être pas d'application générale.

Nous croyons que les résultats de cette étude peuvent probablement être généralisés à d'autres cas que Kitchener-Waterloo. Par exemple, le piètre rendement de l'indice du prix des maisons neuves le rend suspect en général et la valeur élevée des moyennes LNH au sommet de 1990 porte à croire qu'il faut les utiliser avec la plus grande prudence au moment des sommets.

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Table of Contents

List of Tables

List of Charts

ABSTRACT

Quality-adjusted price indexes for modest-prices houses and condominiums, "starter" homes, are needed for the construction of home ownership affordability indexes for renters and for accurate information about market price cycles. This study estimates an array of prices indexes for this purpose.

The basic statistical method used for most of the indexes estimated by this study is hedonic regression. This exploits the fact that the market price of a house depends on its characteristics (e.g. the amount of living area, the number of full and half bathrooms, whether or not there is a fireplace), making it possible to estimate the quality-adjusted price of a house at various points of time. Flexible relative price indexes, which allow the relative price of house characteristics to vary over time, are estimated, as are fixed relative price indexes, which assume that the prices of all characteristics change at the same rate. Also estimated are repeat sales indexes. These are not based on a hedonic regression but on a simple regression run on the prices of only those properties trading twice within the period. Roughly, this method takes the quality-adjusted price change as equal to the percentage change in the price of a property, averaged over all properties selling twice. The repeat sales method implicitly assumes that all properties change in price at the same rate.

The hedonic-based indexes are estimated separately for all houses, all condominiums and for starter homes. The data are Multiple Listing Service data for Kitchener-Waterloo for 1988 to 1990. The most striking result is the strong similarity among the estimated indexes. For example, all indexes for houses and condominiums reach their peak in the first quarter of 1990. It is noteworthy that the repeat sales indexes show a higher peak than other indexes.

For this city for this period the MLS average generally closely tracks the quality adjusted starter home indexes, although it is somewhat higher in early quarters. The NHA average for existing houses also tracks estimated indexes well, overall, for houses (but not for condominiums) except that it reaches a later and higher peak. The Royal LePage price for a standard bungalow misses the peak but ends the period at a quite similar level to the estimated indexes. Statistics Canada's New House Price Index substantially undershoots the hedonic index for new houses estimated in this study.

CHAPTER I
INTRODUCTION

I.THE NEED FOR QUALITY ADJUSTED PRICE INDEXES FOR STARTER HOMES

Recently, government agencies and academic researchers have shown interest in quality-adjusted house price indexes for existing houses. Indexes are needed for a number of purposes. First, they are needed as a component of an home ownership affordability index for households who are not home owners. The price index needed for this purpose is a price index for a relatively inexpensive house, a so-called "starter home." Price indexes are also needed to allow analysts to determine whether markets are overheated or depressed, and if so, the extent to which they are in these states. For these purposes indexes must accurately reflect price movements not only over an extended period of time but also within any single price cycle.

The most widely used indicator of house price change is the Multiple Listing Service average price. But for Kitchener-Waterloo, existing quality-adjusted indexes, the Statistics Canada New House Price Index (NHP) and the Royal Lepage (RL) standard bungalow and condominium indexes, rise much less in the boom years of 1988 and 1989 than does the Multiple Listing Service average price. This suggests that the MLS average price may be problematic as an indicator of short run price changes, although the MLS index may be a good indicator of price changes from trough to trough. For different reasons, however, the two quality-adjusted indexes, the NHP and RL indexes, are also unsatisfactory. This leaves the question of how to construct a satisfactory index.

A cheap solution to the requirement for a quality-adjusted index is the "repeat sales" method. This method uses as data the price changes of properties which sold at least twice in the sample period. Hosios and Pesando (1992a and 1992b) have targeted this procedure as the best choice for government agencies.

Several concerns about the repeat sales method have been noted in Goy (1992) and elsewhere (e.g Haurin and Hendershott, 1991; Case and Quigley, 1991; Case, Pollakowski and Wachter, 1991; Clapp, Giacotto and Tirtiroglu, 1992). One concern is the identification of properties in the sample which have undergone renovation between sales. A second problem is the lack of smoothness in the index (Goy, 1992; Clapp, Giacotto and Tirtiroglu, 1991).

A more fundamental concern is the fact that the repeat sales method assumes that the prices of all kinds and qualities of houses in any given market rise at the same rate. For instance the repeat sales method assumes that a small, one-bathroom bungalow built in 1940 experiences the same percentage change in price as a large house with three bathrooms built in 1985. More critically, the repeat sales method assumes that it does not matter whether the sample of sales in any period is dominated by "executive" houses or whether it is dominated by "starters."

A second possible solution to the search for a quality-adjusted price index is the use of the constrained hedonic method (Palmquist, 1980; Clapp, Giacotto, and Tirtiroglu, 1991; di Pasquale and Sommervile, 1993; and others) but this method assumes that all house *characteristics* change in price at the same rate. Thus the same fundamental objections may be made to this method as to the repeat sales method. An advantage of this method over the repeat sales method, however, is that it uses a larger sample, that is, all house transactions rather than the subset which are repeat sales; as a consequence, the resultant index is smoother than the repeat sales index. '

An example of a situation in which the use of the standard repeat sales and constrained hedonic methods may substantially overestimate price rises is the following: suppose that towards the end of price booms big, high quality houses rise more than smaller starter homes, and suppose bigger homes are a more important part of the market in such periods; then constrained hedonic and repeat sales methods will show a higher rate of house price increase than classical price index methods. The possibility that these methods overestimate the extremes of price cycles is a serious concern if price indexes are to be used for policy purposes. Important doubts are raised about the appropriateness of both the repeat sales and the constrained hedonic methods.

The extent of possible differences over a period of first rising and then falling prices, among a variety of house price indicators, is indicated by the time series in Table 1.. The MLS average and the National Housing Act average are both averages of transaction prices; inherently, there is no adjustment for quality change. Accordingly, changes often reflect changes in the mix of houses rather than in the price of any particular type of house. In any case, the MLS average price in the second quarter of 1990 is about 30.2 percent greater than it was in the first quarter of 1988, while the Royal LePage-based standard bungalow index is only 27.1 percent higher, and the New House price index--which, like the Royal LePage index, is a constant quality index for a single-detached house--is merely 22.2 percent higher. The Royal LePage-based condominium index rose only 22.7 percent.

Table 1
Existing Nominal House Price Indexes for Kitchener-Waterloo

Year	Month	CPI (1986)	MLS Ave. Price	StatCan New House	Royal Lepage Stand. Bung.	Royal Lepage Condo	NHA Financed Single-Detach New	NHA Financed Single-Detach Exist.	NHA Financed Condo
1988	1	106.3	100.0	100.0					
	2	106.7	103.5	101.1					
	3	107.3	105.7	102.5	100.0	100.0	100.0	100.0	100.0
	4	107.6	112.2	102.8					
	5	108.3	107.8	103.5					
	6	108.5	110.2	105.9	100.0	100.0	101.3	101.8	104.9
	7	109.1	109.3	106.0					
	8	109.4	111.4	106.9					
	9	109.5	112.4	108.2	110.0	109.0	109.6	104.0	112.1
	10	110.0	121.0	108.6					
	11	110.3	121.9	109.8					
	12	110.3	124.9	111.4	110.0	109.0	132.7	109.8	113.6
1989	1	110.9	117.3	112.0					
	2	111.6	125.2	115.5					
	3	112.2	128.9	116.8	110.0	113.6	117.5	117.7	123.5
	4	112.5	129.6	117.1					
	5	113.7	129.9	117.9					
	6	114.3	138.5	118.4	115.0	119.1	140.2	128.1	130.6
	7	115.0	134.4	118.7					
	8	115.1	129.6	119.6					
	9	115.3	130.6	120.4	120.8	122.7	143.1	133.0	138.0
	10	115.7	134.4	120.5					
	11	116.1	132.6	121.9					
	12	116.0	134.9	122.2	120.8	122.7	141.3	128.5	154.1
1990	1	117.0	135.4	122.8					
	2	117.7	140.3	124.2					
	3	118.1	138.1	124.5	120.8	122.7	128.3	135.6	147.7
	4	118.1	137.0	124.5					
	5	118.7	140.9	123.1					
	6	119.2	130.5	122.2	127.1	122.7	167.5	138.9	140.6
	7	119.8	135.0	121.7					
	8	119.9	128.3	121.1					
	9	120.2	130.5	120.8	127.1	122.7	160.7	131.1	142.7
	10	121.2	127.8	118.7					
	11	121.9	129.6	115.7					
	12	121.8	128.0	114.0	127.1	122.7	130.4	124.7	138.5
Total % Increase		15.5	28.0	14.0	27.1	22.7	30.4	24.7	38.5

Column:
1. The Consumer Price Index for all items (1986=100),
2. Index derived from MLS average price, residential houses sold in KW.
3. Statistics Canada's new house price index for KW, Cat.62-007.
4. Index from Royal LePage quarterly prices for KW.
5. Index derived from average values of dwellings financed under the National Housing Act, for Kitchener CMA.

II THE APPROACH OF THIS STUDY

There are two basic strategies for tackling objections to the constrained hedonic and repeat sales methods. The first is to use alternative price index methods which do not assume that the price of all house characteristics rise at the same rate. These methods all use hedonic regressions which, because they are run separately for each period, may be called unconstrained hedonic regressions. Indexes using these regressions may be called flexible relative price indexes. We assume that the aim is an index showing the price of a constant-utility house and use Laspeyres, Passche, Fisher Ideal and Fisher Ideal chain indexes. Results in Diewert (1983) imply that the chain principle rather than the fixed base principle should yield results which best approximate a constant utility index.

A second strategy is to estimate an index using only a subset of available property transactions. This subset would be a relatively homogenous set of properties which broadly fit into the starter home category. This is consistent with the Consumer Price Index method of pricing only goods which are purchased by households within a limited income range.

In this study we use both these strategies alone, and we combine them as well.

We apply the methods we develop in this study to data, for the period January, 1988 to December, 1990, for Kitchener-Waterloo, a city of about 300,000, with an active new construction market: housing starts were about five per cent of the Ontario total 1988-1990. Kitchener-Waterloo has an economy based in manufacturing, and has two universities. It is located in southwestern Ontario, far enough from Toronto--about 75 miles--to discourage Toronto-bound commuters. Just prior to the data period used for this study, the average Multiple Listing Service Price rose strongly--by about 85 percent from the beginning of 1985 to the beginning of 1988; the average continued to rise during our data period, reaching a peak in May 1990, about 40 percent above its January 1988 value and has fallen quite substantially since then.

In the next part of this report, we set out the details of the constrained hedonic, repeat sales and classical methods. In III, the data are discussed, as are the different samples selected (base samples, starter home samples and other samples) and the specification of the criteria for the starter house category. In IV, we present and discuss hedonic regression results and index results. In V we discuss the most noteworthy results of this study, and implications of these results for the construction of price indexes in Canada.

CHAPTER II

THEORETICAL AND EMPIRICAL ISSUES IN THE CONSTRUCTION OF REGRESSION-BASED HOUSE PRICE INDEXES

I. INTRODUCTION

It is rare, except in the market for new houses, to find two houses which are the same. This makes it difficult to estimate a quality adjusted price index for houses. To some extent the same problem exists for many other durables, such as automobiles. In the case of most other durables, however, the difficulty is reduced by the fact that the market is dominated by the new product rather than the used, or "existing" product. New products are easier to price over time than the existing ones, because the same model is apt to be produced over a substantial period of time, and because it is relatively likely that the prices of various models will reflect differences in producers' costs among models, so that differences between models can be priced by simply netting out the cost of an additional feature.

The special nature of the house market, especially the existing market, makes it impracticable to use such cost-based methods of adjusting for quality change. Instead, it is reasonable to use methods exploiting the fact that a house may be viewed as a bundle of characteristics. For example a house might consist of the following bundle: 110 square metres of living area, 2 full bathrooms, 1 half bathroom, 1 fireplace. Once it is determined what packages of characteristics should be priced, and what price function (where price is assumed a function of the characteristics of a house) should be used, it is possible to construct quality-adjusted price indexes.

In the next section of this chapter we discuss the "index number problem," caused by the fact that a specific package of characteristics has to be priced, and we consider alternative price index formulas. Next, we consider alternative ways to estimate the price of a package of characteristics; that is, we consider alternative regression specifications. Finally, we consider criteria for the selection of the starter home sample used in regressions. The issue of which price index formula to select is a theoretical one, while choices among regression specifications and sample selection are empirical issues, which, however, have theoretical implications.

II. PRICE INDEX THEORY

The Index Number Problem and Laspeyres, Paasche and Ideal Indexes

The standard index number problem arises because the price index number in year t, given that year 0 is the base year, will vary with the bundle of goods incorporated into the price index in the two years. For example, suppose the expenditure required to purchase the bundle of goods actually chosen in the base year by a representative household is 20 per cent higher in year t than in the base year, while the bundle of goods actually chosen in year t is only 10 per cent more expensive than in the base year. Then the price index in year t, calculated using the base year bundle, will be 120, while the price index using the current year bundle will be 110. The lower relative cost of the currently chosen bundle is to be expected, because households optimize when relative prices change, by removing items which have risen in relative price, substituting items which have fallen in relative price. If the base year bundle is used (producing, for our example the index number 120 in year t), the index is called Laspeyres; if the current year bundle is used (producing for our example the index number 110 in year t) the index is called Paasche.

In contrast to these two indexes, the "ideal" price index for household consumption is the expenditure in year t which would leave the household as well off as it was in the base year, divided by the actual expenditure in the base year. In general this index cannot be computed, but it serves as an analytical reference point. Relative to this index, the Laspeyres index is upward biassed (and the Paasche index is downward biassed). In other words, the Laspeyres, which shows the percentage increase in expenditure required to allow the household *to purchase the same bundle* in year t as in the base year overstates the increase in expenditure required to make the household *as well off* in year t as in the base year. The fundamental reason for these biases is the fact that the Laspeyres and Paasche indexes take no account of substitution possibilities. An example will illustrate the point. Consider a household's purchase of a bundle of fruit, which includes pears in the base year. If pears rise in price greatly, the household will tend to substitute apples (or peaches or grapes or oranges) for pears, so that the rise in expense for a basket of fruit, containing the same quantity of pears after the big price rise as before, exaggerates the expenditure needed to make the household just as contented with its fruit basket as before. The Laspeyres index prices the same basket in both years; the ideal price index prices the baskets which leave the household feeling just as contented with its fruit in the two year.

The discussion so far does not take into account the fact that a price index applying to a large number of households--not just a single household--is generally wanted. This aggregation issue may be avoided by assuming that the aim is a price index for a representative household and that the average package of characteristics chosen by all households is the bundle chosen by this representative household.

Alternative price index formulas

We may now state the Laspeyres and Paasche price indexes formally. The Laspeyres prices the bundle actually purchased in the *base* period. The Laspeyres price index in period t is the price of this bundle in period t divided by its price in the base period. More formally it is

$$\frac{p^t \cdot q^0}{p^0 \cdot q^0} \tag{1}$$

where $p^0 \cdot q^0$ denotes $\sum p_k^0 q_k^0$ and $p^t \cdot q^0$ denotes $\sum_{k=1}^{n} p_k^t q_k^0$, period 0 is the base period, and there are n goods. As is noted above, the Laspeyres index is an upward biased indicator of price change in the sense that it overstates the expenditure required in order that a household be as well off in period t as in the base period; this is one of the fundamental results of price index analysis (see, e.g. Deaton and Muellbauer, 1980).

The Paasche index price the bundle actually purchased in the *current* period. More precisely, the Paasche index is

$$\frac{p^t \cdot q^t}{p^0 \cdot q^t} \tag{2}$$

where $p^0 \cdot q^t$ denotes $\sum_{k=1}^{n} p_k^0 q_k^t$ and $p^t \cdot q^t$ denotes $\sum_{k=1}^{n} p_k^t q_k^t$. The Paasche index is a downward biased indicator of price change in the sense that it understates the expenditure required in order that a household be as well off in period t as in the base period.[1]

[1] More directly, it *overstates* the expenditure required *in period 0* in order that a household be as well off in period 0 as in period t and this in turn implies the result stated in the text.

The Fisher index, a compromise, is the geometric mean of the Laspeyres and Paasche indexes:

$$\left[\frac{p^{t}\cdot q^{0}}{p^{0}\cdot q^{0}}\right]^{\frac{1}{2}}\left[\frac{p^{t}\cdot q^{t}}{p^{0}\cdot q^{t}}\right]^{\frac{1}{2}} \tag{3}$$

The Fisher index is superlative price index (Diewert, 1976, 1983) if preferences are homothetic, that is if income changes do not change the proportions of commodities purchased.

Results in Diewert (1983) imply that the chain principle rather than the fixed base principle should typically yield results which best approximate the ideal price index. Applying the chain principle to the Fisher index gives the Fisher Chain index. For year t it is

$$F_{0,1}\cdot F_{1,2}\cdots F_{(t-1),t} \tag{4}$$

where $F_{(t-1),t}$ refers to $\left[\frac{p^{t}\cdot q^{t-1}}{p^{t-1}\cdot q^{t-1}}\right]^{\frac{1}{2}}\left[\frac{p^{t}\cdot q^{t}}{p^{t-1}\cdot q^{t}}\right]^{\frac{1}{2}}$

If the Fisher index were used in its original form rather than in its chain form, the index for year t would be given by

$$\left[\frac{p^{t}\cdot q^{0}}{p^{0}\cdot q^{0}}\right]^{\frac{1}{2}}\left[\frac{p^{t}\cdot q^{t}}{p^{0}\cdot q^{t}}\right]^{\frac{1}{2}} \tag{5}$$

The rationale for the use of the chain principle (as in (4)) rather than the original index, unchained, as in (5)), is that the Fisher Index is closer to the ideal index for small changes, implying that the bundle should be changed frequently.[2] This is especially important if the index maker is mainly interested in period-to-period percentage changes. A chain index changes the bundle every period; for example, one component of the Fisher chain, the chain Laspeyres, uses the bundle from (t - 1) to measure the price change between (t - 1) and t, while the other component, the chain Paasche, uses the bundle from t to measure the price change between (t - 1) and t . Using (5) instead of the chain index, (4), amounts to discarding the information gained by observing all the choices between period 0 and period t.

III. APPLYING PRICE INDEX THEORY TO HOUSES

The price indexes discussed in the previous section assume that packages of goods are unbundleable. The theory applies well to a bundle of apples, oranges and pounds of hamburger. Oranges can removed from the bundle without changing the price of apples and hamburger; that is, quantities are separable. Expenditure on the bundle is simply the sum of the expenditure on each good.

The situation is more complex in the case of houses, because it is reasonable to assume that the (shadow) price of one characteristic, e.g. a half bathroom, depends on the quantities of other characteristics. Another way of expressing the point is to note that the price indexes (1), (2) etc. all assume that expenditure on the total bundle is a simple linear function of the various items in the bundle, while expenditure on the package of

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[2] A more precise way of considering the issue is to note that (1) the true index lies between the two components of the Fisher Index, the Paasche and the Laspeyres and (2) the latter two are most similar for small changes; so that there is a case for adjusting the bundle frequently.

characteristics making up a house (living area in square feet, number of bathrooms, number of bedrooms, number of other rooms, number of fireplaces, type of exterior material etc.) is not in general a simple linear function of amounts of these characteristics. One reason for this in nonlinear technology. More important reasons are associated with the fact that most houses priced are not new. This has repercussions with respect both to technology and with respect to price determination. First, because different vintages of house co-exist, the stock of houses reflects production from different technologies. Second, because older vintages are not reproducible, prices are demand determined and there is no reason the demand price of a house should be a linear function of its characteristics. For this reason the functional form expressing the price of a house (i.e. total expenditure on the package of characteristics making up a house) as a function of its characteristics could plausibly be assumed to be semilogarithm, e.g. :

$$\ln P_i = \alpha + \beta_1 X_{1i} + \cdots + \beta_k X_{ki} + \gamma_1 Z_{1i} + \cdots + \gamma_m Z_{mi} + u_i \tag{6}$$

where the $X_{1i},\cdots,X_{ki}$ and $Z_{1i},\cdots,Z_{mi}$ are sets of continuous and dummy variables, respectively,[3] u_i is a white noise stochastic term, and the time index (on the price of a house and the parameters) is omitted for simplicity. Note that, for this specification, the marginal price of each characteristic equals its coefficient in (6) times P, the price of the house and the price of a house is not simply the sum of its characteristics times their marginal prices.

If (6) is the true price - characteristics relationship for houses, price index formulas

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[3] This form is used by Palmquist (1980). The double log (e.g. Case and Quigley, 1991) or the quasi double log form,

$$\ln P_i = \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \cdots + \beta_k \ln X_{ki} + \gamma_1 Z_{1i} + \cdots + \gamma_m Z_{mi} + u_i$$

is also sometimes used. More general are translog forms, and more general still are nonparametric specifications (see Meese and Wallace, 1988) discussed above cannot be used directly, because these formulas assume linearity and (6) is nonlinear. We replace the indexes with their analogous non-linear version.[4] The semi-log quasi Laspeyres (which we call QLaspeyres) we define as

$$\frac{e^{\alpha_t + X_0'\beta_t + Z_0'\gamma_t}}{e^{\alpha_0 + X_0'\beta_0 + Z_0'\gamma_0}} \quad \text{or} \quad e^{\alpha_t - \alpha_0 + X_0'(\beta_t - \beta_0) + Z_0'(\gamma_t - \gamma_0)} \tag{7}$$

where $X_0'\beta_1$ and $Z_0'\gamma_1$ are characteristics and their coefficients in vector notation. Quasi Paasche, quasi Fisher and quasi Fisher chain indexes are defined analogously.

An alternative procedure for producing price indexes (e.g. Meese and Wallace, 1988) to derive the marginal shadow price for each characteristic (i.e. the partial derivative of P with respect to the characteristic) and then use the standard Laspeyres, Paasche or Fisher formulas. Marginal shadow prices, however, while appropriate for use in demand equations for individual characteristics seem inappropriate here. In constructing price indexes for houses we are primarily concerned with the price of the whole house, not with the marginal price of components of the package. Objection to the use of marginal price can perhaps be better understood if it is recalled that the aim of the construction of these indexes is to correct for quality change.[5]

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[4] This appears to be the procedure used by Case and Quigley (1991) who refer to "indices of the market price for a standardized or 'quality-adjusted' property over time" (p. 50). They do not specify what their standardized unit is.

[5] See Deaton and Muellbauer (1980) for an extended discussion of correcting for quality change.

IV. ALTERNATIVE REGRESSION-BASED PROCEDURES FOR CONSTRUCTING HOUSE PRICE INDEXES

There are three basic regression procedures used for generating house price indexes. The first requires the estimation of an hedonic regression equation such as (6) for each time period. The remaining two procedures each require only a single regression for the whole time period, but each have strong restrictive assumptions. The constrained hedonic procedure assumes that all characteristics of a house change in price at the same rate, so that index number problems are assumed away. The repeat sales procedure uses as raw data the prices of only those properties which transacted twice during the sample period. It eliminates the index number problem by assuming that all properties change in price at the same rate. It has the great advantage that it does not require knowledge of house characteristics. Its disadvantage is that repeat sales properties may be a biased sample of all properties transacted. We now describe these procedures in more detail.

Unconstrained hedonic procedures: flexible relative price indexes

Unconstrained hedonic procedures yielding what we term flexible relative price indexes or flex-rprice indexes, require two steps. First, an equation such as (6) is estimated for each quarter. The estimated parameters are then used to estimate the price of the specified bundle in the quarter. The ratio of this price to the base price, for the bundle consisting of the mean characteristics in the base quarter, gives the Quasi Laspeyres index. The Quasi Paasche is computed using the mean characteristics of the current quarter. Quasi Fisher and Quasi Fisher Chain indexes are computed analogously.

In this study the semi-logarithm specification (6) is used because of certain empirical advantages. First, our data include detailed quantitative, but not qualitative, information. For example, we have information about the number of fireplaces but we have no information about whether or not these fireplaces have safe, high quality chimneys, and about whether they are of traditional construction or they have zero clearance metal core with a brick veneer mantelpiece. We know the number of square feet of living area but we do not know the height of the ceilings, the kind of baseboards used, the type of inner doors and doorknobs used, and the depth of the walls. It seems reasonable, however, to assume that the quality of characteristics like fireplaces and a square foot of living area rises, as the price of the house rises. Thus, if there are constant returns to scale in house building, an empirical price function which has declining returns is appropriate, because of the omission of quality variables. The semi-log function which implies that the change of one unit in a characteristic has a constant percentage effect on price fits this requirement. A second empirical advantage of the semilog form--as compared with the double log and translog forms--is that it does not require compromises in variable definition in order to eliminate zero values.[6]

Parsimony in the list of variables is no advantage in hedonic regression. Its disadvantage, biased parameter estimates is particularly important for the construction of our flex-rprice indexes, because two of them use different bundles each period. Accordingly, we include an exceptionally long list of variables in continuous and dummy variable form.

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[6] These compromises are evident in Case and Quigley (1991), where all dummy variables (for characteristics like presence of a fireplace, air conditioning etc.) are simply eliminated. A pragmatic alternative is to use a specification which is partially double log--that is, use the log of continuous variables but also include dummy variables (e.g. Meese and Wallace, 1992)

Structure, lot, neighbourhood and accessibility variables are all included.

The constrained hedonic procedure: fixed relative price indexes

The constrained hedonic model, yielding what we term fixed relative price (or fixed rprice) indexes assumes that all characteristics of the house rise in price at the same rate. The model is estimated using a single regression for many periods of data, with differences in price over time captured by including a dummy variable for each quarter. More specifically, the regression specification is (6) amended to include time dummies:

$$\ln P_{ti} = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_k X_{ki} + \gamma_1 Z_{1i} + \dots + \gamma_m Z_{mi} + \lambda_2 T_{2i} + \dots + \lambda_k T_{hi} + u_i \qquad (7)$$

where P_{ti} is the price of the i[th] property in quarter t and the $T_{2i}..T_{hi}$ are time dummies for quarters 2 to h (e.g. $T_{2i} = 1$ if property i is sold in quarter 2, and is zero otherwise).

It can be seen that γ_2 gives the log of the ratio of P_{2i} to P_{1i}, or in other words, λ_2 is the log of the price index number for period two (where the price index number for quarter 1 (the base quarter) is set at 1.00); thus the index number for quarter 2 is e^{λ_2} where P_{2i} refers to the price in quarter 2 and P_{1i} refers to the price in quarter 1, the base quarter. Estimated prices and index numbers for the constrained hedonic model are as given in Table 2.1.[7]

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[7] 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 $\ln P_{1i} = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_k X_{ki} + \gamma_1 Z_{1i} + \dots + \gamma_m Z_{mi} + u_i$.
If it is sold in quarter 2, $T_{2i} = 1$ and other time dummies are equal to zero so that

$$\ln P_{2i} = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_k X_{ki} + \gamma_1 Z_{1i} + \dots + \gamma_m Z_{mi} + \lambda_2 + u_i \ .$$

Table 2.1. Constrained Hedonic Index

Period	*Estimated price*	*Estimated index number*
1	$e^{(.)}$	1
2	$e^{(.)+\hat{\lambda}_2}$	$e^{\hat{\lambda}_2}$
3	$e^{(.)+\hat{\lambda}_3}$	$e^{\hat{\lambda}_3}$
⋮	⋮	⋮
36	$e^{(.)+\hat{\lambda}_{36}}$	$e^{\hat{\lambda}_{36}}$

where (.) refers to the estimated value of (7) exclusive of the time dummy portion, with the structural, neighbourhood, and accessibility values taking the same values in all periods.

The repeat sales procedure

This procedure, originally used by Bailey, Muth, and Nourse (1963), employs a sample restricted to houses sold twice in the sample period and uses as raw data pairs of prices for such houses. Each pair of prices indicates the change in the price of a given house, i.e. the change in the price of a bundle of characteristics which is kept identical (except for the inevitable change in age of the house) over time. The underlying assumption is that all types of house--whether starter or executive--change in price at the same rate.

The regression specification capturing these assumptions is one regressing the difference between the log price of the property at its second sale and the log price at its first sale on a set of (-1, 0, 1) dummy variables. For any property i, the dummy variable for the

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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} where P_{2i} refers to the price in quarter 2 and P_{1i} refers to the price in quarter 1, the base quarter.

period of the first sale of the property takes on a value of -1 (unless it is the first period), the dummy variable for the period of the second sale of the property takes the value +1, and all other dummies take the value zero. The coefficients in the regression give the log price index, with the first period being the base period. Formally,

$$\ln P_{si} - \ln P_{ri} = \delta_2 Q_{2i} + \ldots + \delta_h Q_{hi} + u_i \tag{8}$$

where s is the period of the second sale of house i, r is the period of the first sale of property i, h is the number of periods in the sample, and

$$\begin{aligned} Q_{ji} &= 1 && \text{if } j=s \\ &= -1 && \text{if } j=r \\ &= 0 && \text{otherwise.} \end{aligned}$$

The effect of this specification is made clear in two examples.

If s = 2, r = 1:

$$\ln P_{si} - \ln P_{ri} = \ln P_{2i} - \ln P_{1i} = \delta_2$$
$$\therefore \quad \ln\left(\frac{P_{2i}}{P_{1i}}\right) = \delta_2 \quad , \quad \frac{P_{2i}}{P_{1i}} = e^{\delta_2}$$

If s = 5, r = 2:

$$\ln P_{si} - \ln P_{ri} = \ln P_{5i} - \ln P_{2i} = \delta_5 - \delta_2$$
$$\therefore \ln\frac{P_{5i}}{P_{2i}} = \delta_5 - \delta_2, \quad \therefore \frac{P_{5i}}{P_{2i}} = \frac{e^{\delta_5}}{e^{\delta_2}} \quad \therefore \quad \frac{P_{5i}}{P_{1i}} = \frac{P_{5i}}{P_{2i}} \cdot \frac{P_{2i}}{P_{1i}} = \frac{e^{\delta_5}}{e^{\delta_2}} \cdot e^{\delta_2} = e^{\delta_5}$$

Table 2.2 gives the estimated index number formulas where $\hat{\delta}_k$ refers to the estimated value of δ_k.

Table 2.2 Repeat Sales Index

Period	*Index number*
1	1
2	e^{δ_2}
3	e^{δ_3}
. . . . .	
t	e^{δ_t}

A general form which, in its deterministic aspects, has versions of (6), (7), (8) as special cases is given in Case and Quigley (1991) (see also Case, Pollakowski and Wachter, 1992). The estimation of this general form, however, assumes that the stochastic term is white noise. More particularly, it assumes that the disturbance variance is the same in every period, and disturbances of different periods are independent. Because we do not assume that the disturbances in the set of t regressions of form (6) are identically distributed, these regressions are not special cases of Case and Quigley's specification.

Problems with the repeat sales method

There are several potential problems with the repeat-sales method. One problem is that houses that are resold may not be characteristic of all the properties sold during the same period. Houses that have been remodelled must be excluded from the repeat sales subsample but this removes information, especially for neighbourhoods that are experiencing changes in value. This may cause sample selection bias in the repeat-sales regression estimates, and derived index. Palmquist (1980) finds that this was a not problem in his data set, but as pointed out in Hendershott et al (1991) it is clearly a problem in some repeat-sales studies. Capp, Giaccotto, and Tirtiroglu (1991) and Haurin and Hendershott (1991) suggest that many sales in the sample represent "starter homes". They find that the average price in the sample of repeat-sales is less than the sample average price.

A second problem is that of depreciation. The repeat-sales method does not allow for depreciation of the houses over time. The coefficient of the age variable in the semi-log form of the constrained hedonic regressions, however, represents the geometric rate of depreciation. Using this it is possible to calculate a depreciation-corrected price index. Palmquist finds an annual rate of 0.8 percent.

A third problem with the repeat-sales method is identified by Haurin and Hendershott (1991). They note that the repeat-sale model assumes that all houses experience the same percentage price change: the model does not allow for any changes in the relative price of various attributes. For example, lot area may increase in value relative to structure area, but the repeat-sales model cannot allow for this.

V ISSUES ASSOCIATED WITH ESTIMATING A PRICE INDEX FOR STARTER HOMES

Selection of Starter Home Sample

The aim of this study is to construct indexes not for all houses (or condominiums), but for the special category of a modest house, the kind purchased by households buying their first home. We call this category "starter home."[8] Constructing a starter home price index requires the estimation of a hedonic price equation and specification of a bundle of characteristics.

Estimation of a hedonic price equation for a starter home requires the selection of a subsample of all houses sold. An obvious way to select the subsample would be to simply select all houses selling for a price at the lower end of the price range, for example, the 33rd percentile price, (where prices are in constant dollars). A price criterion, however, cannot be used legitimately for sample selection, because it introduces sample selection bias. For example, if a price ceiling is used, then houses with luxury features such as a family room but which happen to sell for a relatively low price, because the sale is a forced sale in a slow market, will be included in the sample, but other houses with a family room will not. As a consequence, family rooms will be estimated to have a relatively low shadow price, but this estimated price will be downward biassed.

Because of the need to avoid sample selection bias, the starter home sample is chosen using as the criteria the absence or presence of specified characteristics. Two general guides are used in the selection of the criteria. The first, a normative guide, is whether or not a characteristic is included in the specification of the Royal LePage Standard bungalow. The second, a purely empirical guide, uses as a basic element the estimated shadow prices of characteristics in the hedonic regression (estimated on the total sample of all single and semi-detached houses). If the estimated shadow price of a characteristic is positive and

[8] In what follows we refer only to houses, for convenience. The same principles applied to selecting starter houses are also used to select the starter condominiums.

quantitatively important, and the characteristic is not deemed essential to the basic function of a house, then houses with the characteristic are generally deemed not to be in the starter category. For example, a bathroom has a high estimated shadow price but it is essential to the function of a house, and so houses with a bathroom are (of course) included,[9] while a family room has a substantial positive coefficient but is not essential, and so houses with a family room are excluded. A detailed description of the criteria for the sample of starter singles and semis, and for the sample of starter condominiums, is given in the next chapter.

Selection of Other Samples

To put the price indexes for starter homes in context, we also estimate indexes for all single detached houses, for all condominiums, and for new houses. The appropriate sample is selected in each case. For single-detached, a repeat sales sample is also delineated, so that the repeat sales index may be estimated. A particular advantage of estimating an index for a new house is the existence of a Statistics Canada's New House Price index which may be used for comparison.

[9] More precisely, included are houses with up to (1 full bathroom and 1 half bathroom) or (2 full bathrooms but no half bathroom).

CHAPTER III
THE DATA: BASE SAMPLES, VARIABLES AND SUBSAMPLES

I. THE BASE SAMPLE

The base sample, for semi and single-detached houses (sometimes referred to below simply as "houses") consists of records for 9856 transactions, all sold in Kitchener Waterloo in 1988 to 1990 through the Kitchener-Waterloo Real Estate Board's Multiple Listing Service (MLS). The base sample for condominiums consists of records for 1616 transactions from the same source. Each record contains price, structure, lot information, dwelling address, and MLS map district. Eliminated from the sample were 22 properties with very large lots (over an acre and a half).[1]

Some descriptive data for the base samples are shown in Tables 3.1, 3.2 and in Appendix Tables A1 and A2. Table 3.1[2] shows that the relative importance of various styles of detached house remained about the same from year to year. Condominiums and semis, however, were slightly more important in the post-boom year of 1990 than they had been during the boom years.

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[1] Also removed was a record for a bungalow that had been severely damaged by fire and was reduced in price because of the extensive structural damage. No other records were found with severe abnormalities but five records from five pairs of *identical* records were removed from the sample.

[2] This table refers to properties within a larger geographic area than included in the samples used for regressions.

Table 3.1
Proportion of MLS Properties Sold by Style

Style	Percent of the Sample 1988	1989	1990
Bungalow	17	16	17
1 and 1/2 storey	9	9	9
2 or more storeys	27	29	26
Side split	6	6	6
Back split	9	7	8
Raised bungalow	7	7	6
Semi-detached	10	10	11
Condominium	13	14	15
Town/Link House	2	2	2
Number in sample	4670	4228	2838

Appendix Table A1 shows that the mean selling price of houses in this sample is $151,000, with a standard deviation of $51,000.[3] Some other noteworthy means (Table 3.2[4]) are 1200 square feet living area (using inside dimensions), 6,300 square feet lot area, 1.5 full bathrooms and 0.5 half bathrooms. Also, the incidence of a fireplace is 46 per cent, two-car garage, 23 per cent, family room, 31 per cent and recreation room, 63 per cent. For the condominium sample the mean sales price is $108,000 (Table 3.2), 39 per cent less than that for houses. The average number of bedrooms for condominiums is less than that for houses, but the differential is surprisingly small--2.6 as compared to 3.2. The mean number of full bathrooms, 1.2, is less than for houses, but the number of half baths, 0.6, is somewhat greater. The incidence of a family room is very similar, 38 per cent as compared to 32 per cent. A somewhat lower percentage of condominiums are new (6.9 per cent as compared to 9.5 per cent), but a far higher proportion are 5 to 16 years old (66 per cent compared to 24 per cent).

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[3] Numbers in text are rounded, for ease of reading; numbers in tables are not rounded, or retain more significant digits than numbers in text.

[4] See end of chapter text.

II. SPECIFICATION OF VARIABLES

Structure and lot variable specification

Virtually all information on structure and lot variables given in the MLS records was used in the definition of house characteristics, on the grounds that listing real estate agents, in principle should be good judges of characteristics which affect purchase decisions and house prices. Most variable definitions need no explanation, but some do. First, "size," is total living area in thousands of square feet, found by summing the square footage in individual rooms; excluded are living areas in halls, bathrooms and some closets. The living area defined in this way is only about two-thirds the living area based on the standard measure (outside dimensions) so long as all rooms are above ground. Certain rooms in our sample, such as recreation rooms, laundry rooms, and games rooms are typically found in basements, and the inclusion of this low quality space in total living area distorts the "size" variable.[5]

Lot area in thousands of square feet is included quadratically (as is "size," i.e. living area), and in addition a large lot variable (zero if less than one-half acre, actual area otherwise) is included. Garages and fireplaces have highly nonlinear effects--the second garage (and second fireplace) add much more to estimated value than does the first[6]- and so these two variables are entered in partially discrete form. Houses insulated using urea formaldehyde foam (UFFI), are identified, as are houses which have had UFFI removed (UFFI (removed)). UFFI was at one time popular and government subsidized, but was later

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[5] The effect of this is offset in the specification by the inclusion of dummy variables for kinds of rooms typically found in basements; these dummy variables are expected to have negative effects, and do in fact have such effects (see Chap. IV).

[6] That is, the shadow price of the second unit is much higher than the shadow price of the first unit.

banned after highly publicized accounts of its polluting effects. Evidence of the likely negative effects of UFFI on selling value is the fact that offers to purchase in Toronto commonly include a clause requiring vendors to certify that UFFI is absent.

Neighbourhood and accessibility variables

Neighbourhood variables such as incidence of poverty are extracted from the 1986 Statistics Canada for the 52 Census Tracts in the Kitchener-Waterloo (KW) CMA. Variables from this source, such as the incidence of poverty, indicate the socio-economic character of neighbourhoods. Additional location and accessibility variables are based on information provided by the Economic Development Offices of the cities of Kitchener and Waterloo. Accessibility is measured by distances to the Central Business District and to the closest industrial area, respectively.

Neighbourhood variables

Incidence of poverty (INPOV)

INPOV refers to the percentage of economic families of household maintainers who had total income in 1985 below the Statistics Canada Low Income Cut-off. These cut-offs are determined separately for families of different sizes and living in areas of different degrees of urbanization. They are based on the revised 1978 cut-offs which were initially estimated from the 1978 National Family Expenditure Survey and then updated to 1980 and 1985 in accordance with changes in the Consumer Price Index.

Table 3.3
Neighbourhood and Accessibility Variables

Variable	Min.	Max.	Means	Stdev.
UR (%)	1.8	10.7	5.506	1.572
INPOV (%)	0.0	26.0	10.7	5.9
CBD (mi)	0.165	4.611	1.966	1.056
INDUST(mi)	0.165	4.776	1.709	1.312
POP/DEN	0.017	18.5	8.715	5.164

Unemployment Rate

The unemployed include those persons who, during the week prior to enumeration:

(a) were without work, had actively looked for work in the past four weeks and were available for work; or
(b) had been on lay-off and expected to return to their job; or
(c) had definite arrangements to start a new job in four weeks or less.

The unemployment rate (UR) in each district is the total number of unemployed people at the time of enumeration as a percentage of the labour force of the census tract. Each census tract includes the number of adults 15 years or older who are employed, unemployed, or not in the labour four.

Accessibility (CBD, INDUST)

Two accessibility variables are used to determine whether or not accessibility has an influence on the price of housing. The distance from the centre of each census district to the centre of the Central Business District (CBD) was measured, as was that to the fringe of the closest industrial area (INDUST). The functional form of the accessibility measures are designed to allow for the possibility that for houses very close to the central business districts and industrial areas there may be negative externalities which offset the positive effects of accessibility. The functional form for distance is $\beta_{a1}\log(d) + \beta_{a2}\frac{1}{d}$ where d is the distance from the house to the centre. This is an adaption and simplification of the functional form used by Li and Brown (1980). It allows values to rise with distance from the centre, at first, and then decline at a declining rate--a shape suggested by urban theory.

Each city has its own CBD, so the distance to the closest centre of a CBD from the centre of each census district is used. This means that the distances for most districts in city of Kitchener refer to the CBD in Kitchener. The centre of each CBD--rather than the fringe of the CBD--is chosen as the endpoint because of the composition and the shape of each CBD: it is a narrow tract of land in both cites. Also, within each CBD are several condominiums and some single detached houses, and a distance to the centre rather than to the fringe of each CBD is an appropriate accessibility variable for these properties.

The information supplied by both city offices about the industrial and commercial locations revealed that these businesses were concentrated in three areas within both cities. These three areas were located in the north end of Waterloo, the south end of Kitchener, and close to the Kitchener-Waterloo border on the east side of Kitchener, respectively.

Density

For each Census Tract within the limits of KW, the size in acres and the population is known. This allows an approximate estimate of the population density (eg. people per acre) for each district. The population count represent the number of individuals whose usual place of residence is in that census district, regardless of where they happened to be on Census Day in 1985. The population in some districts will have experienced a greater growth rate since 1986 than others but the census number should provide a good proxy for most districts.

Mapping of Census Tracts and MLS Districts

Each MLS record is located within the cities of KW by the unique mapping of the

Kitchener-Waterloo Real Estate Board. To use the Census Tract information for each neighbourhood, the CT of each MLS record has to be identified using Census Tract maps.[7]

There are 31 MLS districts within the CMA of KW. The boundaries are often similar to the Census Tract boundaries except the MLS districts are larger. The boundaries of both MLS and CT maps are often natural features such as rivers or major streets. MLS districts can contain at least two part or full Census Tract districts.

The task of overlaying the Census Tracts onto the MLS boundaries was difficult but not impossible. For each MLS district which contained two Census Tracts, the separation between Census Tracts was straight forward. The common boundaries of MLS districts and Census Tracts are used as control points. For example, if one complete CT is located within a MLS district, the streets in this CT are listed. Then these streets in the MLS sample are identified by the street name and MLS district number, and given the appropriate Census Tract number. The remaining dwellings in the MLS district are in the second CT. Properties on streets that ran between two CTs and within a single MLS district could be identified by street numbers or directions such as north or south, and thus placed in the correct Census Tract. Properties on streets which are a common boundary between CTs are identified by whether they have an even or odd street number.

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[7] A Census Tract refers to a permanent small census geostatistical area established in large urban communities with the help of local specialists interested in urban and social science research. Census tracts are reviewed and approved by Statistics Canada according to the following criteria:

a) the boundaries must follow permanent and easily recognized lines on the ground;

b) the population must be between 2,500 and 8,000, with a preferred average of 4,000 persons, except for census tracts in the central business district, major industrial zones, or in peripheral rural or urban areas that may have either a lower or higher population;

c) the area must be as homogeneous as possible in terms of economic status and social living conditions; and the shape must be as compact as possible.

III. SUBSAMPLES

Repeat Sales Subsamples

Singles and Semis

Repeat sales account for 1234 transactions. Of these, 200 transactions, or 16 per cent of the total, are eliminated because the property involved changed between transactions; netting these out leaves repeat sales as 10.5 per cent of the total sample. This ratio is quite high in view of the data range of only 3 years; while Clapp, Giaccotto and Tirtiroglu (1990) found 25 per cent repeats over a seven year range and Mark and Goldberg (1984) found 40 per cent repeats over a twenty-two year range, Case and Shiller (1989) found a ratio of only 4.1 per cent repeats over a sixteen year interval. For this study, properties which changed between transactions were identified using the MLS records. Changes leading to exclusion were changes to the number of bathrooms or rooms, the addition of a pool, garage, or fireplace or recreation room, changes to number of bathroom fixtures, changes in the dimensions of any room or the lot. This plausibly led to substantially more exclusions than would have been the case if assessment data were used, as in Clapp, Giaccotto and Tirtiroglu.

Also deleted from the sample are 16 transactions for properties transacting more than twice. Finally, deleted were 168 transactions for which the two transactions occurred three or fewer months apart. The final sample consisted of 856 transactions or 428 properties.

Condominiums

Repeat sales account for 308 condominium transactions. None were eliminated because of modification between transactions (in dramatic contrast to the 16 per cent elimination rate for this reason in the case of houses). This is to be expected, because of the relative newness of condominiums and the relative difficultly of making additions and renovations in large, multiple unit buildings. There were 16 transactions that related to property sold three times in the three-year period; these were omitted, leaving 292 transactions (146 properties) in the repeat sales sample. Confining the sample to properties selling for the second time in a subsequent quarter, rather than in the same quarter, eliminated 11 properties and left a sample of 135 condominiums (accounting for 270 transactions) which were sold twice. These repeat sales transactions make up 16.7 per cent of all condominium transactions; this incidence of repeats is substantially higher than that for houses.[8]

Subsample of New Houses

New houses accounted for 935 or 9.49 percent of the sample of single and semi detached houses. Their mean sales price are $207,000 (Table 3.4), far above the mean for existing houses. The much higher price is reflected not so much in the size of the houses as in other characteristics. The average number of rooms, 7.5, is not very much greater than that (6.6) for existing houses, and total living area is also not much greater, but the average number of fullbaths is 1.8 (as compared to 1.5), and half bathrooms, 0.7 (compared to 0.5); more important, 60 per cent of new houses are 2 or more storeys (as compared with 30 per cent), 70 per cent have a double garage (vs. 19 per cent), and 71 per cent percent a fireplace (vs. 43 per cent). Only 12 per cent have a finished basement, compared to 48 per cent (Table A4); this suggests that purchasers of new houses prefer to defer the upgrading

[8] The differential between the incidence of repeats for houses and for condominiums remains if gross repeat sales transactions are used; in that case the ratio is 12.5 per cent vs. 19.1 per cent.

involved in finishing a basement until some time after purchase.

Neighbourhood characteristics of these new houses reveal that they are built in areas with somewhat high median household income ($38,000 as opposed to $34,000 for existing (Table A4)). These areas have an unemployment rate and incidence of poverty which is only slightly lower on average than for existing housing. Unsurprisingly, differences in accessibility and density between new and existing are quite substantial: new are an average of 2.3 miles from the Central Business District compared the 1.9 miles for existing; new houses are in areas with a much lower population density (5.5 people/acre compared to 9.1 people/acre). Overall the new houses are much higher priced, have larger living area, have more desirable structural characteristics, and are found in slightly higher quality neighbourhoods.

Table 3.5 and Table A4 show the relation of the new house subsample to all new houses. New houses sold through MLS are much more expensive than NHA new houses. The number of sales of MLS new houses fell much more in the bust year of 1990 than did that of all new houses overall. The average (nominal) value of these houses changed little more in 1989 than did that of NHA new houses but value fell sightly in 1990, while average NHA value rose.

Table 3.5

Average Prices and Percent of New Houses Sold Under MLS

	1988	1989	1990
MLS Sales (new)	465	290	180
New houses absorbed[9]	3108	2530	2122
(MLS as % of total)	(15.5)	(10.7)	(8.5)
Completions	2723	2460	1548
(MLS as % of comp.)	(17.1)	(11.8)	(11.6)
Ave. value, MLS (new)	$180294	$236122	$231492
Ave. value, MLS (single)	$135370	$160502	$165176
Ave. value, MLS (starter)	$107807	$127167	$132890
Ave. value, NHA new[10]	$138116	$174715	$185473

Sample of Starter Houses

As discussed in the previous chapter, the sample used for the starter home regressions was not selected on the basis of price, because of concern about sample selection bias. Instead a two step selection procedure was used. The first step was to use the Royal LePage specification for a standard bungalow as a starting guide. The Royal LePage standard bungalow has 1200 sq. feet (using outside dimensions) and a lot of 5500 sq. feet; it has three bedrooms, a kitchen, living room, dining room, one and half bathrooms, a one car garage, a full basement, no recreation room, no fireplace and exterior construction of brick.

The second step was to amend this specification in view of the particular characteristics of Kitchener-Waterloo houses. Specifically, contrary to the Royal LePage specification, houses with a finished basement and/or a recreation room were not eliminated because a high proportion of low-priced homes in Kitchener-Waterloo have a basement recreation room. Houses with a single fireplace and with a lot size over 5,500 square feet

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[9] These are total new houses completed and absorbed in the Cities of Kitchener and Waterloo each year (information from the Hamilton CMHC office).

[10] single-detached only.

were not eliminated because this would have eliminated many old, modest houses.

Next, the specification was amended using as a guide the sign and size of estimated coefficients (estimated shadow prices) in the constrained hedonic regression for all single-detached houses. Houses with a feature found in superior houses--i.e. a feature with a positive and substantial estimated shadow price[11]--were eliminated from the sample. Thus, houses with a den, a family room, a two or three-car garage, more than one fireplace and/or an inground pool were eliminated.

Even a minimal house must have bathrooms and bedrooms, and so bathrooms and bedrooms could not be treated like family rooms and dens, in considering the appropriate specification; instead, the *number* to allow was the issue. In view of the fact that a full bathroom had a shadow price not very much larger than the shadow price of a half-bathroom, the starter home sample allows units with either two full bathrooms or a bathroom and a half, or less. Many old, inexpensive homes would have had a second bathroom added, perhaps in a basement, since their original construction. Houses with two full bathrooms and a half bathroom, or one full bath and two half bathrooms were excluded from the sample.

The starter sample includes houses with four bedrooms. Confining the sample to houses with three or fewer bedroom houses eliminated substantial number of low priced, quite small (in terms of living area), houses. Note that the fourth bedroom may be found in relatively low-valued parts of the dwelling such as attics or basements, and that houses with over 1000 sq.ft. of living area are eliminated from the sample (see below), so long as they do not have a recreation room. The same kind of reasoning that led to the retention of houses with four bedrooms in the sample also led to the retention of houses with six rooms

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[11] In other words, a substantial positive estimated coefficient in the constrained hedonic regression using the base sample of houses.

other than bedrooms.

Houses built within the last five years were eliminated from the starter sample, despite their inclusion in the RLeP standard bungalow, because regression results showed that newness adds substantially to value, given other characteristics.

Setting maximum living area and lot area

The most important characteristics for defining the starter sample are the living area and lot area. Houses with a large living area were eliminated. The definition of "large" was complex partly because of the method used to compute size (living area): it is the sum of the areas of all rooms, excluding bathrooms, hallways, unfinished basements and unfinished attics.[12] The elimination of large houses proceeded as follows. For a house with an unfinished basement and no recreation room a maximum size (or total living area) of 1000 square feet was set.[13] For houses with a finished basement and a recreation room, a different maximum was set. The rationale for the differential is that basement space contributes little to the value of a property (see regression results), and yet in the calculation of total living area, area in a recreation room is included without discounting. Thus for houses with a recreation room, the maximum living area is set at 1000 square feet plus the size of the typical recreation room (200 square feet), for a total of 1,200 square feet. A typical house with a recreation room and a measured area of 1,200 square feet would have about 1000 square feet above ground.

[12] This must be multiplied by an adjustment factor of about 1.54 (see Goy, 1992) to yield a size comparable with that arrived at using standard outside measurement methods.

[13] Setting the maximum lower than this, at 900 square feet, eliminated many low priced houses because many lie in the range 900 to 1000 square feet of living area, while setting the maximum higher than this, at 1100 square feet of living area added many higher priced houses.

Determining the lot area constraint for the starter sample was also complex. Different lot areas configurations for new and old houses were considered, because the lots of the former are typically smaller than the lots of the latter, as would be expected in view of the lower relative price of lots at the time older houses were built. In very old subdivisions, lot sizes were measured in survey chains (a chain is 66 feet), so that these lots would tend to be 66 feet by 66 feet (4356 sq. ft.) or 66 feet by 132 feet (8712 sq. ft.). Newer lots are usually approximately .15 acres or less, as compared with these lots of 0.10 acres and 0.20 acres respectively.

Two different scenarios were tried. The first used restrictions varying with the age of the house: thus an older house (built before 1970) was included in the sample so long as its lot area was less than 10,000 square feet, while only those newer houses having a lot size of less than 6,000 square feet were included. The second scenario simply allowed, for all ages of house, lots 10,000 square or less. Typical old lots would be included within this limit; any lots over this size--ones that could be subdivided into two smaller lots, so adding a premium to the price of a property-- would be excluded.

It was found that the first scenario excluded approximately 100 modest priced houses, ones ranging in value from $90,000 to $100,000. This indicates that when the structure on a large lot is modest, the larger lot often adds little to the value of the property. Therefore, the second scenario was used.

Mean characteristics of the starter sample

Using the above constraints, remarkably, *both* the average price ($121,000) and the average living area (937 sq. feet) of properties in the starter house sample, were 72 per cent of the analogous values for other houses (i.e. houses other than starters), as shown in Table

3.6; see also Chart 3.1. This implies that the gross cost per square foot of living area does not vary with size, which in turn tells us that any economies of scale in production of living area are offset by higher quality per square foot as size increases. Table 3.7 shows the selling price distribution. It can be seen that the vast majority (83 per cent) of starters are found in the selling price range $80,000 and $115,000 (1988 dollars) and only 1.5 per cent are above $140,000 (1988 dollars) while 45 per cent of non-starters are.

Table 3.7
Distribution by Nominal and Constant Dollar* Selling Price

Price Range	Total Sample		Other Than Starters		Starter Houses	
	Nom.	Real	Nom.	Real	Nom.	Real
< 80000	85	198	31	57	54	141
80001 to 95000	447	835	88	78	359	757
95001 to 105000	572	1187	208	306	364	881
105001 to 115000	1477	2462	622	1376	855	1086
115001 to 140000	2633	2156	1493	1804	1140	352
140001 to 160000	1713	1184	1303	1138	410	46
160001 to 180000	1237	716	1156	713	81	3
180001 to 200000	490	353	486	352	4	1
> 200000	1202	765	1201	765	1	0
	9856	9856	6588	6588	3268	3268

* 1988, 1st quarter dollars. Price index used for deflation is computed using the constrained hedonic regression results for the base house sample.)

Examination of the incidence of certain characteristics reveals much greater differences than those indicated by size variables (Chart 3.2). The incidence of luxury characteristics is much lower in the starter sample: e.g. half-bathroom incidence is 54 per cent of the non-starter incidence[14] and fireplace, 39 per cent (see Table 3.6)). Certain inferior features are relatively much more common in starters. Because houses less than 5 years old are excluded by design from the starter sample, on average the incidence of houses 5 years or older must be greater for

[14] Of course, starter houses were defined in part by using a constraint on size, number of half bathrooms and certain other variables.

starters than for other houses; but while the incidence of age 6-15 years is only 26 per cent higher for starters, the incidence of houses 31 or more years old is 153 per cent higher for starters than for other houses, as can be inferred from Table 3.6. Also, while 74 per cent of starters have a recreation room, only 58 per cent of non-starters do; while 27 per cent of starters are heated with oil (Table A1)--a surprisingly high proportion given the time that has elapsed since the initial oil price shock--only 11 per cent of non-starters are. While 21 per cent of starters are semi-detached, only 9 per cent of non-starters are, and the incidence of two-story houses is less than half as great for starters as for non-starters.

Values for neighbourhood characteristics suggest that starter houses are not in a very different socio-economic setting from non-starters: median income is not much lower and the unemployment and poverty rates are not much greater (Table A1). Starters are much somewhat more distinctive, however, in their accessibility: on average they are 1.7 miles from the Central Business District (CBD), 20 per cent closer than non starters, and they are in neighbourhoods with population density 28 per cent greater.

Sample of Starter Condominiums

A method similar to that used to select starter houses was applied to select the sample of starter, or modest condominiums. The condominium market is often considered to be a market consisting very largely of modest dwelling, but in reality, a substantial portion are in the luxury category, and it is necessary to eliminate these to create a starter sample. The Royal Lepage standard apartment condominium specification is the starting guide for selecting this sample. The Royal Lepage specification is 900 square feet of inside living area, two bedrooms, living room, dining room, kitchen, one and a half bathrooms, a one car parking space, in a building with a swimming pool.

As was the case for houses, condominiums with luxury features--den, family room, two or more parking spaces, and two or more fireplaces--were deleted. Because old condominiums The rationale for allowing two bathrooms in the starter sample for houses did not apply to condominiums and the sample is confined to units with only one bathroom, or a full and a half bathroom.

The size limit set for starters is 900 square feet total living area if there is no recreation room, and 1200 if there is one. Implicitly, a recreation room is assumed to be a basement room of 1200 - 900 (= 300) square feet; this is the typical size indicated by room dimensions of recreation rooms in the listing records. Note that the presence of a recreation room is an indicator that the condominium is a townhouse rather than an apartment; no other information on the MLS record except basement data provides an indication of this distinction. The maximum number of bedrooms is set at three, and three is also the maximum for other rooms. Condominiums of all ages, new as well as old, are included in the starter sample because many new condominiums are modest dwellings.

Mean characteristics

The starter sample as defined above amounts to 61 per cent of all condominiums. The average price of the starter sample is $94,000, 74 per cent of the average for non-starter condominiums (see Table 3.8) . The mean size (living area) of this sample is 789 square feet, 78 per cent of the mean for non-starters. This implies the cost per square foot rises as the number of square feet rises; the room data in Table 3.8 also imply that rooms in starters are considerably smaller than those in non-starters.

As can be inferred from Table 3.8 the incidence of very recently built (less than six years old) units among starters is only one-third that for non-starters; 86 per cent of the starter sample is 6-30 years old compared with only 61 per cent of the non-starter sample. Only 3 per cent of starters have a fireplace, compared with 33 per cent of non-starters; only 16 per cent have central air conditioning, compared with 45 per cent (Table A2 and Chart 3.2).

Neighbourhood differences between the starter and non-starter condominium samples, overall, are almost non-existent, although starters are in areas with a slightly higher incidence of poverty than non-starters. Starter condominiums are slightly less well-located with respect to distance to the CBD and to industrial areas than non-starters. Somewhat surprisingly both categories of condominium are on average further from the CBD than houses.

In sum, condominiums in the starter sample on average have less living area, fewer bath rooms (especially half bathrooms), and are less likely to have air conditioning, fireplaces, parking spaces and to be less than 6 years old than non-starters. Their location characteristics, however, are similar.

The Homogenized Starter House Subsample (outliers eliminated using DFFITS)

A matter of concern in the construction of house price indexes is the likelihood that some transactions in the sample are outliers, taking place at relatively very high or relatively very low prices, reflecting idiosyncratic characteristics and thin markets. Such observations have the potential to greatly affect shadow prices in OLS regressions, because the least squares criterion makes outliers heavily influential. For this reason we re-estimate the constrained hedonic, eliminating influential observations, following Belsley, Kuh and Welsch (1983), on the basis of DFFITS value--the scaled difference in the fit of the estimated dependent variable when the observation is included in the sample used to estimate the regression, as compared to when it is not. The sample remaining after the elimination of observations using the DFFITS criterion is referred to here as the homogenized subsample.

The DFFIT value, formally, is given by

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

where $\hat{y}_i$ is the predicted value of dependent variable (here, natural log of selling 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. If a house with an above average number of bathrooms sells at a bargain price, this will tend to lower the shadow price of bathrooms. The estimated 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. 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, as implicitly defined by $\hat{y} = Hy$ (so that $H = X(X'X)^{-1}X'$ where X is the regressor matrix). 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, 1983) 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 a significance level of 1 per cent, our DFFITS cut-off is $\left[\frac{k}{n - k}\right]^{\frac{1}{2}} t_{.005}$. For our data this means eliminating observations with DFFITS greater than 0.32 or less than -0.32; if the significance level is 0.2 per cent the DFFITS limits are -0.39 and 0.39.

As Table 3.9 shows, eliminating outliers using the 1% level eliminated one-third of the observations in the lowest value class (using constant dollar values), all observations in the top four value classes, and one-half the observations in the fifth highest value class. This leaves a sample with less value dispersion than the original sample. In particular, the standard deviation of value in the homogenized sample is $19,300 (Table A5) compared to the standard deviation of $20,500 in the original starter sample and $51,200 in the base house sample (Table A1). Because the outliers disproportionately come from the extremes of the original distribution, the standard deviation of the outliers is $43,700.

The most striking characteristic of the outliers is their typical age: 56 per cent are over 50 years of age, compared to only 16 per cent of the homogenized starter sample. The extreme heterogeneity, idiosyncrasy, that puts a house in the outlier category is thus strong associated with age. On average, outlier houses have relatively little living area but sit on a relatively large lot, are three times as likely as remaining starters to have currently or have had in the past, UFFI, are far less likely to have a recreation room or a finished basement and are far more likely to have two or more storeys. On average they are centrally located---just 1.2 miles from the CBD, compared to 1.7 for remaining starters. It can be inferred that many of these properties are ones with lots accounting for a high proportion of value.

Table 3.9
Distribution by Nominal and Constant Dollar* Selling Price
Homogenized Sample and Deletions

Significance Level:	0.002				0.01			
	Sample		Deletions		Sample		Deletions	
	Nom.	Real	Nom.	Real	Nom.	Real	Nom.	Real
< 80000	32	105	22	36	29	93	25	48
80001 to 95000	348	754	11	3	339	751	20	6
95001 to 105000	359	881	5	0	356	881	8	0
105001 to 115000	852	1083	3	3	851	1078	4	9
115001 to 140000	1138	346	2	6	1132	337	8	15
140001 to 160000	400	31	10	15	390	23	20	23
160001 to 180000	71	0	10	3	67	0	14	3
180001 to 200000	1	1	3	0	0	0	5	0
> 200000	0	0	1	1	0	0	1	1
	3201	3201	67	67	3163	3163	105	105

* 1988, 1st quarter dollars. Price index used for deflation is computed using the constrained hedonic regression results for the base house sample.)

Table 3.2
Sample Means of Selected Variables, Houses and Condominiums

	Houses	Condominiums
Sale Price ($)	151608	107694
Living Area(sqft)	1180	876
Lot Area (sqft)	6310	N/A
Bedrooms	3.16	2.60
Fullbaths	1.491	1.209
Halfbaths	0.522	0.616
Total Rooms	6.712	5.588
Recreation Room*	0.628	0.463
Family Room*	0.315	0.038
One Fireplace*	0.459	0.147
Two Car Garage*	0.234	0.012
Central Air Cond*	0.202	0.271
Miles to C Bus Dist	1.97	2.22
Age (new)*	0.095	0.069
Age (1-5)*	0.185	0.165
Age (6-15)*	0.238	0.661
Age (16-30)*	0.223	0.101
Age (31-50)*	0.146	0.004
Age (51+)*	0.114	0.001

* Number gives proportion of sample with the characteristic.

Table 3.4
Sample Means of Selected Variables, New and Existing Houses

	New	Existing
Sale Price($)	207466	145753
Living Area	1.281	1.164
Lot Area	7.103	6.226
Bed Rooms	3.440	3.136
Total Rooms	7.520	6.627
Fullbaths	1.818	1.457
Halfbaths	0.718	0.501
Recreation Room*	0.171	0.676
Family Room *	0.640	0.281
Two Car Garage*	0.703	0.185
One Fireplace*	0.713	0.432
Central Air Condit*	0.086	0.214
Central Business Dist.*	2.335	1.928
Age (new)*	1.000	0.000
Age (1 - 5)*	0.000	0.205
Age (6 - 15)*	0.000	0.263
Age (16 - 30)*	0.000	0.246
Age (31 - 50)*	0.000	0.161
Age (51 +)*	0.000	0.126

* Number gives proportion of sample with the characteristic.

	Other than starters	Starters
Sale Price($)	166983	120612
Living Area	1294	937
Lot Area	6865	5187
Bedrooms	3.284	2.924
Total Rooms	7.126	5.876
Full Bathrooms	1.616	1.241
Half Bathrooms	0.615	0.334
Recreation Room[a]	0.575	0.735
Family Room [a]	0.472	0.000
Two Car Garage[a]	0.350	0.000
One Fireplace [a]	0.576	0.224
Central Air [a]	0.237	0.131
Central Business [a]	2.11	1.69
Age (new) [a]	0.142	0.000
Age (1-5) [a]	0.277	0.000
Age (6-15)[a]	0.219	0.276
Age (16-30)[a]	0.190	0.288
Age (31-50) [a]	0.087	0.263
Age (51+) [a]	0.085	0.173

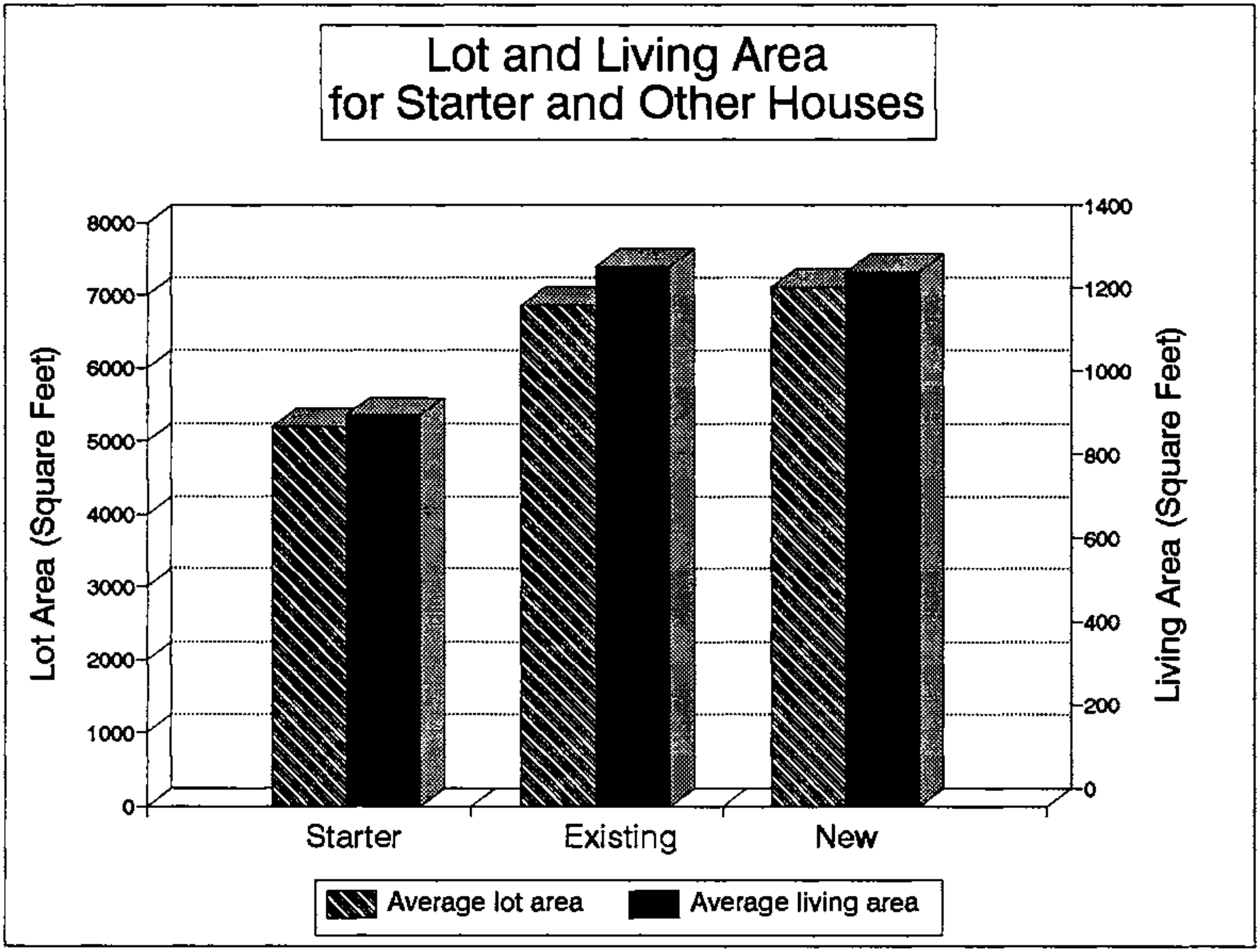
[a] Number gives proportion of sample with the characteristic.

Table 3.8
Sample Means of Selected Variables, Starter Condominiums and Other Condominiums

	Other than starters	Starters
Sale Price ($)	128395	94466
Living Area	1013	789
Total Rooms	6.103	5.259
Bedrooms	2.646	2.572
Fullbath	1.537	1.000
Halfbath	0.759	0.524
Game Room [a]	0.317	0.101
Recreation Room [a]	0.544	0.411
Family Room [a]	0.098	0.000
Two Car Garage[a]	0.032	0.000
One Fireplace [a]	0.333	0.027
Central Air Condit. [a]	0.446	0.159
Central Business Dist[a]	2.12	2.29
Age (new) [a]	0.097	0.051
Age (1 - 5)[a]	0.292	0.083
Age (6 - 15)[a]	0.540	0.738
Age (16 - 30) [a]	0.067	0.123
Age (31 - 50)[a]	0.003	0.005
Age (51 +) [a]	0.002	0.000

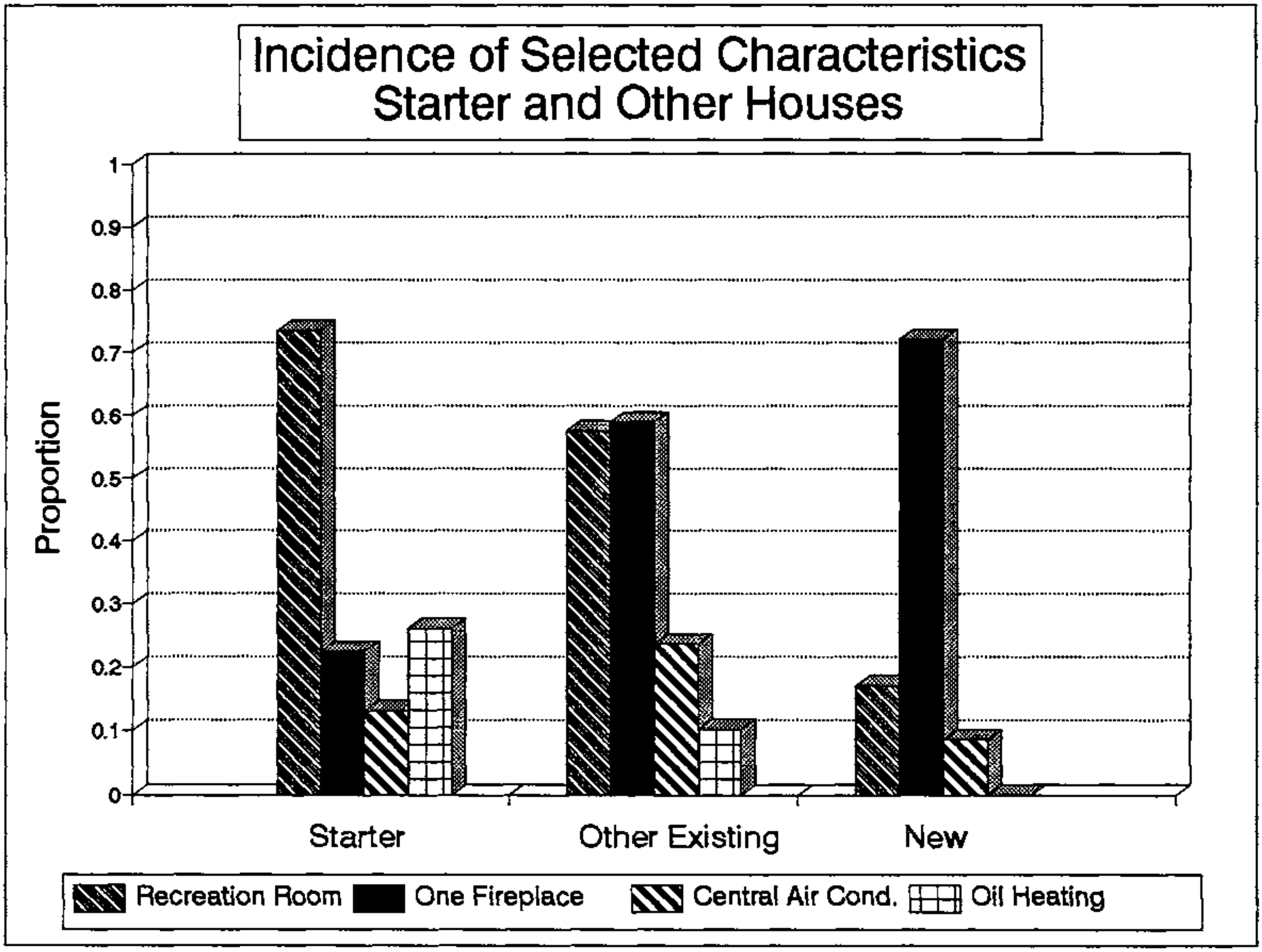
[a] Number gives proportion of sample with the characteristic.

Chart 3.1



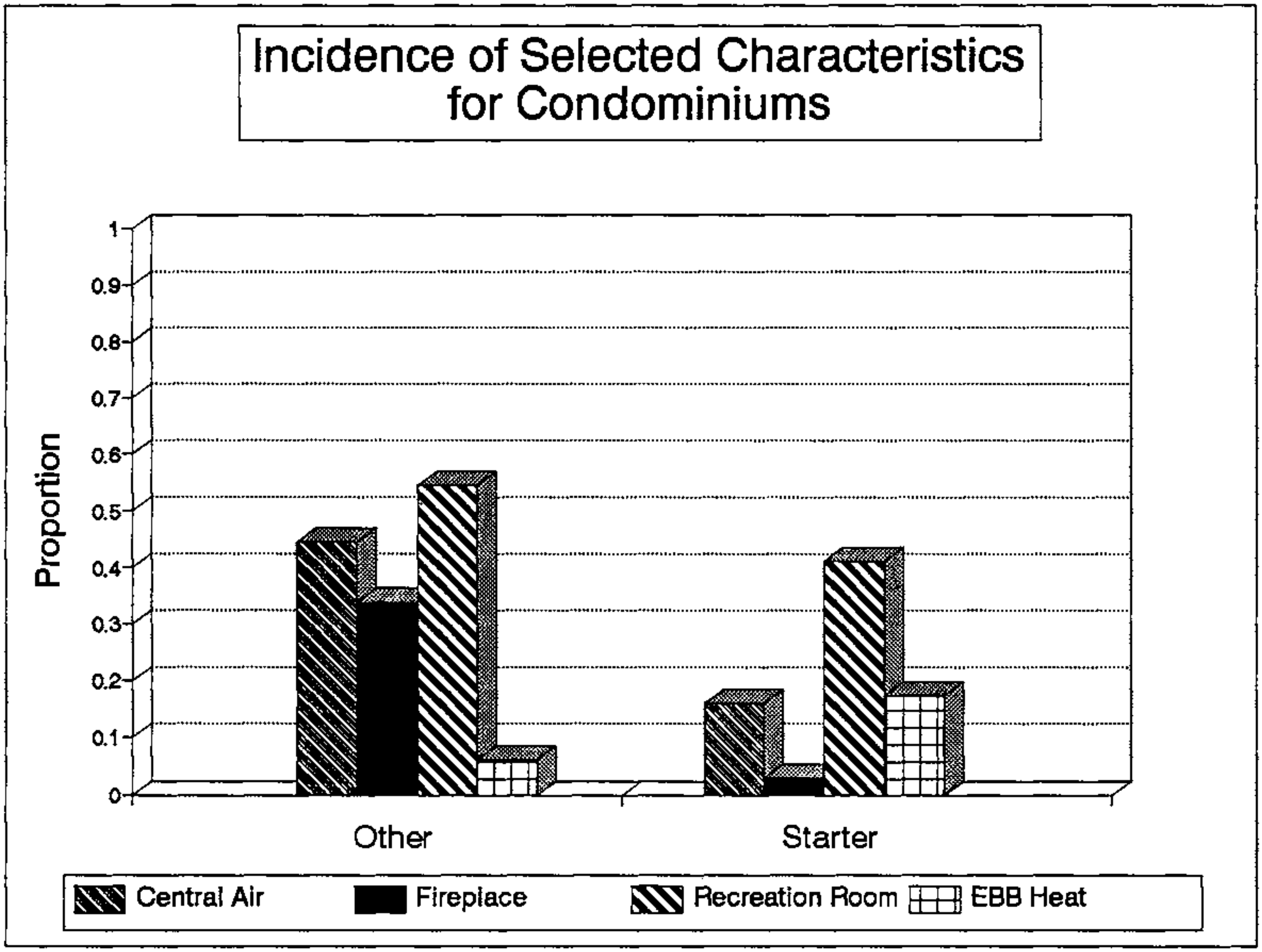
Lot and Living Area
for Starter and Other Houses
Lot Area (Square Feet)
8000
7000
6000
5000
4000
3000
2000
1000
0
1400
1200
1000
800
600
400
200
0
Living Area (Square Feet)
Starter
Existing
New
Average lot area
Average living area

Chart 3.2



Incidence of Selected Characteristics
Starter and Other Houses
Proportion
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Starter
Other Existing
New
Recreation Room
One Fireplace
Central Air Cond.
Oil Heating

Chart 3.3


Incidence of Selected Characteristics
for Condominiums
Proportion
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Other
Starter
Central Air
Fireplace
Recreation Room
EBB Heat

CHAPTER IV
REGRESSION RESULTS AND INDEX NUMBERS

I. HEDONIC REGRESSION RESULTS

Hedonic regression results for the unconstrained and constrained hedonic specifications for starter houses, all houses, and condominiums are given in the appendix. Despite the fact that the list of independent variables is far larger here than is common in hedonic regressions, the results are good from the point of view of correct signs, plausible shadow prices, and size of t ratios. Of 480 estimated coefficients in the starter house unconstrained hedonic regression, 40 per cent are significant at least at the 5 per cent level (55 per cent of coefficients other than accessibility and neighbourhood one are significant); in the constrained hedonic regression, three quarters are statistically significant. The proportion of the variance of the logarithm of price explained by the independent variables, as indicated by the $\bar{R}^2$ ranges from 0.509 to 0.619 in the quarterly regressions and is 0.684 in the constrained hedonic. These values for $\bar{R}^2$ are quite low relative to those usually found in hedonic regressions, because of the fact that the variance of the dependent variable here is greatly reduced by the use of a sample of starter homes; in the hedonic regressions for the sample of all houses the $\bar{R}^2$ are much higher.[1]

On the basis of the constrained hedonic results (Table A6a) it can be seen that an additional square foot is estimated to add about 0.01 of one per cent (*given other characteristics such as the number of bedrooms, bathrooms etc.*) to the value of a 1000 square foot house. For a house valued at $121,000--the mean value in this 1988-1990 starter

[1] They range from 0.791 to 0.855 in the unconstrained regressions, and the value for the constrained regression is 0.841.

sample--this translates to $12. An additional 10 square feet of lot adds about 0.0015 per cent to the value of property on a 5000 square foot lot. A bedroom adds over 3 per cent (in addition to 1 to 2 per cent attributable to its living area)[2] but a recreation room adds less, overall.[3] An additional full bathroom adds 4 per cent and a half bathroom, 3 per cent.[4] A fireplace adds 4 per cent. All these effects are less in proportional terms, and very much less at average values, for starter houses than for the all houses (see Table A7). The existence of UFFI, however, has a greater negative proportional effect--about 4 per cent--in this regression than in the regression for all houses. A house over 50 years old is estimated to be worth 9.5 per cent less than an otherwise similar house under 6 years old, implying a straight line depreciation rate less than 0.2 per cent per year. This is a little lower than the depreciation rate implied by the hedonic regression for all houses. It is worth noting that the latter regression estimates (Table A9) indicate that the annual depreciation rate is sharply highly for relatively new houses than for old: the annual depreciation rate for the first five

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[2] The 3% effect represents the effect of adding a bedroom, with the total living area constrained to remain unchanged. If the effect of interest is the effect of adding a bedroom without carving it out of existing space, the total effect is 3% plus the effect attributable to the living area added by adding the bedroom (with this latter amount depending on the dimensions of the bedroom); thus here the total effect is between 4% and 5%, depending on room dimensions. Other room variables must be interpreted in the same way.

[3] The estimated effect of a recreation room, *other things equal*, is a drop in value of about 0.4 of one per cent (although this coefficient estimate is not statistically significant); in the hedonic regression for *all* houses the negative impact is much greater--2.4 per cent--and the effect is very significant. It is important to interpret the negative effect of the recreation room dummy variable carefully. The full proportional effect of adding a recreation room of 200 square feet is the effect of an additional room plus the effect of a recreation room plus the effect of an additional 200 square feet; assuming the house is 1000 square feet to start with, the proportional effect is estimated to be about (see Table A8a) 0.00783 + (-0.00375) + [0.2307 - 2*(0.0637)]*0.2 = 0.025, or 2.5 per cent, if it is assumed the basement does not have to be finished in order to add the room. If finishing the basement is required the effect increases by about 0.003.

[4] These are effects assuming total living area of the house is kept constant.

years is estimated to be about 3 per cent, for the next 10 years about 1 per cent and for the next 35 years only about 0.1 per cent.[5]

Using the homogenized sample for starters does not change the estimated shadow prices for starter characteristics very much (cf Table A6b and Table A6a). One notable exception is living area: small houses are estimated to be worth less, and larger houses to be worth more, than in the unhomogenized sample.

The most striking aspect of the condominium hedonic regressions (Table A8) is the large estimated effect of additional living area. An additional square foot of living area, for a starter condominium of 800 square feet adds about 0.0021 per cent to value, much more than the proportional effect estimated for houses. The marginal shadow price of an additional bathroom, for all condominiums (Table 9a) is much greater than it is for houses, while that of a half bathroom is less. The estimated coefficient of the recreation room dummy variable is -0.007 for starter condominiums but close to -0.04 for all condominiums; it seems likely this large negative effect reflects the fact that this variable is to a substantial extent a proxy variable for townhouse, so that this effect indicates that, other things (such as living area and number of bedrooms) equal, a townhouse condominium is worth less than an apartment condominium.

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[5] Note that this is the depreciation rate net of maintenance and renovation. The gross physical depreciation rate could be much higher than the net rate. Suppose, for example, that the typical house in the age range 16 years and over has had kitchen, bathroom and other renovations which have, on average, added gross value of two per cent a year; then the gross depreciation rate would be slightly over two per cent per annum.

II. HEDONIC PRICE INDEX RESULTS

Price Indexes for Starter Houses

Price indexes estimated using the starter house subsample

For starter houses, alternative estimated flexible relative price indexes--those applying quasi Fisher Chain, quasi Laspeyres and quasi Paasche formulas (see Chapter II) using separate hedonic regressions for each quarter and variable means for each quarter--are shown in given in Table 4.1. These indexes all use the same estimated price functions, but differ in the bundles of house characteristics. Also given in Table 4.1 is the index estimated using the constrained hedonic regression, a single regression for all 12 quarters with a dummy variable for quarter 2 to 12. (Repeat sales indexes are discussed in a later section.)

As can be seen, the indexes computed by these various methods are strikingly similar. All four indexes show a steep rise from 1988 4 to the last quarter of 1989, rise slightly to a peak in the first quarter of 1990, and then fall substantially by 1990 4th quarter to a price level about 8 percentage points less than that reached at the peak but about 24 per cent higher than in 1988, 1st quarter. The biggest differences are in 1989, 3rd quarter, when the boom came to a sudden halt: the quasi Fisher Chain rises very slightly in this quarter while the quasi Laspeyres falls, as does the constrained hedonic (albeit very slightly). The remarkable similarity of the various relative price indexes means that for starter houses there is little evidence that the quasi Laspeyres index is an upward biased indicator of price change. Indeed, at the peak, the quasi Fisher Chain and the Paasche indexes are slightly higher than the quasi Laspeyres, suggesting that if anything, purchasers are substituting into characteristics with relatively higher prices, rather than away from them, perhaps driven by investment motives.

An examination of the indexes computed using homogenized samples--samples with outliers, identified using DFFITS, removed--indicates that there is not much to be gained by removing outliers (houses with prices much higher or lower than predicted). The indexes with outliers included and without outliers are very similar. It is noteworthy, however, that when outliers are removed the quasi Fisher chain index is almost always closer to the constrained hedonic index (see Chart 4.1) than otherwise; note the 1989 and 1990 index numbers, especially those in the second quarters of those two years. This suggests that there is a small payoff to removing outliers, which with other samples might be greater. In any case, the cost of removing outliers is small so that even a small payoff makes it worthwhile.

Comparisons to price indexes estimated using the all houses sample

Table 4.2 and Chart 4.2 give indexes computed using all houses. It can be seen that these price indexes are substantially similar to the starter indexes. There are some notable differences, however. First, the constrained hedonic and quasi Fisher Chain indexes are even closer for all houses than for starters. Second, and more interesting, the price of starter houses rises slightly more slowly than the price of all houses during 1988 but rise faster in 1989, so that the peak is higher for starter houses than all houses and the fall is less (Charts 4.8 and 4.9). This result is in contrast to a common perception that starters rise less than other houses in boom periods.[6] It may be that this perception is the consequence of

[6] Of course, the indexes here show only the last two years of the price boom; it is possible that starter houses rose less than all houses over the whole boom, 1985 to 1990. Smith and Tesarek (1991) find that high quality houses rise more than low quality houses in Houston, Texas in the 1970s and 1980s but it is possible that this finding is spurious, caused by the fact that they included few

confusing increases in selling prices because of houses being larger and of higher quality with pure price change; in addition, during boom periods excessive attention may be paid to high-priced outliers.

Comparisons to other indicators of the price of starter houses

It is useful to compare the quality-adjusted price indexes estimated here with other commonly used indicators of the price of starter houses: the Royal LePage price for a standard bungalow; the MLS average price for houses; the average price of existing NHA houses. The Royal LePage price is the opinion of Royal LePage staff in the area concerned, in this case Kitchener Waterloo, so that it is a judgment-based rather than a standard-estimator based price. The MLS average price series is based on all houses, so that it contains no adjustment for changes in the average quality of houses sold from one quarter to the next. Similarly, the NHA existing average contains no adjustment for quality, but there is some presumption that the average NHA house will be relatively more modest than the average house sold under MLS, so that the price of the former will more closely approximate the price of a starter house.

Indicators are put on a comparable basis by converting each to index form; that is, the value of the series in the base quarter (1988, 1st quarter) is set at 100. Thus, the value of 110.0 for the Royal LePage index in 1989, 1st quarter, means that the Royal LePage price for a bungalow is 10 per cent greater in that quarter than in the base quarter. These indexes are shown in Table 4.2 and Chart 4.3.

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characteristics other than lot size, living area and distance from CBD in their hedonic regression.

Remarkably, all three alternative indexes show an increase over the whole 1988-1990 period very close to that shown by the quasi Fisher Chain (quality-adjusted) index--that is they all show prices close to 25 per cent greater in the last quarter of 1990 than in the first quarter of 1988. There is substantial variation, however, over the intervening quarters. Only the MLS average is very close to the quasi Fisher Chain in the last quarters of the boom and during the downturn. The MLS average, however, increased substantially more than the quasi Fisher Chain in 1988, indicating that higher quality houses were sold in the last three quarters of that year than in the first quarter. The NHA index showed the opposite pattern to MLS index: it was close to the quasi Fisher Chain in the first part of the period, but substantially higher at the peak and shortly after. This indicates that the NHA mix changed as the boom was coming to a close and in the first part of the downturn, with relatively expensive houses playing a more important role. The Royal LePage index shows the step pattern characteristic of appraisal-based indexes and is far below the other indexes at the peak of the price boom. It cuts off the peak of the boom and instead shows a steady, slower rise and then a flattening.[7]

Price Indexes for Starter Condominiums

Price indexes estimated using the starter condominium subsample

A price index for starter condominiums is estimated using the constrained hedonic regression, a single regression for all 12 quarters with a dummy variable for quarter 2 to 12

[7] This pattern seems consistent with Royal LePage's business which requires it to advise vendors. After the second quarter of 1989--i.e. before the price peak--the *number* of sales fell substantially, so that a listing price below that indicated by the other indexes might be a risk-averse strategy for a vendor who strongly wishes to sell.

(Table 4.3 and Chart 4.5). (The relatively small sample size precluded estimation of an array of other indexes in this case.) This shows a peak in the same quarter as indexes for houses, in 1990, first quarter, but the peak is substantially higher--about 38 per cent above the base quarter--and the index ends 1990 at a substantially higher level--28 per cent above the base quarter.

Price indexes estimated for all condominiums

The full array of indexes estimated for houses is estimated for all condominiums (Table 4.3 and Chart 4.6). There is substantially more variation among the flexible relative price indexes and constrained hedonic price index here than there is for houses (cf. Chart 4.2). At the peak the quasi Laspeyres index is six percentage points above the quasi Fisher Chain and ten above the quasi Paasche. This suggests that here, unlike the case for houses, late in the boom the standard consumer good substitution did occur: that is, characteristics which rose in relative price were less frequently purchased.

The constrained hedonic index peaked at just under the peak shown by the quasi Laspeyres but ended up close to both the quasi Laspeyres and the quasi Fisher Chain.

Comparisons to other indicators of the price of starter condominiums

As can be seen in Table 4.3 and Chart 4.5, there is great variation among indicators of the price of starter condominiums. The MLS average is much closer on average to the quasi Fisher Chain (all condominiums) and the constrained hedonic (starter condominiums) than are the other two. The relation of the MLS average here to the quasi Fisher Chain is similar to the relation in the case of houses; here, as earlier, the MLS rises more in the early quarters and then follows the quasi Fisher Chain index closely.

The Royal LePage ends up close to the quasi Fisher Chain, but as for houses, the peak and downturn is cut off, with however, the index ending up very close to the first two. The NHA average moves to a much higher level than the other indexes at the peak and after the downturn, indicating a shift of higher quality condominiums into NHA financing at the peak and over the downturn.

III REPEAT SALES PRICE INDEXES

Repeat sales price indexes are computed for both condominiums and houses (Tables 4.2, 4.3, Chart 4.10). In both cases the repeat sales index in early quarters understates the price increase, but reaches a higher peak in first quarter, 1990, and ends at a higher level; still, the repeat sales index is much closer to the hedonic regression-based indexes than the Royal LePage estimate and NHA average are. This suggests that the repeat sales index, which is cheap to compute, is a more reliable indicator than other non-hedonic based indexes.

IV NEW HOUSE PRICE INDEXES

Because the sample used for this study contains a substantial number of new houses, it is possible to assess a further indicator of house prices, the Statistics Canada new house price index. The Statistics Canada index is produced by surveying tract builders who report the price in succeeding months of a model house(s); when a model(s) is discontinued, the new series with the new model is linked to the old series by using relative prices or relative costs at the link month. The sample of new houses in this study are new houses sold under MLS and so we presume it consists very largely of houses built by non-tract builders who have only a few houses to sell at a given location at any point of time.

As Chart 4.4 shows, the Statistics Canada index is smoother than the constrained hedonic and rises at a much lower rate, so that at its peak in 1990, first quarter, it is close to 10 percentage points less than the constrained hedonic. It ends the period showing an increase over the three years about one third less than shown by the constrained hedonic index. This result suggests that the Statistics Canada index may be seriously downward biassed.[8]

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[8] It seems possible that when builders introduce a new model they use the opportunity to increase the quality adjusted price as well. That is, a model may be left on the market for some time without much increase in price and towards the end of its life it may be relatively speaking a bargain, until inventory runs out. A new model, however, may typically be priced at a slight pure price premium when it is first introduced. If this hypothesis is correct, a price index produced using the Statistics Canada method would be downward biassed.

Table 4.1
Estimated Indexes

Starter Houses

All Starter Transactions

	1988				1989				1990			
	1	2	3	4	1	2	3	4	1	2	3	4
Flexible relative price indexes												
Fisher Chain	100.00	103.59	106.12	110.88	119.91	127.48	127.80	130.68	133.59	133.18	127.59	124.99
		3.59	2.44	4.49	8.14	6.31	0.25	2.26	1.97	-0.06	-4.19	-2.04
Laspeyres	100.00	103.97	106.32	109.99	119.92	126.59	125.92	129.56	132.12	131.66	127.98	124.81
		3.97	2.26	3.46	9.03	5.57	-0.53	2.89	1.98	-0.35	-2.79	-2.48
Paasche	100.00	103.20	105.77	109.94	119.19	126.40	126.46	129.79	132.78	132.48	127.87	123.95
		3.20	2.49	3.94	8.41	6.05	0.05	2.63	2.31	-0.22	-3.48	-3.06
Const. hed.	100.00	103.33	105.93	110.53	118.91	126.36	126.25	129.89	132.71	132.14	127.16	124.58
		3.33	2.59	4.60	8.38	7.45	-0.11	3.64	2.82	-0.57	-4.98	-2.58

Sample of Starters Homogenized using DFFITS

	1988				1989				1990			
Flexible relative price indexes												
Fisher Chain	100.00	103.72	106.10	111.06	119.73	127.37	127.57	130.68	133.82	133.00	127.46	125.27
		3.72	2.29	4.67	7.81	6.38	0.16	2.44	2.40	-0.61	-4.17	-1.72
Laspeyres	100.00	104.10	106.29	110.17	119.75	126.49	125.69	129.57	132.36	131.49	127.86	124.71
		4.10	2.10	3.65	8.70	5.63	-0.63	3.09	2.15	-0.66	-2.76	-2.46
Paasche	100.00	103.34	105.76	110.12	119.01	126.29	126.24	129.78	133.01	132.31	127.75	123.85
		3.34	2.34	4.12	8.07	6.12	-0.04	2.80	2.49	-0.53	-3.45	-3.05
Const. hed.	100.00	103.27	106.32	110.51	119.67	126.83	127.05	130.19	133.18	132.91	128.80	125.24
		3.27	3.05	4.18	9.17	7.16	0.22	3.14	2.99	-0.27	-4.11	-3.56

Standard Bungalow (Royal LePage) from sample of Starter Houses

	100.00	109.64	112.10	115.38	127.28	131.39	122.98	130.18	132.43	138.16	126.07	138.92

Note: Const. hed. refers to the constrained hedonic method of estimation. Flex. rel. pr. refers to the use of coefficients which are taken from 12 separate estimated quarterly regressions. The index for the standard Royal LePage bungalow taken from the sample of starter houses refers to an index computed using values for characteristics given by the specification for the Royal LePage standard bungalow, mean sample values for remaining characteristics and the 12 quarterly estimated regressions.

Table 4.2

Estimated Indexes

Single and Semi-detached Houses

All Transactions

	1988				1989				1990			
	1	2	3	4	1	2	3	4	1	2	3	4
Flexible relative price indexes												
Fisher Chain	100.00	104.05	107.69	111.11	118.87	125.77	125.42	129.18	131.57	130.90	126.40	122.81
		4.05	3.50	3.18	6.99	5.80	-0.28	2.99	2.16	-0.81	-3.44	-2.84
Laspeyres	100.00	104.08	107.85	111.03	119.25	124.88	126.01	129.52	130.99	130.30	126.03	120.29
		4.08	3.62	2.95	7.40	4.72	0.90	2.78	1.13	-0.53	-3.28	-4.55
Paasche	100.00	104.02	107.31	110.94	118.04	124.68	124.61	128.82	131.33	130.30	126.76	121.47
		4.02	3.16	3.38	6.39	5.63	-0.06	3.38	1.95	-0.79	-2.71	-4.17
Const. hed.	100.00	103.98	107.51	111.04	118.85	125.58	125.43	129.10	131.98	131.17	127.01	121.49
(All)		3.98	3.53	3.53	7.81	6.73	-0.15	3.66	2.88	-0.82	-4.16	-5.52
Const. hed.	100.00	103.24	106.60	110.21	117.41	123.78	124.02	127.89	130.55	129.62	126.26	120.78
(Existing)		3.24	3.36	3.61	7.20	6.37	0.25	3.87	2.66	-0.94	-3.35	-5.48
Const. hed.	100.00	103.87	107.25	110.93	119.02	126.04	126.19	129.35	132.27	132.06	127.41	121.70
(OFFITS)		3.87	3.38	3.68	8.09	7.02	0.15	3.16	2.91	-0.21	-4.65	5.71
Other Estimated Indexes												
Repeat Sales	100.00	100.91	106.83	109.44	118.66	124.72	126.47	126.88	134.33	134.15	127.28	126.92
		0.91	5.92	2.61	9.22	6.06	1.75	0.42	7.44	-0.17	-6.87	-0.36
Standard Bungalow (Royal LePage) All Transactions												
Bungalow	100.00	101.04	106.88	106.09	118.15	122.84	125.46	128.01	128.77	129.15	118.24	118.41
		1.04	5.78	-0.74	11.37	3.97	2.13	2.03	0.59	0.30	-8.45	0.14
Sample of New Houses sold under MLS												
Const. hed.	100.00	107.00	111.27	112.23	119.73	126.66	126.24	128.44	132.01	133.95	126.21	122.45
(New)		7.00	4.27	0.96	7.50	6.92	-0.42	2.20	3.57	1.94	-7.74	-3.77
Other Existing Indexes												
MLS	100.00	106.78	107.73	118.97	120.12	128.75	127.61	129.96	133.79	132.07	127.35	124.63
(Average)		6.78	0.89	10.43	0.97	7.18	-0.89	1.84	2.95	-1.29	-3.57	-2.14
Royal Lepage	100.00	100.00	110.00	110.00	110.00	115.00	120.80	120.80	120.80	127.10	127.10	127.10
(Bungalow)		0.00	10.00	0.00	0.00	4.55	5.04	0.00	0.00	5.22	0.00	0.00
StatCan	100.00	102.90	105.80	108.70	113.60	116.60	118.40	120.30	122.60	122.10	120.00	114.90
(New)		2.90	2.82	2.74	4.51	2.64	1.54	1.60	1.91	-0.41	-1.72	-4.25
NHA Financed Dwellings												
New	100.00	101.30	109.60	132.70	117.50	140.20	143.10	141.30	128.30	167.50	160.70	130.40
		1.30	8.19	21.08	-11.45	19.32	2.07	-1.26	-9.20	30.55	-4.06	-18.86
Existing	100.00	101.80	104.00	109.80	117.70	128.10	133.00	128.50	135.60	138.90	131.10	124.70
		1.80	2.16	5.58	7.19	8.84	3.83	-3.38	5.53	2.43	-5.62	-4.88

Note: Const. hed. refers to the constrained hedonic method of estimation.

Table 4.3

Estimated Indexes

Condominiums

All Transactions

	1988				1989				1990			
	1	2	3	4	1	2	3	4	1	2	3	4*
Flexible relative price indexes												
Fisher Chain	100.00	103.87	109.60	110.61	117.51	127.07	128.78	130.79	134.13	133.20	131.10	123.98
		3.87	5.52	0.92	6.23	8.14	1.34	1.56	1.34	0.50	-1.57	-5.43
Laspeyres	100.00	103.89	109.82	109.59	117.69	129.14	132.25	134.28	140.41	140.45	131.73	126.47
		3.89	5.71	-0.21	7.39	9.72	2.41	1.54	4.56	0.03	-6.21	-3.99
Paasche	100.00	103.86	109.52	111.38	121.00	126.93	127.41	129.74	130.29	128.79	127.08	112.15
		3.86	5.45	1.70	8.64	4.90	0.38	1.83	0.42	-1.15	-1.33	-11.75
Other Estimated Indexes												
Const. hed.	100.00	104.23	110.71	111.21	120.23	129.65	131.68	133.99	137.30	137.34	133.53	125.93
		4.23	6.22	0.45	8.11	7.84	1.56	1.76	2.47	0.03	-2.77	-5.70
Const. hed.	100.00	104.25	110.12	111.78	120.31	129.56	131.58	134.10	138.21	139.10	134.48	127.97
(DFFITS)		4.25	5.63	1.51	7.63	7.69	1.56	1.92	3.07	0.64	-3.32	-4.84
Repeat Sales	100.00	102.91	108.64	110.01	118.78	125.72	128.76	134.82	140.71	135.16	129.71	129.06
		2.91	5.73	1.37	8.77	6.94	3.04	6.06	5.88	-5.54	-5.46	-0.65
Other Existing Indexes												
Royal Lepage	100.00	100.00	109.00	109.00	113.60	119.10	122.70	122.70	122.70	122.70	122.70	122.70
		0.00	9.00	0.00	4.22	4.84	3.02	0.00	0.00	0.00	0.00	0.00
NHA Financed	100.00	104.90	112.10	113.60	123.50	130.60	138.00	154.10	147.70	140.60	142.70	138.50
		4.90	6.86	1.34	8.71	5.75	5.67	11.67	-4.15	-4.81	1.49	-2.94

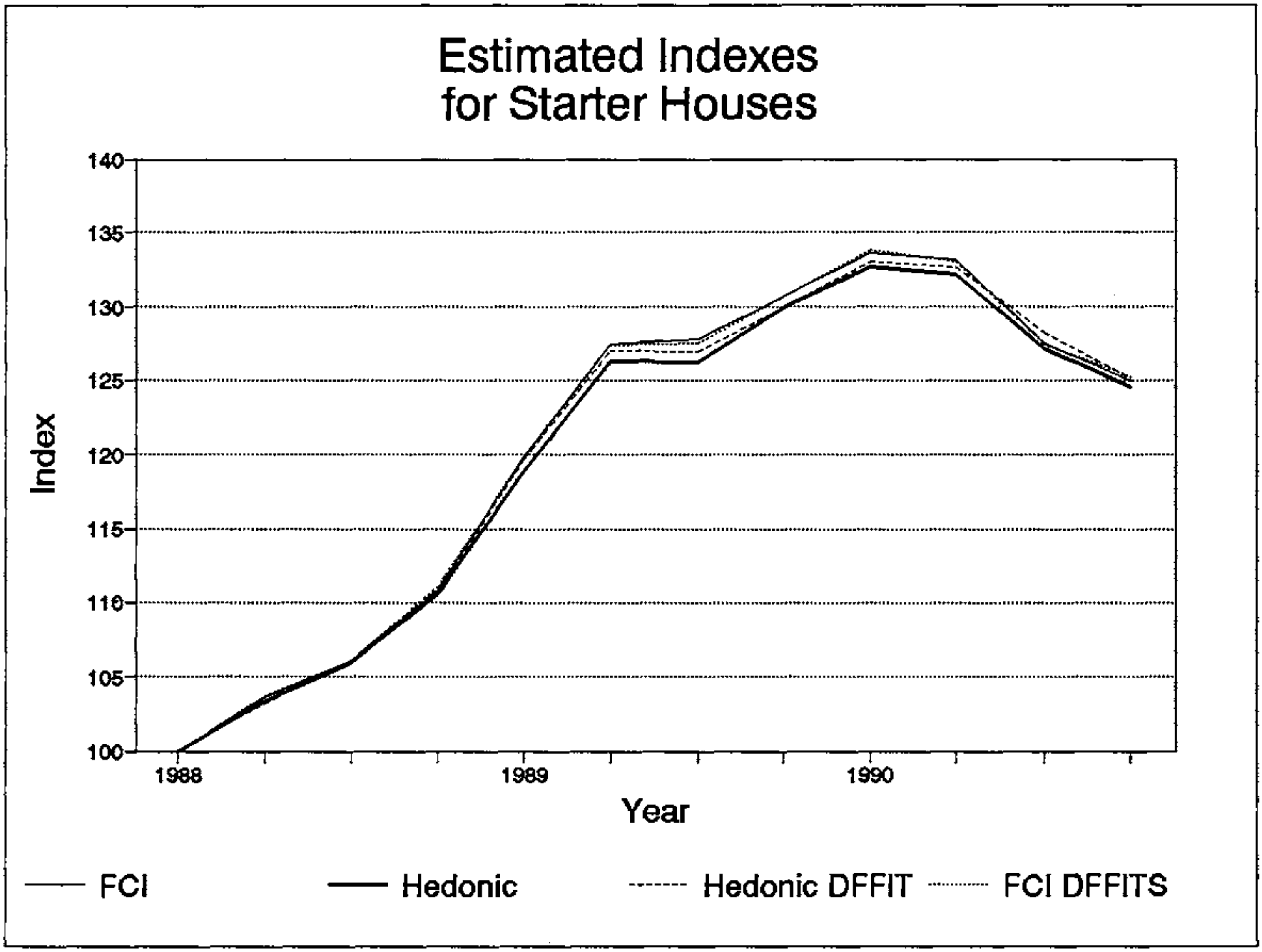
Starter Condominiums

Const. hed.	100.00	104.96	110.80	112.14	120.13	130.62	134.41	134.29	137.97	136.19	134.81	128.29
		4.96	5.85	1.34	7.99	10.49	3.79	-0.12	3.69	-1.78	-1.38	-6.52

* There were only 56 observations in the 4th quarter 1990 used in the estimation

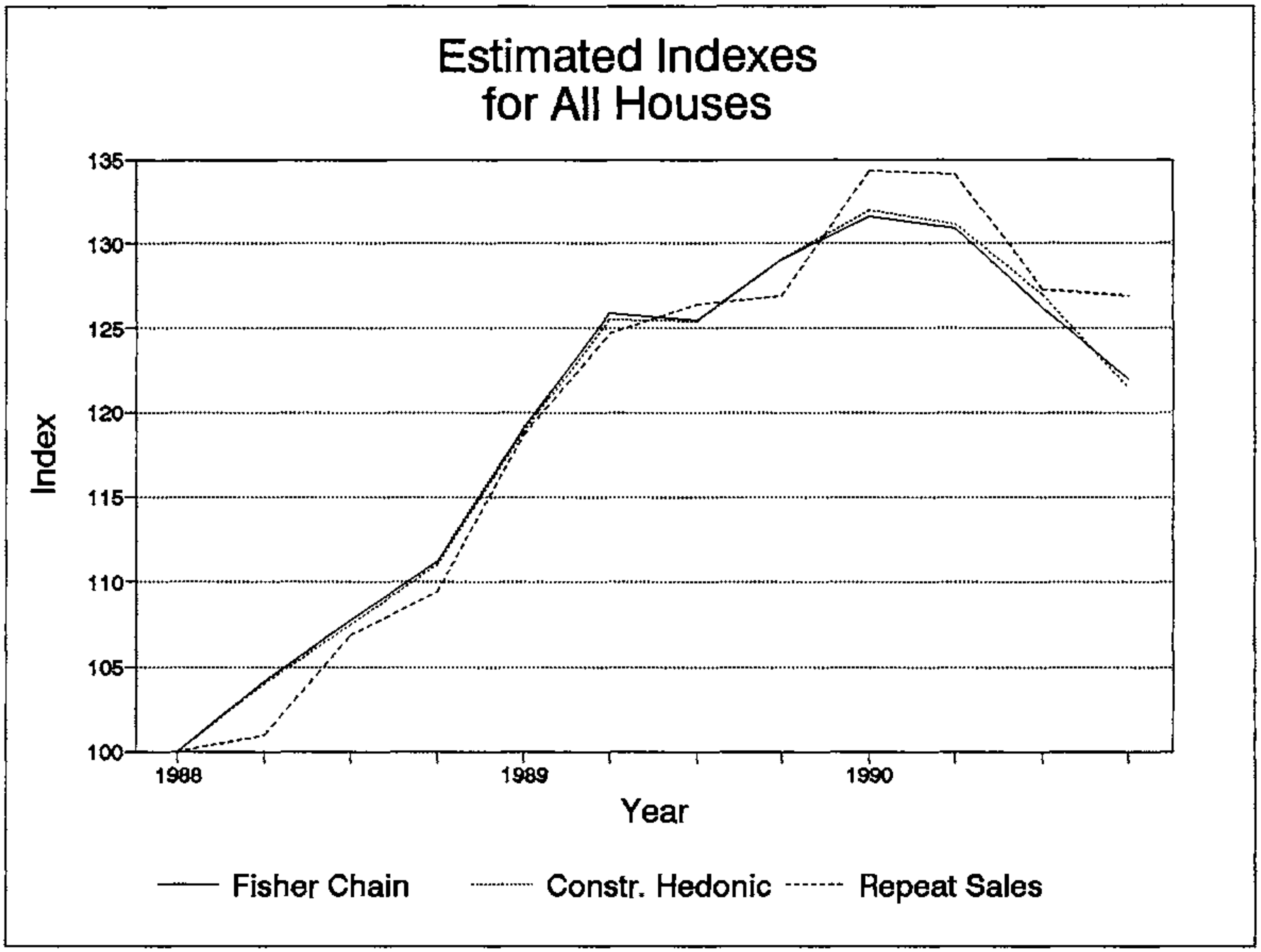
Note: Const. hed. refers to the constrained hedonic method of estimation.
Numbers under index number give the percentage change from the previous quarter.

Chart 4.1



Estimated Indexes
for Starter Houses
Index
140
135
130
125
120
115
110
105
100
1988
1989
1990
Year
FCI
Hedonic
Hedonic DFFIT
FCI DFFITS

Chart 4.2



Estimated Indexes
for All Houses
Index
135
130
125
120
115
110
105
100
1988
1989
1990
Year
Fisher Chain
Constr. Hedonic
Repeat Sales

Chart 4.3

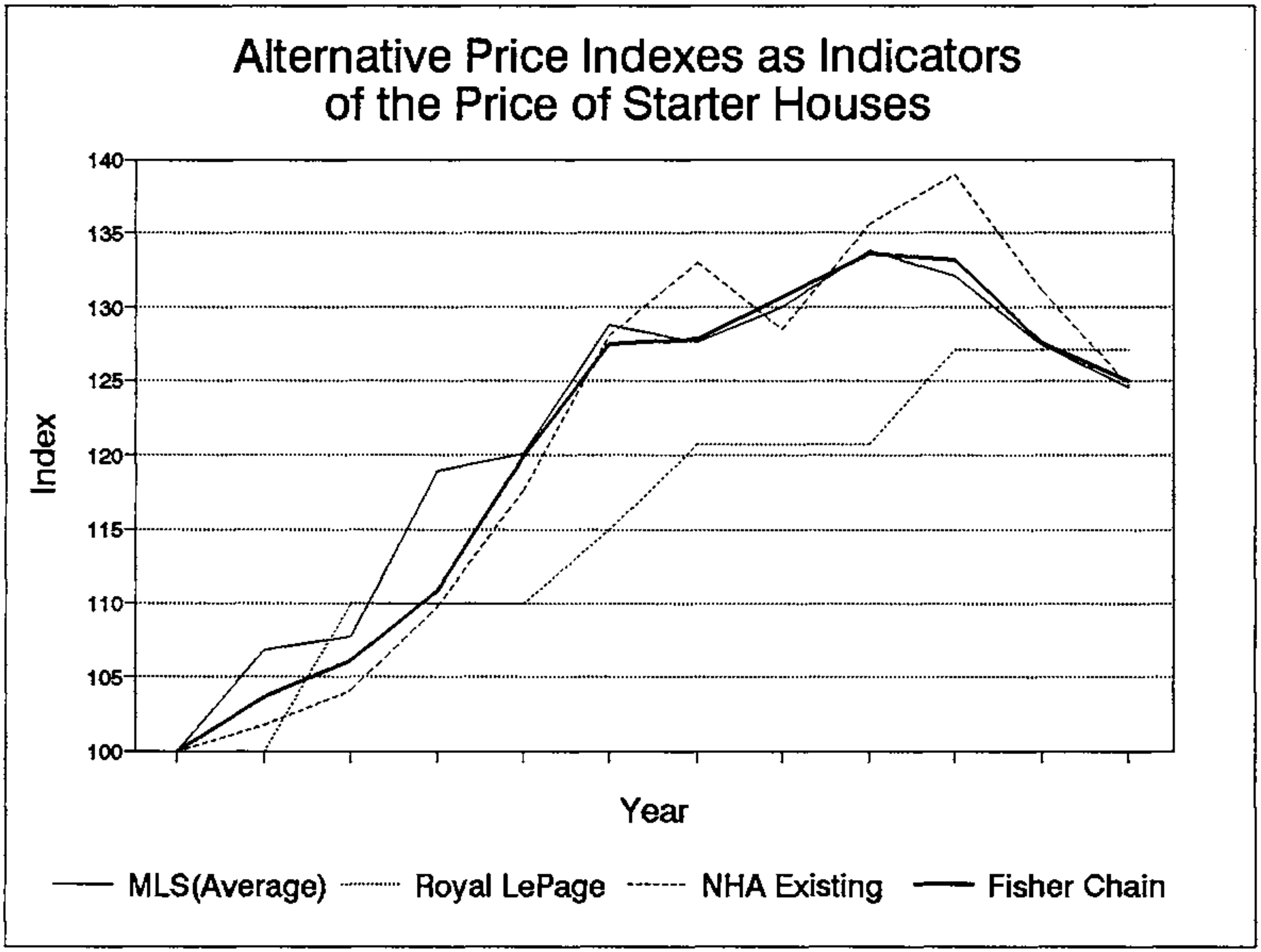
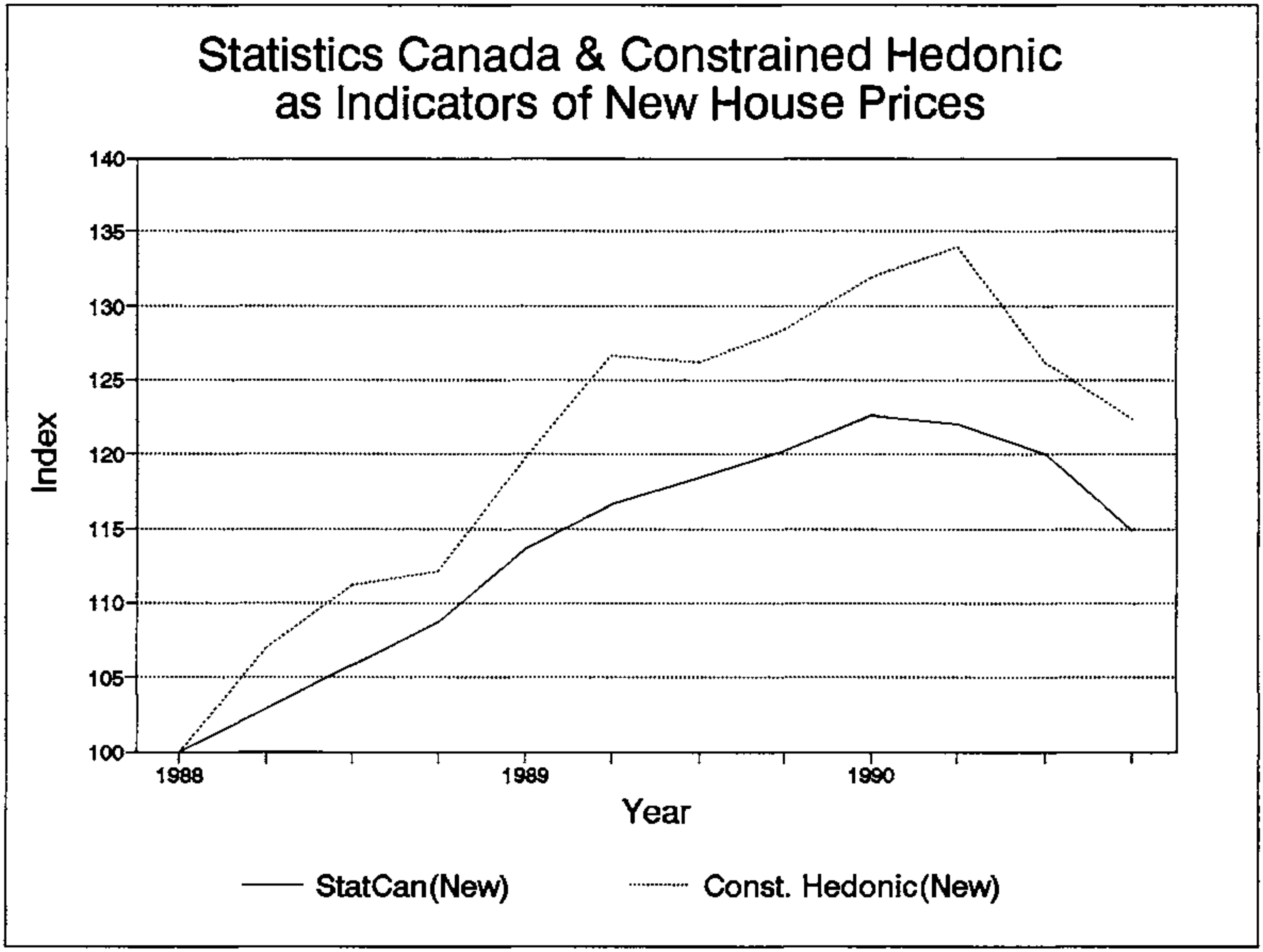
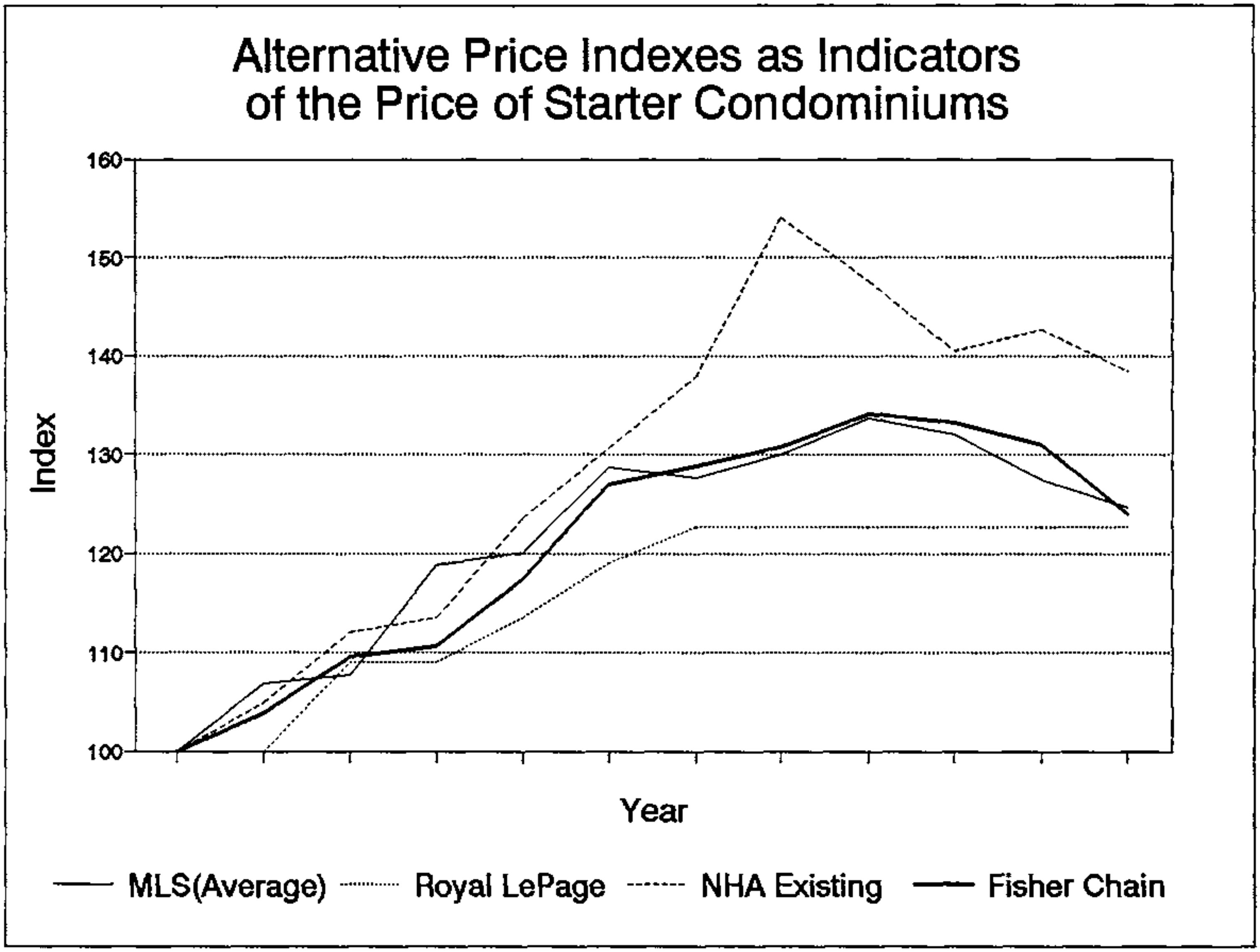

Alternative Price Indexes as Indicators
of the Price of Starter Houses
140
135
130
125
120
115
110
105
100
Index
Year
MLS(Average)
Royal LePage
NHA Existing
Fisher Chain

Chart 4.4



Statistics Canada & Constrained Hedonic
as Indicators of New House Prices
140
135
130
125
120
115
110
105
100
Index
1988
1989
1990
Year
StatCan(New)
Const. Hedonic(New)

Chart 4.5



Alternative Price Indexes as Indicators of the Price of Starter Condominiums
160
150
140
130
120
110
100
Index
Year
MLS(Average)
Royal LePage
NHA Existing
Fisher Chain

Chart 4.6

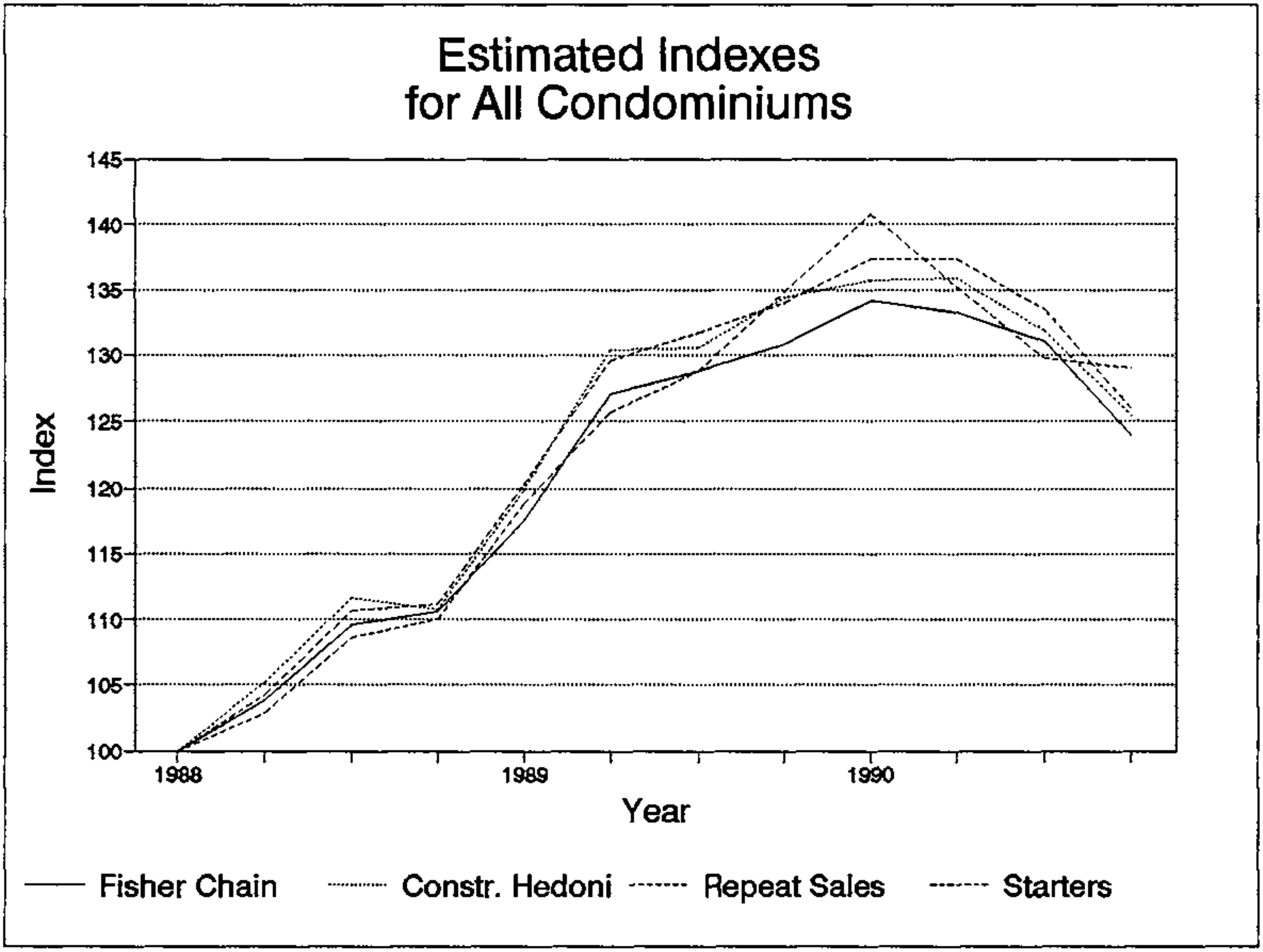
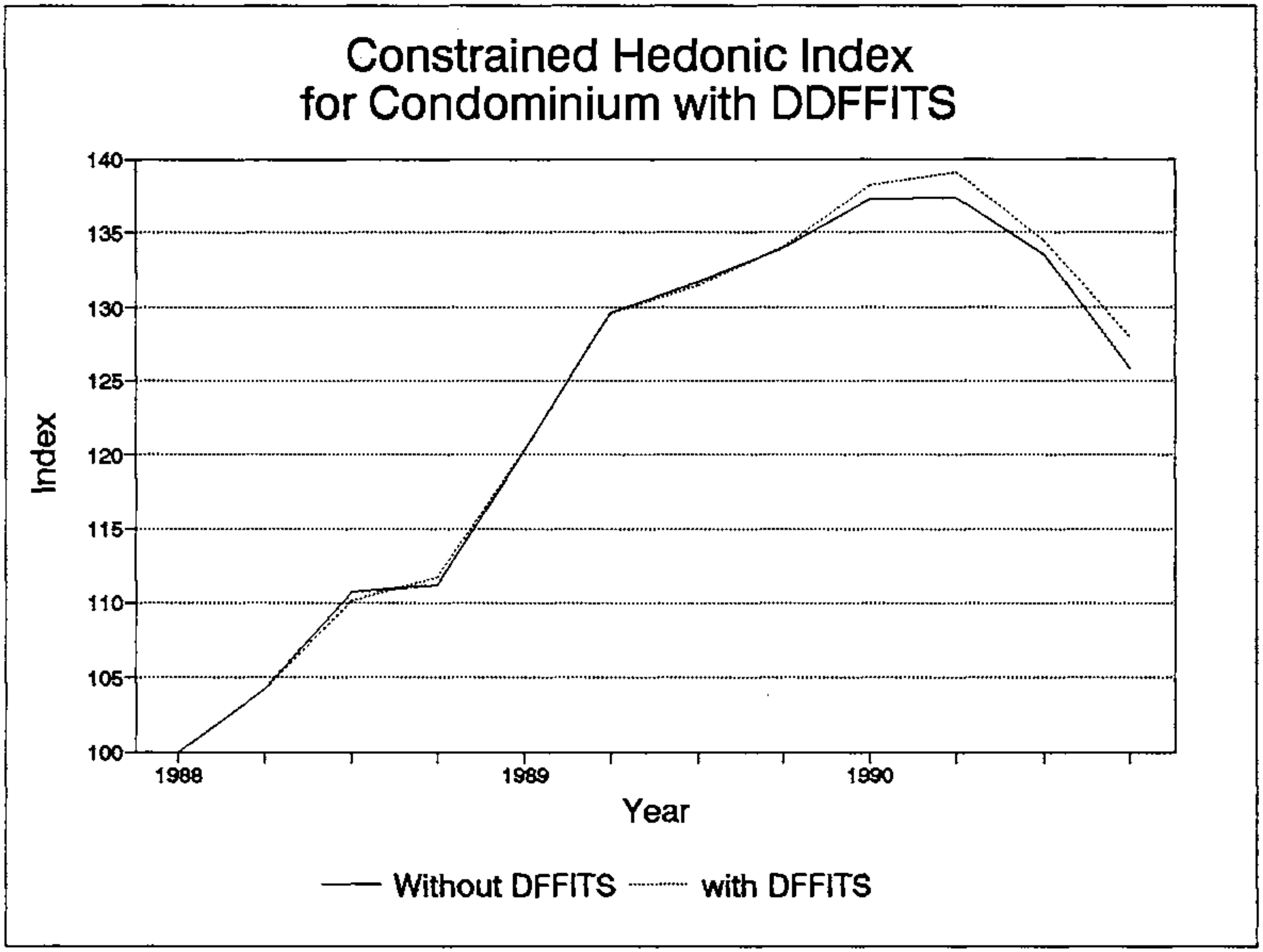
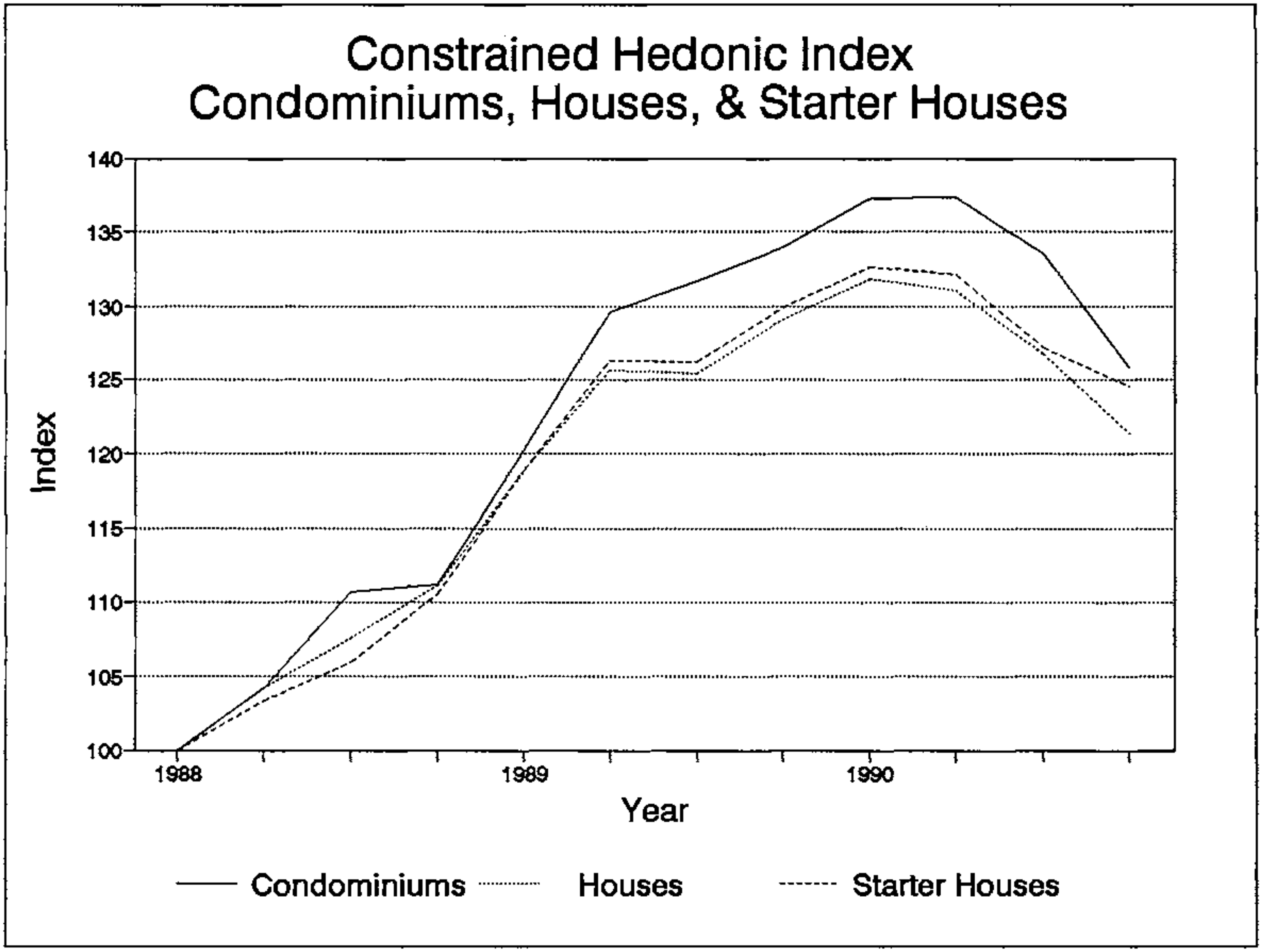

Estimated Indexes
for All Condominiums
145
140
135
130
125
120
115
110
105
100
Index
1988
1989
1990
Year
Fisher Chain
Constr. Hedoni
Repeat Sales
Starters

Chart 4.7



Constrained Hedonic Index
for Condominium with DDFFITS
140
135
130
125
120
115
110
105
100
Index
1988
1989
1990
Year
Without DFFITS
with DFFITS

Chart 4.8



Constrained Hedonic Index
Condominiums, Houses, & Starter Houses
Index
140
135
130
125
120
115
110
105
100
1988
1989
1990
Year
Condominiums
Houses
Starter Houses

Chart 4.9

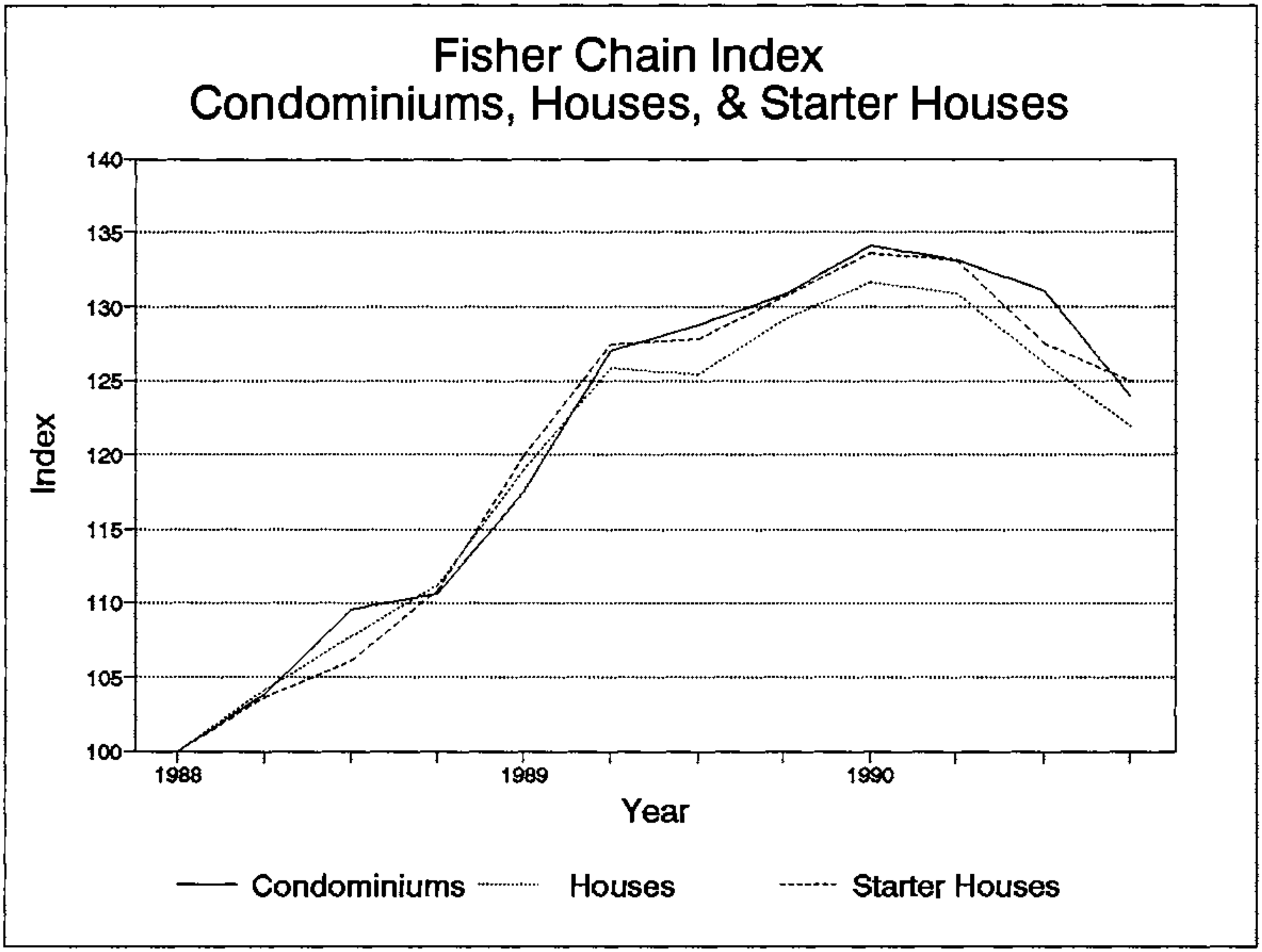
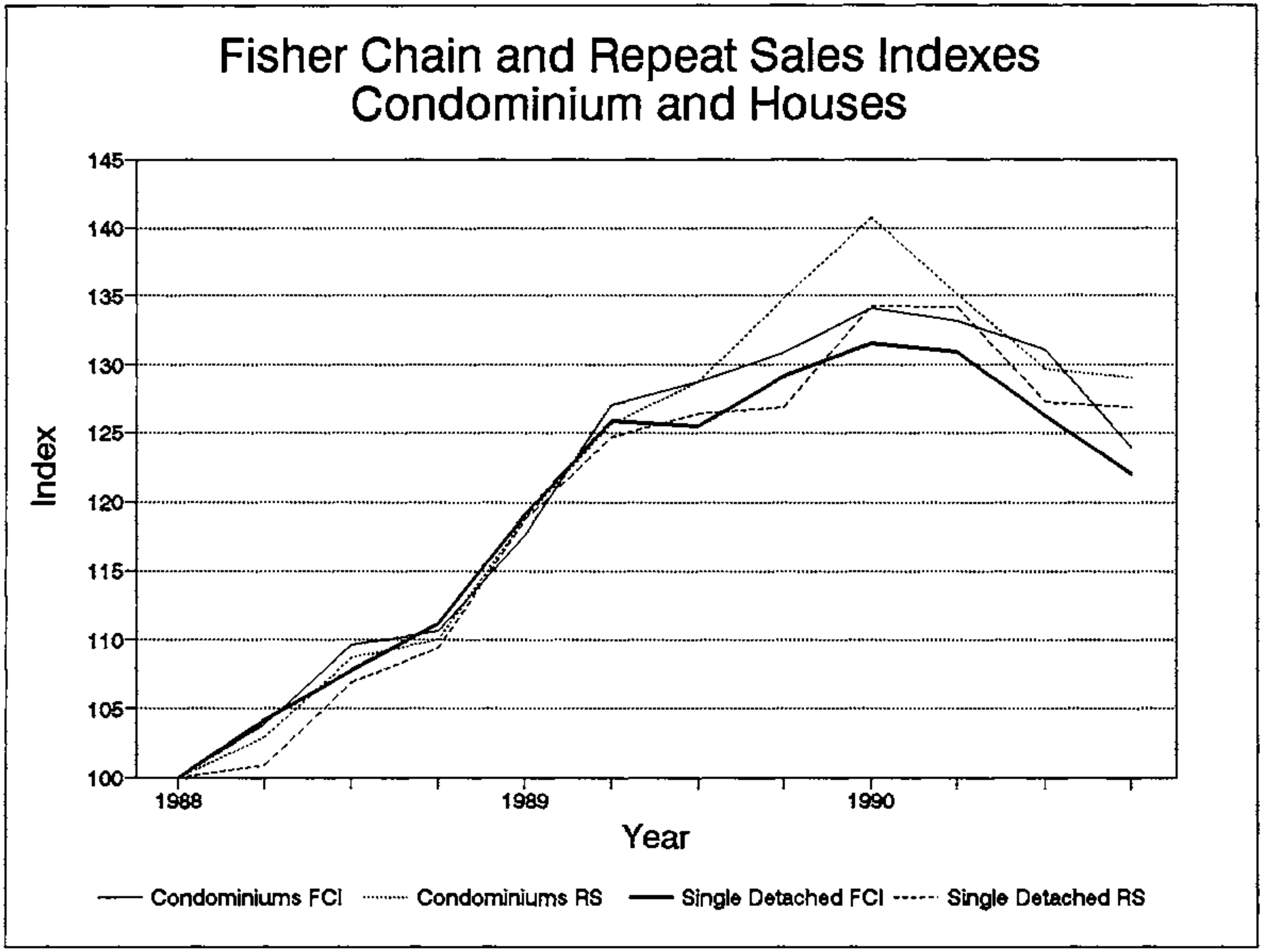

Fisher Chain Index
Condominiums, Houses, & Starter Houses
140
135
130
125
120
115
110
105
100
Index
1988
1989
1990
Year
Condominiums
Houses
Starter Houses

Chart 4.10



Fisher Chain and Repeat Sales Indexes
Condominium and Houses
145
140
135
130
125
120
115
110
105
100
Index
1988
1989
1990
Year
Condominiums FCI
Condominiums RS
Single Detached FCI
Single Detached RS

CHAPTER V
NOTEWORTHY RESULTS, LESSONS AND IMPLICATIONS

I. NOTEWORTHY RESULTS OF THE HEDONIC REGRESSIONS

The Effect of Age on Value

Hedonic regressions estimated in this study suggest that the age of a house plays a major role in determining its value, but a somewhat different one than is often assumed. First, value declines with age, but the rate of decline is far from constant: in fact the rate falls dramatically with age. For houses in the total sample, the rate of decline is about 3 per cent (per year) for the first five years, about 1 per cent for the next 10 years, and for the next 35 years is only about 0.1 per cent (see Table A7). For the sample of modest houses the indicated rate of depreciation for older houses is even less. This implies that appraisal methods which assume a constant rate of depreciation will overstate the value of houses a few years old and greatly understate the value of old houses.

The surprisingly low rate of observed depreciation of old houses is probably attributable to the fact that, on average, maintenance and renovation, especially of bathrooms and kitchens largely offsets physical depreciation and obsolescence.[1] A pragmatic rationale for caution in appraisal of the values of old houses, however, is the evidence in this study that the price of a specific old house is tougher to predict with accuracy than the price of a relatively new one. Over a long period of time differences in maintenance and little renovation can result in greatly varying prices for two houses with the same number of

[1] If appraisals explicitly include a substantial allowance for renovations, then they are less apt to understate the value of old houses than suggested here. The depreciation rate here is estimated with the *number* of bathrooms, half bathrooms and presence of a two-car garage etc. controlled for, but without *renovations* of bathrooms etc. controlled for.

bathrooms. This is manifest in this study in the fact that the sample of outlying observations (as identified on the basis of their DFFITS) is dominated by old houses.

Nonlinearities in the effects of characteristics on value

The functional form used in this study for the hedonic regressions assumes that the a unit change in a characteristic has a constant *percentage* effect on value (e.g. the addition of a bathroom increases value by 5.5 per cent (Table A7)), rather than a constant dollar effect. This assumed nonlinearity is consistent with the view that, when a bathroom is added to an expensive house, it is likely to be of higher quality than when it is added to an inexpensive house; the regression specification assumes, for example, that on average, *if* a bathroom adds $5,000 to the value of a $100,000 house, a bathroom adds $10,000 to a $200,000 house. Comparison of the starter house regression results with the results for all houses provides further evidence of nonlinearity. While a bathroom is estimated to increase value by 5.5 per cent in the latter regression, it is estimated to increase in value by only 4.2 per cent in the starter regression (Table A6a); thus the all houses regression tells us a bathroom adds $8,400 to value, while the starter regression tells us a bathroom adds only $5,100.[2] Note the nonlinearity in the effect of a fireplace: one adds 5.5 per cent to the value of all houses but only 3.9 per cent to the value of a starter. Consider also garages: in the all houses regression, the first garage adds just 3.5 per cent to value but the second adds 10.2 per cent.

The most important nonlinearity, however, is for space. In the all houses regression

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[2] The $8,400 shadow price for a bathroom is computed at the mean value of *all* houses, $152,600, while the $5,100 shadow price is computed at the mean value of the starter subsample.

an additional square foot of living area adds a greater *percentage* amount to value the larger the house; i.e. when the house is large the effect of an additional square foot is a greater percentage of value than when the house is small. This suggests that the quality per square foot of living space increases strongly with the size of house, since it seems plausible that the marginal production cost of a square foot *of given quality* would fall as the number of square rises. In the case of starter houses this relationship observed for all houses does not hold; in particular, in the case of starter houses, the marginal effect of a square foot of living area falls when living area increases (Table A6a).

II PRICE INDEX RESULTS

The best index method, when resources are not a constraint

The results of this study suggest that the quasi Fisher Chain Index estimated using the starter subsample is the best choice of index for starter houses. The quasi Fisher Chain is preferable on theoretical grounds to the two alternative flexible relative price indexes, the quasi Laspeyres and quasi Paasche indexes because it is weighted to reflect current and previous choices of purchasers. The results for houses show that for them there is little difference between indexes computed using the three methods. For all condominiums, however, differences are quite large: the quasi Laspeyres index is six percentage points higher at the peak and somewhat higher also, at the end of the period; the quasi Paasche is four percentage points lower at the peak and is much lower at the end of the period. This suggests that in the case of condominiums the classic substitution effect did take place--that is, purchasers shifted towards units with characteristics rising relatively little in price. Note that computerization means that computing the quasi Fisher Chain is no more troublesome than computing the quasi Laspeyres and quasi Paasche.

The choice of method when resources are constrained

Limited data

Resources required for the estimation of the quasi Fisher Chain index are sometimes not available. What method should be used in this circumstance? The answer depends on the nature of the resource constraint. Suppose the constraint is limited data. A sample may contain only a few observations in some quarters. This is especially likely to be the case during market downturns when typically the volume of sales plummets. In this case, rather than dropping many characteristics from the regression specification, a better option would be to use the constrained hedonic specification. This specification is also simpler to compute--because only one regression is estimated, rather than the large number of regressions (one for each quarter) required for the flexible relative price methods. For both all houses and starter houses the index estimated here using the constrained hedonic regression is very close to the quasi Fisher Chain index (Charts 4.1,4.2,), indicating that *for this sample* the relative price of characteristics changed very little over the period. For condominiums there is however, a substantial divergence (Chart 4.6).

Limited funds and/or no information about characteristics

The cheapest price index method is the repeat sales method. This method uses only those transactions in the data set which involve properties sold at least twice in the data period. The sample used for the repeat sales regression is thus necessarily much smaller than the total number of transactions. It is a surprise, however, to most analysts new to repeat sales studies to discover how large the number of repeat sales transactions actually is: in our sample of houses they amount to over 12 per cent of all transactions, despite the fact the sample covers only three years.

The great attraction of the repeat sales method is that apparently no information on the characteristics of the property is required; differences in quality are fully controlled for because the *same* house is priced at two different points of time. Unfortunately, however, some information about the property is required, however, to determine whether the property actually did remain the same (except for pure physical depreciation) between the two transactions; for example, if a bathroom has been added, the property is not the same. In this study, 16 per cent of the repeat sales transactions had to be discarded because of changes between sales dates.

The results of this study show that the repeat sales index is apparently slightly upward-biassed--showing lower rates of increase in early years and then higher rates, so that at the peak and at the end of the period it is distinctly higher than the other indexes (see Charts 4.2 and 4.6). For many purposes, however, the repeat sales index is close enough to the quasi Fisher Chain. Our recommendation would be that the repeat sales method is good enough for most purposes, but it must be used with caution for the beginning few periods, the ending few periods, and peaks. .

Should a separate starter sample be used for starter homes ?

For this study great effort was expended to identify starter subsamples and compute price indexes using them. The results suggest that this effort is not greatly warranted. As can be seen in Charts 4.8 and 4.9, indexes based on the starter subsample for houses move very similarly to those based on the total sample, although the starter index is a little higher at the peak and several percentage points higher at the end of the period; the same pattern holds for starter condominiums as compared with all condominiums (Table 4.3).

III INDEXES COMPUTED IN THIS STUDY COMPARED WITH READILY AVAILABLE ALTERNATIVES

Already available as indicators of house prices and condominium prices are an array of other data series. Our assessment of these is as follows (see Charts 4.3, 4.4, 4.5):

- Statistics Canada's New House Price index appears to be seriously downward biased and should not be used, unless some way is found to appropriately correct for its bias.

- Royal LePage's expert opinion-based prices are excessively smooth (in that they cut off the peak in the boom) but they appear to contain little bias over substantial periods of time.

- NHA averages exaggerate the peak. For existing houses, however, they appear unbiased at the end point, so that they appear usable with caution. For condominiums, the NHA average rises so far above other indexes at the peak and ends so far above them, that it should not be used as a pure price indicator.

• MLS averages contain substantial noise (although much less than we had expected) as indicators of changes in pure prices from quarter to quarter, but they are remarkably unbiased over a longer period of time.

IV WARNINGS

The conclusions of this study are based on the careful analysis of an exceptionally rich data set, one with far more information on house characteristics than is usually available, and covering a period during which prices changed in a major way. Nonetheless the data period covers only three years from one city. It is possible that the results of this study do not generalize to apply to other data periods and other cities.

We believe that these results probably do generalize, in view of their reasonableness. Even if they do not, at least their negative results must be taken seriously. For example, the poor performance of the New House Price index means that in general it is suspect; and the high value of NHA averages at peak suggests that NHA averages should be used gingerly at such times.

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Table A1
Means and Standard Deviations for Single and Semi-Detached Houses

	all houses		other than starters		starter houses	
Number of Obs.	9856		6588		3268	
	mean	std	mean	std	mean	std
Sale Price	151608	51190	166983	54763	120612	20499
Bedrooms	3.165	0.591	3.284	0.614	2.924	0.455
Full Bathrooms	1.491	0.576	1.616	0.599	1.241	0.427
Half Bathrooms	0.522	0.570	0.615	0.591	0.334	0.472
Total Rooms	6.712	1.411	7.126	1.416	5.876	0.956
Other Rooms	3.547	1.151	3.842	1.172	2.952	0.835
Living Area	1180	333	1294	333	937	164
Lot Area	6309	3645	6865	4202	5187	1612
Large Lot	0.298	3.238	0.445	3.953	0.000	0.000
Game Room	0.022	0.146	0.027	0.163	0.011	0.103
Den	0.071	0.256	0.106	0.308	0.000	0.000
Second Kitchen	0.020	0.141	0.025	0.157	0.010	0.100
Laundry	0.034	0.180	0.042	0.201	0.016	0.126
Recreation Room	0.628	0.483	0.575	0.494	0.735	0.441
Family Room	0.315	0.465	0.472	0.499	0.000	0.000
One Car Garage	0.421	0.494	0.417	0.493	0.428	0.495
Two Car Garage	0.234	0.423	0.350	0.477	0.000	0.000
Three Car Garage	0.002	0.049	0.004	0.060	0.000	0.000
Carport	0.043	0.202	0.030	0.171	0.067	0.251
Fireplace	0.468	0.511	0.590	0.510	0.224	0.417
One Fireplace	0.459	0.498	0.576	0.494	0.224	0.417
Two Fireplaces	0.003	0.059	0.005	0.072	0.000	0.000
Three Fireplaces	0.001	0.028	0.001	0.035	0.000	0.000
Uffi	0.010	0.098	0.007	0.083	0.015	0.122
Uffi Removed	0.012	0.108	0.008	0.087	0.020	0.141
Inground Pool	0.031	0.173	0.046	0.210	0.000	0.000
Above Ground Pool	0.035	0.183	0.037	0.190	0.029	0.167
Central Air	0.202	0.401	0.237	0.425	0.131	0.337
Age (new)	0.095	0.293	0.142	0.349	0.000	0.000
Age (1-5)	0.185	0.389	0.277	0.448	0.000	0.000
Age (6-15)	0.238	0.426	0.219	0.413	0.276	0.447
Age (16-30)	0.223	0.416	0.190	0.392	0.288	0.453
Age (31-50)	0.146	0.353	0.087	0.282	0.263	0.440
Age (51+)	0.114	0.318	0.085	0.278	0.173	0.378
Gas Heating	0.739	0.439	0.775	0.418	0.667	0.471
Oil Heatng	0.155	0.362	0.106	0.303	0.265	0.439
Electric Heat	0.106	0.303	0.119	0.324	0.068	0.252
Electric BaseBoard	0.034	0.182	0.041	0.199	0.020	0.140
Forced Air	0.903	0.296	0.908	0.289	0.892	0.310
Basement Finished	0.444	0.496	0.422	0.494	0.478	0.500
Basement Unfin.	0.357	0.469	0.359	0.470	0.336	0.468
Basement Partly Fin.	0.189	0.387	0.199	0.394	0.176	0.372
Basement Walkout	0.094	0.291	0.105	0.306	0.071	0.257
Brick Veneer	0.260	0.439	0.243	0.429	0.293	0.455
Aluminium Siding	0.036	0.186	0.025	0.157	0.058	0.233
Vinyl Siding	0.013	0.114	0.012	0.108	0.016	0.125
Stone & Brick	0.018	0.132	0.021	0.144	0.010	0.101
Frame & wood	0.006	0.078	0.005	0.070	0.009	0.094
Frame & Stucco	0.006	0.076	0.004	0.061	0.010	0.098
Brick & Wood	0.102	0.302	0.091	0.287	0.124	0.330
Brick & Aluminium	0.475	0.499	0.527	0.499	0.368	0.482
Condrete Block	0.002	0.045	0.001	0.028	0.005	0.068
Solid Masonry	0.057	0.232	0.052	0.223	0.067	0.250
Other	0.025	0.158	0.018	0.134	0.040	0.195
Quarter 1	0.094	0.292	0.090	0.287	0.102	0.302
Quarter 2	0.120	0.325	0.121	0.326	0.119	0.324
Quarter 3	0.102	0.302	0.098	0.297	0.109	0.312

Table A1
Means and Standard Deviations for Single and Semi-Detached Houses

	all houses		other than starters		starter houses	
	mean	std	mean	std	mean	std
Quarter 4	0.082	0.275	0.084	0.278	0.077	0.267
Quarter 5	0.110	0.313	0.114	0.318	0.103	0.303
Quarter 6	0.086	0.280	0.087	0.281	0.084	0.277
Quarter 7	0.088	0.284	0.089	0.284	0.087	0.282
Quarter 8	0.079	0.270	0.076	0.266	0.086	0.280
Quarter 9	0.088	0.283	0.087	0.282	0.088	0.284
Quarter 10	0.060	0.238	0.062	0.241	0.056	0.230
Quarter 11	0.055	0.228	0.054	0.226	0.057	0.232
Quarter 12	0.036	0.185	0.037	0.190	0.032	0.176
Semi-Detached	0.125	0.331	0.086	0.280	0.205	0.404
Bungalow	0.197	0.398	0.169	0.375	0.254	0.435
1½ Storey	0.105	0.306	0.065	0.246	0.185	0.388
Two or more Storey	0.329	0.470	0.399	0.490	0.190	0.392
Side Split	0.068	0.253	0.085	0.279	0.035	0.184
Back Split	0.096	0.294	0.115	0.319	0.056	0.230
Raised Bungalow	0.079	0.269	0.081	0.273	0.074	0.262
Household Income	34599	7718	35969	7618	31837	7159
Unemployed Rate	5.51	1.57	5.27	1.48	5.99	1.64
Incidence Of Povert	10.71	5.88	10.21	5.95	11.73	5.61
Kitchener	70.34	0.46	66.70	0.47	77.69	0.42
hwy_401	6.97	2.59	7.17	2.70	6.57	2.31
Central Business	1.97	1.06	2.11	1.03	1.69	1.06
Industrial Area	1.71	1.32	1.72	1.37	1.70	1.22
Population Density	8.71	5.17	7.96	5.15	10.21	4.87
Number of Owners	66.84	18.90	69.56	18.82	61.36	17.84
Number of Renters	33.16	18.90	30.44	18.82	38.64	17.84

Table A2

Means and Standard Deviations for Condominiums

	All Condominiums		Other than starters		Starters	
Number of Obs.	1616		630		986	
	mean	std	mean	std	mean	std
Sale Price	107694	33281	128395	40728	94466	17539
Bedrooms	2.601	0.610	2.646	0.600	2.572	0.616
Fullbath	1.209	0.416	1.537	0.518	1.000	0.000
Halfbath	0.616	0.551	0.759	0.596	0.524	0.500
Total Rooms	5.588	0.922	6.103	0.944	5.259	0.738
Other Rooms	2.987	0.715	3.457	0.778	2.687	0.471
Living Area	876	222	1013	237	789	159
Game Room	0.002	0.430	0.317	0.569	0.101	0.318
Den	0.027	0.163	0.070	0.255	0.000	0.000
Second Kitchen	0.002	0.050	0.006	0.079	0.000	0.000
Laundry	0.039	0.194	0.060	0.238	0.025	0.157
Recreation Room	0.463	0.499	0.544	0.498	0.411	0.492
Family Room	0.038	0.192	0.098	0.298	0.000	0.000
One Car Garage	0.431	0.495	0.554	0.497	0.352	0.478
Two Car Garage	0.012	0.111	0.032	0.175	0.000	0.000
Three Car Garage	0.000	0.000	0.000	0.000	0.000	0.000
Carport	0.070	0.255	0.060	0.238	0.076	0.265
One Fireplace	0.147	0.354	0.333	0.472	0.027	0.163
Two Fireplaces	0.001	0.035	0.003	0.056	0.000	0.000
Three Fireplaces	0.000	0.000	0.000	0.000	0.000	0.000
UFFI	0.000	0.000	0.000	0.000	0.000	0.000
UFFI Removed	0.001	0.035	0.000	0.000	0.002	0.045
Pool Inground	0.056	0.231	0.071	0.258	0.047	0.211
Pool Above Ground	0.075	0.264	0.083	0.275	0.071	0.257
Central Air Condit.	0.271	0.445	0.446	0.497	0.159	0.366
Age (new)	0.069	0.253	0.097	0.296	0.051	0.220
Age (1 - 5)	0.165	0.371	0.292	0.455	0.083	0.276
Age (6 - 15)	0.661	0.474	0.540	0.499	0.738	0.440
Age (16 - 30)	0.101	0.301	0.067	0.250	0.123	0.328
Age (31 - 50)	0.004	0.066	0.003	0.056	0.005	0.071
Age (51 +)	0.001	0.025	0.002	0.040	0.000	0.000
Gas Heating	0.609	0.488	0.640	0.480	0.589	0.492
Oil Heating	0.009	0.074	0.005	0.069	0.009	0.078
Electric Heating	0.379	0.485	0.354	0.478	0.399	0.488
Electric BaseBoard	0.129	0.336	0.060	0.238	0.173	0.379
Forced Air	0.800	0.400	0.927	0.260	0.719	0.450
Basement Finished	0.282	0.450	0.376	0.485	0.221	0.415
Basement Unfinished	0.350	0.477	0.287	0.453	0.389	0.488
Basement Partly Fin.	0.071	0.257	0.062	0.241	0.077	0.267
Basement Walk out	0.092	0.289	0.114	0.318	0.077	0.267
Brick Veneer	0.205	0.404	0.171	0.377	0.226	0.419
Aluminium Siding	0.014	0.116	0.021	0.142	0.009	0.095
Vinyl Siding	0.018	0.133	0.017	0.131	0.018	0.134
Stone & Brick	0.019	0.135	0.019	0.137	0.018	0.134
Frame Wood	0.006	0.074	0.010	0.097	0.003	0.055
Frame Stucco	0.009	0.093	0.005	0.069	0.011	0.105
Brick & Wood	0.183	0.386	0.160	0.367	0.197	0.398
Brick & Aluminium	0.368	0.482	0.462	0.499	0.307	0.462
Concrete Block	0.051	0.220	0.024	0.153	0.068	0.252
Solid Masonry	0.062	0.241	0.037	0.188	0.078	0.268
Other	0.060	0.238	0.071	0.258	0.053	0.224
Quarter 1	0.083	0.276	0.078	0.268	0.086	0.281
Quarter 2	0.105	0.306	0.075	0.263	0.124	0.329
Quarter 3	0.105	0.306	0.113	0.316	0.099	0.299
Quarter 4	0.073	0.260	0.070	0.255	0.075	0.264
Quarter 5	0.103	0.304	0.086	0.280	0.114	0.317
Quarter 6	0.096	0.295	0.105	0.306	0.090	0.287
Quarter 7	0.084	0.277	0.095	0.294	0.076	0.265

Table A2
Means and Standard Deviations for Condominiums

	All Condominiums		Other than starters		Starters	
	mean	std	mean	std	mean	std
Quarter 8	0.087	0.281	0.078	0.268	0.092	0.290
Quarter 9	0.111	0.315	0.111	0.315	0.112	0.315
Quarter 10	0.059	0.236	0.076	0.266	0.049	0.215
Quarter 11	0.061	0.239	0.054	0.226	0.065	0.246
Quarter 12	0.035	0.183	0.060	0.238	0.018	0.134
Household Income	32419	6087	32321	6197	32481	6017
Unemployment Rate	6.03	1.55	5.91	1.48	6.11	1.58
Incidence of Poverty	11.96	5.71	11.54	5.65	12.24	5.74
Highway 401 (miles)	5.89	2.98	6.57	3.08	5.45	2.83
Central Business Dist	2.22	1.23	2.12	1.17	2.29	1.26
Industrial Areas	1.65	1.05	1.71	0.93	1.62	1.11
Population/Density	9.39	5.21	9.91	4.64	9.06	5.52
Percent of Owners	59.76	21.54	61.41	21.63	58.70	21.44
Percent of Renters	40.24	21.54	38.59	21.63	41.30	21.44

Table A3

Means and Standard Deviations for Repeat Sales Subsamples

	Houses		Condominiums	
Number of Obs.	428		135	
	mean	std	mean	std
Saale Price	150924	44821	109000	26673
Bed rooms	3.0408	0.5753	2.6414	0.5734
Full Bathrooms	1.4252	0.5400	1.1655	0.3729
Half Bathrooms	0.4971	0.5487	0.6000	0.5578
Total rooms	6.4816	1.3685	5.5448	0.9203
Other rooms	3.4408	1.1305	2.9034	0.6803
Living Area	1119.6	328.7	885.7	217.7
Lot Area	5700.5	3021.1		
Large Lots	0.3139	2.9218		
Game room	0.0175	0.1312	0.0000	0.0000
Den	0.0680	0.2519	0.0276	0.1644
Second Kitchen	0.0252	0.1570	0.0069	0.0830
Laundry	0.0427	0.2024	0.0828	0.2765
Recreation rm	0.6408	0.4802	0.5448	0.4997
Family room	0.2544	0.4359	0.0276	0.1644
One Garage	0.4602	0.4989	0.3793	0.4869
Two Garage	0.1650	0.3716	0.0069	0.0830
Three Garage	0.0000	0.0000	0.0000	0.0000
Carport	0.0272	0.1628	0.1034	0.3056
One Fireplace	0.3961	0.4896	0.0828	0.2765
Two Fireplaces	0.0000	0.0000	0.0000	0.0000
Three Fireplaces	0.0000	0.0000	0.0000	0.0000
UFFI	0.0078	0.0879	0.0000	0.0000
UFFI (removed)	0.0214	0.1447	0.0000	0.0000
Pool Inground	0.0252	0.1570	0.0552	0.2291
Pool Aboveground	0.0350	0.1838	0.0414	0.1999
Central Air	0.2369	0.4256	0.2345	0.4251
Age (new)	0.0136	0.1159	0.0069	0.0830
Age (1 - 5)	0.2000	0.4004	0.1379	0.3460
Age (6 - 15)	0.2466	0.4315	0.7655	0.4251
Age (16 - 30)	0.2097	0.4075	0.0828	0.2765
Age (31 - 50)	0.1786	0.3834	0.0069	0.0830
Age (51 +)	0.1515	0.3588	0.0000	0.0000
Gas heating	0.7398	0.4392	0.6345	0.4832
Oil heating	0.1592	0.3662	0.0069	0.0830
Electric heating	0.0990	0.2990	0.3517	0.4792
Electric BB	0.0388	0.1934	0.1448	0.3531
Forced Air heat	0.9126	0.2827	0.7862	0.4114
Basement (fin.)	0.4738	0.4998	0.3586	0.4813
Basement (unfin)	0.2408	0.4280	0.2276	0.4207
Basement (ptfin)	0.2039	0.4033	0.0966	0.2964
Basement (W/O)	0.0680	0.2519	0.0828	0.2765
Brick Veneer	0.2350	0.4244	0.2207	0.4161
Alumumin Siding	0.0544	0.2270	0.0207	0.1428
Vinyl Siding	0.0194	0.1381	0.0138	0.1170
Stone	0.0155	0.1238	0.0000	0.0000
Frame wood	0.0039	0.0623	0.0138	0.1170
Frame stucco	0.0097	0.0981	0.0069	0.0830
Brick wood	0.0932	0.2910	0.2345	0.4251
Brick Alum.	0.4757	0.4999	0.3586	0.4813
Concrete Block	0.0039	0.0623	0.0483	0.2151
Solid Masonry	0.0641	0.2451	0.0207	0.1428
Other exterior	0.0252	0.1570	0.0552	0.2291
QTR1	0.0019	0.0441	0.0069	0.0830
QTR2	0.0078	0.0879	0.0069	0.0830
QTR3	0.0136	0.1159	0.0345	0.1831
QTR4	0.0369	0.1887	0.0207	0.1428
QTR5	0.0796	0.2710	0.0759	0.2657
QTR6	0.1068	0.3092	0.1034	0.3056

Table A3

Means and Standard Deviations for Repeat Sales Subsamples

	Houses		Condominiums	
	mean	std	mean	std
QTR7	0.1146	0.3188	0.1241	0.3309
QTR8	0.1476	0.3550	0.1655	0.3729
QTR9	0.1379	0.3451	0.2207	0.4161
QTR10	0.1534	0.3607	0.0552	0.2291
QTR11	0.1262	0.3324	0.1103	0.3144
QTR12	0.0738	0.2617	0.0759	0.2657
Semi-detached	0.1437	0.3511		
Bungalow	0.2000	0.4004		
1½ Storey	0.1301	0.3367		
2 or more Storey	0.3049	0.4608		
Side Split	0.0427	0.2024		
Back Split	0.0971	0.2964		
Raised Bungalow	0.0796	0.2710		
Household Incm	33796	794	33530	628
Unemployed (%)	5.6590	1.6716	6.0366	1.4766
Incidence Pov.	11.0548	5.7739	11.5717	5.0827
Central Bus. Dtr	1.9005	1.0973	2.4056	1.2943
Industrial Areas	1.6901	1.3403	1.7764	1.0781
Pop. Density	8.7032	4.9617	9.4237	5.2601
% of Owners	65.6414	18.7535	62.2492	22.2714
% of Renters	34.3586	18.7535	37.7508	22.2714

Table A4
Means and Standard Deviations for New and Existing Houses

	New		Existing	
Number of Obs.	935		8921	
	mean	std	mean	std
Sale Price	207466	70657	145753	44844
Bed Rooms	3.440	0.573	3.136	0.585
Fullbath	1.818	0.577	1.457	0.565
Halfbath	0.718	0.523	0.501	0.571
Total Rooms	7.520	1.380	6.627	1.387
Other Rooms	4.080	1.067	3.491	1.145
Living Area	1.281	0.387	1.164	0.325
Lot Area	7.103	3.054	6.226	3.692
Large Lot	0.199	2.336	0.308	3.319
Game Room	0.002	0.046	0.024	0.153
Den	0.111	0.315	0.066	0.249
Second Kitchen	0.003	0.057	0.022	0.147
Laundry	0.024	0.152	0.035	0.183
Recreation Room	0.171	0.377	0.676	0.468
Family Room	0.640	0.480	0.281	0.450
Garage	1.647	0.631	0.818	0.727
One Car Garage	0.213	0.410	0.443	0.497
Two Car Garage	0.703	0.457	0.185	0.388
Three Car Garage	0.010	0.098	0.002	0.041
Carport	0.000	0.000	0.047	0.212
Fire place	0.720	0.456	0.442	0.509
One Fireplace	0.713	0.452	0.432	0.495
Two Fireplaces	0.003	0.057	0.003	0.059
Three Fireplaces	0.000	0.000	0.001	0.030
UFFI	0.000	0.000	0.011	0.103
UFFI (Removed)	0.000	0.000	0.013	0.113
Pool In Ground	0.002	0.046	0.034	0.181
Pool Above Ground	0.016	0.126	0.037	0.188
Central Air Condit	0.086	0.280	0.214	0.410
Age (new)	1.000	0.000	0.000	0.000
Age (1 - 5)	0.000	0.000	0.205	0.403
Age (6 - 15)	0.000	0.000	0.263	0.440
Age (16 - 30)	0.000	0.000	0.246	0.431
Age (31 - 50)	0.000	0.000	0.161	0.367
Age (51 +)	0.000	0.000	0.126	0.332
Gas Heating	0.928	0.258	0.719	0.450
Oil Heating	0.000	0.000	0.175	0.376
Electric Heating	0.069	0.237	0.106	0.308
Electric BaseBoard	0.026	0.158	0.035	0.184
Forced Air	0.963	0.190	0.896	0.305
Basement Finished	0.119	0.313	0.475	0.499
Basement Unfinished	0.596	0.497	0.309	0.460
Basement Partly Fin.	0.275	0.442	0.196	0.380
Basement Walkout	0.090	0.286	0.094	0.292
Brick Veneer	0.230	0.421	0.263	0.440
Aluminium Siding	0.021	0.145	0.038	0.190
Vinyl	0.014	0.117	0.013	0.114
Stone & Brick	0.011	0.103	0.018	0.134
Frame Wood	0.001	0.033	0.007	0.082
Frame Stucco	0.004	0.065	0.006	0.077
Brick & Wood	0.017	0.130	0.111	0.314
Brick & Aluminium	0.648	0.478	0.456	0.498
Concrete Block	0.000	0.000	0.002	0.047
Solid Masonry	0.045	0.207	0.059	0.235
Other	0.009	0.092	0.027	0.163
Quarter 1	0.158	0.365	0.087	0.282
Quarter 2	0.147	0.354	0.118	0.322
Quarter 3	0.094	0.292	0.103	0.303

Table A4
Means and Standard Deviations for New and Existing Houses

	New		Existing	
	mean	**std**	**mean**	**std**
Quarter 4	0.098	0.298	0.080	0.272
Quarter 5	0.117	0.321	0.110	0.312
Quarter 6	0.061	0.239	0.088	0.284
Quarter 7	0.063	0.243	0.091	0.287
Quarter 8	0.070	0.254	0.080	0.272
Quarter 9	0.059	0.235	0.091	0.287
Quarter 10	0.045	0.207	0.062	0.241
Quarter 11	0.051	0.221	0.055	0.229
Quarter 12	0.037	0.190	0.035	0.185
Semi-Detached	0.093	0.291	0.129	0.335
Bungalow	0.092	0.289	0.208	0.406
1½ Storey	0.018	0.134	0.114	0.318
Two or more Storey	0.595	0.491	0.302	0.459
Side Split	0.015	0.122	0.074	0.262
Back Split	0.158	0.365	0.089	0.285
Raised Bungalow	0.027	0.161	0.084	0.278
Household Income	37.961	6.751	34.247	7.729
Unemployed Rate	4.650	1.165	5.596	1.583
Incidence of Pov.	9.603	6.145	10.831	5.840
Kitchener	0.571	0.495	0.717	0.450
Highway 401 (miles)	7.762	2.805	6.888	2.556
Central Business Dist.	2.335	0.827	1.928	1.071
Industrial Areas	1.834	1.507	1.696	1.301
Population Density	5.398	4.397	9.055	5.122
Percentage of Owner	71.961	18.274	66.306	18.884
Percentage of Renters	28.039	18.274	33.694	18.884

Table A5

Means and Standard Deviations for Homogenized Starter Subsample, Houses

	Subsamples after deletions				Subsample deleted using DFFITS			
Significance Level	0.01		0.002		0.01		0.002	
No. of Obs.	3163		3201		105		67	
	mean	std	mean	std	mean	std	means	std
Sale Price	120700	19265	120758	19529	117957	43701	113631	47533
Bedrooms	2.93	0.45	2.93	0.45	2.84	0.62	2.75	0.61
Full Bathrooms	1.24	0.43	1.24	0.43	1.22	0.42	1.16	0.37
Half Bathrooms	0.33	0.47	0.33	0.47	0.32	0.47	0.33	0.47
Total Rooms	5.87	0.94	5.87	0.95	6.07	1.25	6.01	1.27
Other Rooms	2.94	0.83	2.95	0.83	3.23	0.94	3.27	0.98
Living Area	941	162	939	163	827	184	828	171
Lot Area	5174	1587	5174	1594	5593	2204	5843	2243
Large Lot	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Game Room	0.011	0.105	0.011	0.104	0.000	0.000	0.000	0.000
Den	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Second Kitchen	0.010	0.099	0.010	0.099	0.019	0.137	0.015	0.122
Laundry	0.015	0.124	0.016	0.124	0.038	0.192	0.045	0.208
Recreation Room	0.750	0.433	0.746	0.435	0.276	0.449	0.209	0.410
Family Room	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Garage	0.426	0.495	0.427	0.495	0.514	0.502	0.493	0.504
One Car Garage	0.426	0.495	0.427	0.495	0.514	0.502	0.493	0.504
Two Car Garage	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Three Car Garage	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Carport	0.069	0.253	0.068	0.252	0.019	0.137	0.030	0.171
Fireplace	0.227	0.419	0.226	0.418	0.152	0.361	0.149	0.359
One Fireplace	0.227	0.419	0.226	0.418	0.152	0.361	0.149	0.359
Two Fireplaces	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Three Fireplaces	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Uffi	0.014	0.117	0.015	0.122	0.048	0.214	0.015	0.122
Uffi Removed	0.019	0.135	0.019	0.138	0.067	0.251	0.060	0.239
Inground Pool	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Above Ground Pool	0.029	0.167	0.029	0.167	0.029	0.167	0.030	0.171
Central Air	0.133	0.340	0.133	0.340	0.067	0.251	0.015	0.122
Age (new)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Age (1-5)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Age (6-15)	0.282	0.450	0.280	0.449	0.086	0.281	0.090	0.288
Age (16-30)	0.294	0.456	0.292	0.455	0.095	0.295	0.090	0.288
Age (31-50)	0.263	0.441	0.264	0.441	0.257	0.439	0.239	0.430
Age (51+)	0.160	0.367	0.165	0.371	0.562	0.499	0.582	0.497
Gas Heating	0.674	0.470	0.669	0.471	0.552	0.500	0.567	0.499
Oil Heating	0.257	0.437	0.259	0.438	0.362	0.483	0.328	0.473
Electric Heat	0.068	0.251	0.069	0.251	0.086	0.281	0.105	0.308
Forced Air Heat	0.897	0.304	0.895	0.307	0.752	0.434	0.776	0.420
Basement Finished	0.488	0.500	0.485	0.500	0.162	0.370	0.119	0.327
Basement Unfinish	0.329	0.463	0.316	0.465	0.724	0.449	0.731	0.447
Basement Partly Fin	0.178	0.374	0.169	0.373	0.105	0.308	0.149	0.359
Basement Walkout	0.072	0.259	0.072	0.258	0.048	0.214	0.045	0.208
Brick Veneer	0.294	0.456	0.295	0.456	0.267	0.444	0.239	0.430
Aluminium Siding	0.058	0.234	0.058	0.234	0.038	0.192	0.030	0.171
Vinyl Siding	0.015	0.122	0.015	0.123	0.038	0.192	0.045	0.208
Stone & Brick	0.010	0.099	0.010	0.098	0.029	0.167	0.045	0.208
Frame & Wood	0.008	0.089	0.008	0.088	0.038	0.192	0.060	0.239
Frame & Stucco	0.007	0.085	0.007	0.086	0.086	0.281	0.119	0.327
Brick & Wood	0.122	0.327	0.123	0.328	0.200	0.402	0.194	0.398
Brick & Aluminium	0.377	0.485	0.374	0.484	0.095	0.295	0.090	0.288
Concrete Block	0.004	0.064	0.004	0.064	0.019	0.137	0.030	0.171
Solid Masonry	0.065	0.247	0.067	0.250	0.124	0.331	0.075	0.265
Other	0.039	0.193	0.039	0.194	0.067	0.251	0.075	0.265
Quarter 1	0.101	0.302	0.101	0.301	0.114	0.320	0.149	0.359
Quarter 2	0.120	0.324	0.120	0.325	0.114	0.320	0.104	0.308
Quarter 3	0.108	0.311	0.110	0.313	0.133	0.342	0.090	0.288
Quarter 4	0.077	0.267	0.077	0.266	0.076	0.267	0.104	0.308

Table A5

Means and Standard Deviations for Homogenized Starter Subsample, Houses

	Subsamples after deletions				Subsample deleted using DFFITS			
Significance Level	0.01		0.002		0.01		0.002	
No. of Obs.	3163		3201		105		67	
	mean	std	mean	std	mean	std	means	std
Quarter 5	0.103	0.304	0.102	0.303	0.086	0.281	0.119	0.327
Quarter 6	0.082	0.274	0.083	0.276	0.133	0.342	0.104	0.308
Quarter 7	0.089	0.284	0.088	0.283	0.048	0.214	0.045	0.208
Quarter 8	0.086	0.281	0.086	0.280	0.067	0.251	0.075	0.265
Quarter 9	0.090	0.286	0.089	0.285	0.048	0.214	0.045	0.208
Quarter 10	0.057	0.231	0.057	0.231	0.038	0.192	0.030	0.171
Quarter 11	0.056	0.229	0.056	0.230	0.095	0.295	0.090	0.288
Quarter 12	0.032	0.175	0.032	0.176	0.048	0.214	0.045	0.208
Semi-Detached	0.209	0.407	0.208	0.406	0.086	0.281	0.090	0.288
Bungalow	0.255	0.436	0.254	0.436	0.210	0.409	0.224	0.420
1 1/2 Storey	0.184	0.388	0.184	0.387	0.210	0.409	0.254	0.438
Two or more Storey	0.181	0.385	0.186	0.389	0.457	0.501	0.403	0.494
Side Split	0.036	0.187	0.036	0.186	0.000	0.000	0.000	0.000
Back Split	0.058	0.233	0.057	0.232	0.010	0.098	0.000	0.000
Raised Bungalow	0.076	0.265	0.075	0.264	0.019	0.137	0.015	0.122
Household Income	31946	7165	31897	7169	28553	6168	28964	6065
Unemployed Rate	5.98	1.64	5.99	1.64	6.16	1.66	6.08	1.55
Incidence Of Povert	11.75	5.64	11.74	5.64	11.16	4.59	11.35	4.37
Kitchener	77.71	0.42	77.63	0.42	77.14	0.42	80.60	0.40
Highway 401 (miles)	6.57	2.32	6.57	2.31	6.58	1.91	6.46	2.12
Central Business	1.70	1.06	1.70	1.06	1.17	1.02	1.30	1.15
Industrial Area	1.71	1.23	1.70	1.22	1.40	1.03	1.38	1.00
Population Density	10.22	4.89	10.23	4.88	9.85	4.40	9.19	4.48
Number of Owners	61.52	17.91	61.45	17.89	56.51	14.95	56.70	14.64
Number of Renters	38.48	17.91	38.55	17.89	43.49	14.95	43.30	14.64

Table A6a
Constrained hedonic regression results
for Sample of Starters Houses

Variable	Parameter Estimate	Standard Error	T for H0: Parameter=0
Intercept	11.075001	0.05243324	211.221
Bedrooms	0.032693	0.00450116	7.263
Other rooms	0.007826	0.00227056	3.447
Living Area	0.230685	0.10483613	2.200
Living Area²	-0.063670	0.05709628	-1.115
Lot Area	0.044368	0.00655550	6.768
Lot Area²	-0.002841	0.00055501	-5.119
Recreation Rm	-0.003751	0.00654000	-0.574
Full Bathroom	0.042279	0.00453833	9.316
Half Bathroom	0.029963	0.00423895	7.068
Basement (unfin)	-0.002862	0.00508408	-0.563
Basement (W/O)	0.013178	0.00685967	1.921
One Car Garage	0.038917	0.00385764	10.088
Fireplace	0.039198	0.00463420	8.458
UFFI	-0.038266	0.01430795	-2.674
UFFI (removed)	-0.019806	0.01241541	-1.595
Central Air	0.027624	0.00534162	5.171
Bungalow	-0.023687	0.00793935	-2.983
1½ Storey	-0.056454	0.00907946	-6.218
Two Storey	0.009529	0.00876818	1.087
Side Split	0.040147	0.01153213	3.481
Back Split	-0.006339	0.01000087	-0.634
Semi-detached	-0.115295	0.00824560	-13.983
AGE (16 - 30)	0.003395	0.00519948	0.653
AGE (31 - 50)	-0.030775	0.00718079	-4.286
AGE (51 +)	-0.095253	0.00851931	-11.181
Brick veneer	0.058312	0.00891198	6.543
Vinyl & Alum.	-0.008239	0.01043812	-0.789
Stone& Brick	0.056426	0.01887685	2.989
Frame	-0.047162	0.01518565	-3.106
Brick & Wood	0.036780	0.00969754	3.793
Brick & Alum.	0.056104	0.00886953	6.326
Solib Masonry	0.055855	0.01074236	5.200
Unemployed	-0.003612	0.00140465	-2.571
Inpov. Pov.	-0.000376	0.00038333	-0.980
CBD (inv)	0.001997	0.00393721	0.507
CBD (log)	-0.002481	0.00616768	-0.402
Indust (inv)	-0.005729	0.00257472	-2.225
Indust (log)	-0.013849	0.00486107	-2.849
Pop/Den.	-0.000873	0.00040700	-2.146
QTR2	0.032846	0.00740541	4.435
QTR3	0.057637	0.00759112	7.593
QTR4	0.100103	0.00828529	12.082
QTR5	0.173228	0.00778965	22.238
QTR6	0.234014	0.00819757	28.547
QTR7	0.233154	0.00811182	28.742
QTR8	0.261564	0.00815527	32.073
QTR9	0.283080	0.00803632	35.225
QTR10	0.278764	0.00922292	30.225
QTR11	0.240324	0.00916145	26.232
QTR12	0.219814	0.01122580	19.581

n = 3268
R^2 = 0.684

Table A6b
Constrained hedonic regression results for Sample of Starters Houses with outliers eliminated

Variable	Parameter Estimate	Standard Error	T for H0: Parameter=0
Intercept	11.166950	0.04349489	256.742
Bedrooms	0.033673	0.00369388	9.116
Other rooms	0.008028	0.00184418	4.353
Living Area	0.157971	0.08782634	1.799
Living Area^2	-0.021621	0.04753266	-0.455
Lot Area	0.029600	0.00539275	5.489
Lot Area^2	-0.001515	0.00045809	-3.307
Recreation rm	-0.012010	0.00536679	-2.238
Full Bathroom	0.039265	0.00366784	10.705
Half Bathroom	0.026472	0.00343310	7.711
Basement (unfin)	-0.004482	0.00411854	-1.088
Basement (W/O)	0.006807	0.00552181	1.233
One Car Garage	0.038621	0.00312115	12.374
Fireplace	0.034436	0.00373602	9.217
UFFI	-0.053306	0.01162756	-4.584
UFFI (removed)	-0.024447	0.01027931	-2.378
Central Air	0.027667	0.00427380	6.474
Bungalow	-0.022844	0.00636899	-3.587
1½ Storey	-0.055121	0.00733678	-7.513
2 Storey	0.001611	0.00709442	0.227
Side Split	0.037311	0.00920257	4.054
Back Split	-0.006732	0.00798132	-0.844
Semi-detached	-0.119636	0.00661328	-18.090
AGE (16 - 30)	0.002270	0.00416890	0.545
AGE (31 - 50)	-0.032473	0.00583329	-5.567
AGE (51 +)	-0.092285	0.00703345	-13.121
Brick Veneer	0.048054	0.00733479	6.552
Vinyl & Alum.	-0.011194	0.00857061	-1.306
Stone & Brick	0.040648	0.01569017	2.591
Frame	-0.038379	0.01328147	-2.890
Brick & Wood	0.037699	0.00797722	4.726
Brick & Alum.	0.047423	0.00728229	6.512
Solid Masonry	0.038175	0.00881603	4.330
Unemployed	-0.004983	0.00113765	-4.380
Inpov. Pov.	-0.000345	0.00030749	-1.120
CBD (inv)	0.003460	0.00324457	1.066
CBD (log)	0.000904	0.00502298	0.180
Indust (inv)	-0.006838	0.00207540	-3.295
Indust (log)	-0.016093	0.00392079	-4.105
Pop/Den.	-0.000726	0.00032703	-2.221
QTR2	0.031122	0.00599048	5.195
QTR3	0.058575	0.00614562	9.531
QTR4	0.101333	0.00671085	15.100
QTR5	0.179267	0.00629423	28.481
QTR6	0.238938	0.00664281	35.969
QTR7	0.238735	0.00653532	36.530
QTR8	0.261223	0.00659490	39.610
QTR9	0.285593	0.00648800	44.019
QTR10	0.282391	0.00744254	37.943
QTR11	0.248760	0.00744130	33.430
QTR12	0.223928	0.00908446	24.650

= 3201
^{2}= 0.771

Table A7
Constrained Hedonic Regression Results for All Houses

$n = 9856$
$\bar{R}^2 = .841$

Variable	Parameter estimate	Standard error	t statistic
Intercept	11.361008	0.01850125	614.067
Bedrooms	0.033141	0.00248852	13.318
Other rooms	0.015442	0.00132191	11.682
Living Area	0.083391	0.01815192	4.594
Living Area²	0.035127	0.00601274	5.842
Lot Area	0.013260	0.00076941	17.235
Lot Area²	-0.000059	0.00002647	-2.261
Large lot	-0.002004	0.00083482	-2.400
Recreation rm	-0.023675	0.00361979	-6.541
Family room	0.014845	0.00366991	4.045
Game room	-0.020462	0.00830928	-2.463
Den	0.038879	0.00482436	8.059
Laundry	-0.015449	0.00665976	-2.320
Kitchen (Second)	-0.037299	0.00868033	-4.297
Full bath	0.055382	0.00278294	19.901
Half bath	0.040318	0.00271570	14.846
Basement(unfun)	-0.002825	0.00318341	-0.887
Basement(W/O)	0.014392	0.00414913	3.469
Garage(one)	0.034580	0.00302177	11.444
Garage(2+)	0.137256	0.00473883	28.964
Fireplace	0.054746	0.00297829	18.382
Pool Inground	0.036426	0.00704600	5.170
Pool Above	0.011837	0.00661313	1.790
UFFI	-0.032546	0.01227027	-2.652
UFFI (removed)	0.001492	0.01113682	0.134
CAC	0.035705	0.00318377	11.215
BBB (heat)	-0.024805	0.00682238	-3.636
OIL (heat)	-0.015844	0.00390458	-4.058
Bungalow	0.005782	0.00533252	1.084
1½ Storey	-0.026700	0.00663332	-4.025
2 + Storey	0.055571	0.00542515	10.243
Side Split	0.026956	0.00652951	4.128
Back Split	-0.008112	0.00607035	-1.336
Semi-detached	-0.085213	0.00592300	-14.387
AGE(1 - 5)	-0.089979	0.00504612	-17.831
AGE(6 - 15)	-0.158869	0.00529126	-30.025
AGE(16 - 30)	-0.146953	0.00585931	-25.080
AGE(31 - 50)	-0.184493	0.00694806	-26.553
AGE(51+)	-0.271820	0.00715989	-37.964
Brick veneer	0.034386	0.00754627	4.557
Vinyl/Aluminium	-0.017297	0.00895003	-1.933
Stone & Brick	0.057176	0.01152761	4.960
Frame	-0.071186	0.01302418	-5.466
Brick & wood	0.014223	0.00810545	1.755
Brick & Alum.	0.020008	0.00746315	2.681
Solid Masonry	0.045426	0.00877827	5.175
Unemployed(%)	-0.002470	0.00098310	-2.512
Incidence Pov.	-0.000331	0.00024420	-1.355
CBD (inv)	-0.014471	0.00299399	-4.833
CBD (log)	-0.027217	0.00441916	-6.159
INDUST (inv)	-0.013061	0.00168200	-7.765
INDUST (log)	-0.026292	0.00323053	-8.138
POP/DEN	-0.002060	0.00029450	-6.996
QTR2	0.041275	0.00518180	7.965
QTR3	0.073329	0.00540174	13.575
QTR4	0.106058	0.00569140	18.635
QTR5	0.172976	0.00534105	32.386
QTR6	0.228531	0.00568573	40.194
QTR7	0.227099	0.00565687	40.146
QTR8	0.255301	0.00579532	44.053
QTR9	0.276920	0.00564974	49.015
QTR10	0.270976	0.00628737	43.098
QTR11	0.237399	0.00643911	36.868
QTR12	0.193662	0.00750344	25.810

Table A8

Constrained Hedonic Regression Results
for Starter Condominiums

Variable	Parameter Estimate	Standard Error	t Statistic
Intercept	10.517750	0.08235105	127.718
Bedrooms	0.043738	0.00809669	5.402
Halfbath	0.023282	0.00756480	3.078
Other rooms	0.016097	0.00700821	2.297
Living area	1.616521	0.20928663	7.724
Living Area²	-0.880252	0.12219821	-7.203
Recreation rm	-0.007023	0.00953588	-0.737
Pool	0.034126	0.01120731	3.045
Central Air Cond.	0.091105	0.00969102	9.401
AGE	-0.021254	0.00164964	-12.884
AGE²	0.000408	0.00005265	7.748
Fireplace	0.102313	0.01998835	5.119
Garage	0.039980	0.00855317	4.674
Carport	0.100996	0.01273735	7.929
Incid. poverty	-0.001987	0.00086285	-2.303
Unemployed(%)	0.006686	0.00366824	1.823
CBD(log)	-0.049069	0.01347605	-3.641
CBD(inv)	0.015959	0.00898463	1.776
Indust(log)	-0.003191	0.01493063	-0.214
Indust(inv)	0.002689	0.00754850	0.356
Pop/Den	-0.002526	0.00092117	-2.742
QTR2	0.048385	0.01367088	3.539
QTR3	0.102561	0.01439804	7.123
QTR4	0.114606	0.01539868	7.443
QTR5	0.183375	0.01402737	13.073
QTR6	0.267147	0.01481289	18.035
QTR7	0.295740	0.01548207	19.102
QTR8	0.294817	0.01474445	19.995
QTR9	0.321874	0.01422389	22.629
QTR10	0.308990	0.01767766	17.479
QTR11	0.298712	0.01629126	18.336
QTR12	0.249095	0.02541284	9.802

$n = 986$
$\bar{R}^2 = .729$

Table A9a

Constrained Hedonic Regression for Condominiums

Variable	Parameter Estimate	Standard Error	t Statistic
Intercept	10.901347	0.05330263	204.518
Bedrooms	0.016632	0.00702367	2.368
Full Bath	0.115383	0.01031286	11.188
Half Bath	0.016583	0.00671798	2.468
Other Rooms	0.019716	0.00491620	4.010
Living Area	0.603815	0.09106886	6.630
Living Area²	-0.190413	0.04253021	-4.477
Recreation	-0.038698	0.00870882	-4.444
Family Room	0.104545	0.01767702	5.908
Pool	0.027474	0.00987739	2.781
Central Air	0.098032	0.00874182	11.214
Age	-0.017850	0.00113086	-15.784
Age²	0.000275	0.00003153	8.713
Fireplace	0.149859	0.01157330	12.949
Garage	0.055197	0.00757181	7.290
Carport	0.065797	0.01318921	4.989
Incid. pov.	-0.002874	0.00078618	-3.656
Unemployed	0.008356	0.00366180	2.282
CBD (log)	-0.058402	0.01650072	-3.539
CBD (inv)	-0.015667	0.00974551	-1.608
Indust(log)	-0.000657	0.00939238	-0.070
Indust(inv)	-0.006165	0.00865575	-0.712
Pop.Density	-0.004546	0.00085928	-5.291
QTR2	0.041411	0.01436526	2.883
QTR3	0.101731	0.01438407	7.072
QTR4	0.106270	0.01569240	6.772
QTR5	0.184247	0.01446207	12.740
QTR6	0.259687	0.01475150	17.604
QTR7	0.275175	0.01522219	18.077
QTR8	0.292580	0.01510149	19.374
QTR9	0.317026	0.01431491	22.147
QTR10	0.317309	0.01684535	18.837
QTR11	0.289170	0.01656601	17.456
QTR12	0.230531	0.02017715	11.425

n = 1616
$\bar{R}^2$ = 0.7960

Table A9b

Constrained Hedonic Regression Results for Condominiums Outliers (Between DFFITS Values 0.45 and 0.45) Eliminated

Variable	Parameter Estimate	Standard Error	t Statistics
Intercept	10.880266	0.05012214	217.075
Bedrooms	0.026460	0.00629576	4.203
Full Bath	0.123189	0.00901782	13.661
Half Bath	0.012928	0.00588749	2.196
Other Rooms	0.020211	0.00437456	4.620
Living Area	0.661192	0.09148141	7.228
Living Area²	-0.241179	0.04467671	-5.398
Recreation	-0.035184	0.00759845	-4.630
Family room	0.079109	0.01637566	4.831
Pool	0.023174	0.00870058	2.664
Central Air	0.097917	0.00764583	12.807
Age	-0.022519	0.00131522	-17.122
Age²	0.000472	0.00004569	10.326
Fireplace	0.144595	0.01016220	14.229
Garage	0.049553	0.00679419	7.293
Carport	0.063716	0.01148744	5.547
Incid. Pov.	-0.003140	0.00069456	-4.521
Unemployed	0.006796	0.00325391	2.088
CBD(log)	-0.065265	0.01468512	-4.444
CBD(inv)	-0.009254	0.00857235	-1.080
Indust(log)	-0.002436	0.00821245	-0.297
Indust(inv)	-0.006832	0.00756100	-0.904
Pop. Density	-0.004259	0.00075201	-5.664
QTR2	0.041621	0.01248260	3.334
QTR3	0.096384	0.01250082	7.710
QTR4	0.111385	0.01364213	8.165
QTR5	0.184880	0.01252239	14.764
QTR6	0.258991	0.01284786	20.158
QTR7	0.274430	0.01321193	20.771
QTR8	0.293403	0.01309071	22.413
QTR9	0.323611	0.01247286	25.945
QTR10	0.330030	0.01488461	22.173
QTR11	0.296243	0.01454949	20.361
QTR12	0.246593	0.01779197	13.860

n = 1583
$\bar{R}^2$ = 0.8334

Table A10a

Variable Means By Quarter

for Sample of Starter Houses

Quarter	1	2	3	4	5	6	7	8	9	10	11	12
Obs.	332	390	357	253	335	273	285	280	289	182	185	104
Bed Rooms	2.9066	2.9308	2.9356	2.9644	2.9343	2.9084	2.9333	2.9214	2.8858	2.9235	2.9301	2.9048
Other Rooms	3.0602	2.8051	3.0812	2.9130	2.8478	3.0110	2.8035	2.9357	2.9689	2.8798	2.9194	3.5714
Living Area	0.9315	0.9424	0.9362	0.9633	0.9293	0.9224	0.9342	0.9337	0.9539	0.9393	0.9334	0.9085
Living Area²	0.8949	0.9177	0.9011	0.9519	0.8883	0.8792	0.9006	0.8977	0.9359	0.9095	0.8999	0.8556
Lot Area	5.3044	5.3632	5.3423	5.2278	5.2676	5.0012	5.1281	5.0227	5.1295	5.1518	4.9356	5.0379
Lot Area²	30.6919	31.3295	31.2528	30.2894	30.4369	27.7036	29.0941	27.7272	28.5298	28.8299	26.6642	27.6961
Recreation Room	0.7319	0.7462	0.7591	0.7787	0.7284	0.6813	0.6877	0.7536	0.7785	0.7541	0.6774	0.7048
Full Bathroom	1.2500	1.2154	1.2353	1.2569	1.2478	1.1905	1.2000	1.3179	1.2595	1.2623	1.2204	1.2381
Half Bathroom	0.3645	0.3282	0.3361	0.3360	0.3075	0.3626	0.3228	0.2679	0.3460	0.3224	0.3710	0.3714
Basement(unfin)	0.4849	0.4923	0.2969	0.3281	0.2478	0.2894	0.2807	0.2393	0.2561	0.2459	0.3172	0.2857
Basement(W/O)	0.0392	0.0436	0.1317	0.0632	0.0896	0.0733	0.0772	0.0536	0.0830	0.0656	0.0484	0.0762
One Car Garage	0.4307	0.4077	0.4258	0.4941	0.4955	0.4103	0.4246	0.4036	0.4048	0.4590	0.3710	0.3714
Fireplace	0.2259	0.2333	0.2689	0.2609	0.2119	0.2308	0.2246	0.1857	0.2111	0.1694	0.2204	0.2095
UFFI	0.0151	0.0128	0.0112	0.0119	0.0119	0.0256	0.0105	0.0143	0.0277	0.0055	0.0215	0.0095
UFFI(Removed)	0.0060	0.0128	0.0252	0.0316	0.0269	0.0147	0.0246	0.0286	0.0208	0.0219	0.0108	0.0190
Central Air	0.1024	0.0897	0.1008	0.0870	0.1284	0.1136	0.1298	0.1464	0.1799	0.2240	0.1935	0.1905
Bungalow	0.2741	0.2795	0.2409	0.2451	0.2627	0.1868	0.2351	0.2286	0.3010	0.2514	0.2312	0.3333
1½ Storey	0.1657	0.1872	0.1737	0.1739	0.1881	0.2015	0.1860	0.1964	0.1592	0.1913	0.2258	0.2095
Two Storey	0.1717	0.1897	0.1905	0.1818	0.1940	0.2271	0.1965	0.1929	0.1626	0.2295	0.1935	0.1333
Side Split	0.0452	0.0385	0.0336	0.0158	0.0448	0.0256	0.0421	0.0286	0.0346	0.0164	0.0323	0.0762
Back Split	0.0512	0.0538	0.0756	0.0632	0.0478	0.0476	0.0667	0.0500	0.0554	0.0546	0.0538	0.0381
Semi-Detached	0.2169	0.1795	0.1933	0.2134	0.1761	0.2418	0.2105	0.2321	0.2215	0.1913	0.2204	0.1524
Age 16 -30	0.2560	0.2872	0.2605	0.3083	0.3134	0.2564	0.2982	0.2929	0.3045	0.2787	0.2849	0.3714
Age 31 - 50	0.2500	0.2538	0.2213	0.2253	0.2716	0.2930	0.2737	0.2679	0.2976	0.2842	0.2688	0.2857
Age 51 +	0.1235	0.1769	0.1737	0.1581	0.1910	0.2051	0.1719	0.2071	0.1315	0.1858	0.1989	0.1714
Brick Veneer	0.3253	0.2949	0.3249	0.3004	0.3552	0.2308	0.2877	0.2679	0.2907	0.2514	0.2312	0.3048
Vinyl/Alum.	0.0904	0.0718	0.0812	0.0672	0.0716	0.0733	0.0632	0.0607	0.0727	0.0765	0.0806	0.0667
Stone	0.0181	0.0103	0.0140	0.0079	0.0090	0.0110	0.0070	0.0107	0.0138	0.0055	0.0054	0.0107
Frame	0.0301	0.0128	0.0224	0.0277	0.0090	0.0403	0.0246	0.0036	0.0173	0.0055	0.0161	0.0189
Brick & Wood	0.1325	0.1000	0.1429	0.1225	0.1284	0.1282	0.1263	0.1250	0.0934	0.1421	0.1613	0.0857
Brick & Alum.	0.3283	0.3923	0.3053	0.3636	0.3194	0.4029	0.4105	0.3857	0.3979	0.3661	0.3710	0.4571
Solid Masonry	0.0422	0.0872	0.0560	0.0632	0.0567	0.0769	0.0526	0.0786	0.0657	0.0820	0.1183	0.0190
Unemployed (%)	5.8816	6.0282	5.9731	5.9980	6.0540	6.1791	5.9474	5.9982	5.7699	6.0831	5.8522	6.2648
Incid. Pov.(%)	11.5611	11.8954	11.7168	12.1138	11.9436	11.6201	11.7870	11.5200	11.3844	11.6945	11.3968	12.3343
CBD (inv)	1.0214	1.0560	0.9622	0.9619	1.0707	1.1010	1.0750	1.1173	0.9938	1.0618	1.0507	1.0786
CBD (log)	0.3529	0.2547	0.3346	0.3591	0.2351	0.2456	0.2653	0.2229	0.3017	0.2658	0.2693	0.2568
Indusy (inv)	1.6791	1.5636	1.6948	1.5795	1.6574	1.5773	1.5933	1.6746	1.6203	1.7659	1.5432	1.7873
Indust (log)	0.0965	0.1554	0.0880	0.1412	0.1258	0.1653	0.0834	0.0999	0.1383	0.1009	0.1592	0.0782
Pop. Den.	9.9880	10.5382	10.5647	9.8158	9.9956	10.5162	10.5068	10.0878	10.2075	9.9817	9.8340	9.9933

Table A10b

Unconstrained hedonic regression results

For Sample of Starter Houses

Quarter	1	2	3	4	5	6	7	8	9	10	11	12
Obs.	332	390	357	253	335	273	285	280	289	182	185	104
$\bar{R}^2$	0.509	0.598	0.518	0.594	0.587	0.515	00.619	0.503	0.543	0.634	0.527	0.572
Intercept	11.331	11.1048	11.4302	10.591	10.6165	11.1007	11.4715	11.2326	11.8041	11.3783	11.0629	10.9514
Bedrooms	0.0444	0.0014a	0.0364	0.0492	0.0558	0.0731	0.0364	0.0249	0.0089a	0.0454	0.012a	0.0612
Other rooms	0.0113a	0.0246	0.0046a	0.0174	0.0158	0.0137a	0.0076a	0.0123	-0.0016a	-0.002a	0.0018a	0.0101a
Living Area	-0.1224a	0.2492a	-0.794	1.1966	1.2921	0.285a	-0.0648a	0.3951a	-0.2043a	0.7005	0.8462	0.6469a
Living Area²	0.1061a	-0.0912a	0.4509	-0.5354	-0.5841	-0.1027a	0.0334a	-0.1541a	0.2066a	-0.3309	-0.3648a	-0.3633a
Lot Area	-0.0084a	0.0467	0.0652	0.0891	0.0644	0.0416	0.0532	0.0735	0.0246a	0.007a	0.0179a	0.1024
Lot Area²	0.0020a	-0.0027	-0.0048	-0.006	-0.0045	-0.0032a	-0.0034	-0.0053	-0.0016a	0.0001a	-0.0004a	-0.0087
Recreation	0.0180a	-0.0027a	0.0327a	-0.0443	-0.0076a	0.0061a	0.0446	-0.0345a	-0.0283a	-0.0121a	0.0660	-0.0234a
Full Bathroom	0.0487	0.0616	0.0494	0.0124a	0.0223a	0.0274a	0.0424	0.0537	0.0381	0.0280	0.0220a	0.0483
Half Bathroom	0.0261	0.0547	0.0343	0.0119a	0.0249	0.027a	0.0197a	0.0188a	0.0227	0.0185a	0.0238a	0.0114a
Basement(unfin)	0.0017a	-0.0125a	-0.013a	0.0027a	0.0316a	0.0119a	-0.0138a	-0.0039a	-0.002a	-0.0196a	0.0683	0.0075a
Basement(W/O)	0.0146a	0.0012a	0.001a	0.0856	0.013a	0.0108a	0.0299a	-0.0362a	0.0169a	0.0145a	-0.0039a	-0.0254a
One Car Garage	0.0383	0.0387	0.0621	0.0381	0.0427	0.0349	0.0424	0.0403	0.0258	0.0456	-0.0039a	0.0373
Fireplace	0.0429	0.0532	0.0357	0.0267	0.0296	0.0439	0.0336	0.0386	0.0438	0.0185a	0.0166a	0.0184a
UFFI	-0.0094a	-0.0763	-0.0942a	-0.1488	-0.0131a	-0.0686a	-0.0454a	0.0314a	-0.0433a	-0.0266	-0.0108a	-0.1238a
UFFI(Removed)	-0.0267a	-0.0507a	-0.0144a	-0.0182a	-0.0173a	-0.0405a	-0.0241a	0.0051a	0.0044a	-0.1669a	-0.0523a	-0.0277a
Central Air	0.0178a	0.029	0.0317a	0.0299a	0.0173a	0.0192a	0.03	0.0263	0.0408	0.0136	0.0649	0.0116a
Bungalow	-0.0604	-0.0266a	-0.0023a	-0.0021a	0.0059a	-0.0125a	-0.0218	-0.018a	-0.0215a	-0.0019a	-0.0605a	-0.0389a
1½ Storey	-0.0946	-0.0486	-0.0645	-0.046a	-0.0519a	-0.0448a	-0.0432a	-0.0921	-0.0596	-0.0384a	-0.0563a	-0.0441a
Two Storey	-0.0226a	-0.0085a	0.0492	0.1001	0.0048	-0.0158a	0.0243a	-0.0055a	0.0117a	-0.0413a	0.0077a	-0.0707a
Side Split	0.0028a	0.0269a	0.1031	-0.0314a	0.0719	0.0572a	0.0429a	0.0359a	0.058	0.0818a	-0.0057a	-0.0824a
Back Split	-0.0451a	0.0274a	0.0178a	-0.0056a	-0.0308a	-0.0157a	0.0037a	0.0133a	-0.0002a	-0.0193	0.0018a	-0.014a
Semi-detached	-0.1785	-0.1233	-0.1188	-0.0819	-0.126	-0.1083	-0.0677	-0.0738	-0.1066	-0.1361	-0.1543	-0.0944
Age (16 - 30)	0.0279a	0.0135a	0.012a	-0.0218a	-0.0111a	0.0212a	-0.005	0.0075a	-0.014a	-0.0134a	0.0088a	-0.007a
Age (31 - 50)	-0.0078a	-0.0472	-0.0323a	-0.0213a	-0.0308a	0.007a	-0.0271	0.0156a	-0.0704	-0.0505	-0.0487a	-0.1013
Age (51 +)	-0.0718	-0.1136	-0.1065	-0.1138	-0.1016	-0.0808	-0.1007	-0.0244a	-0.0881	-0.0834	-0.1406	-0.1517
Brick Veneer	0.0037a	0.1252	0.1357	0.0557	0.0446	0.0842	-0.0155	0.0137a	0.0064a	0.0223a	0.174	0.0982
Vinyl/Alum.	-0.0498a	0.0326a	0.0735	-0.0623	-0.0132a	0.0375a	-0.1477	-0.0443a	-0.0091a	0.0087a	0.1138a	0.0227a
Stone	0.0571a	0.1595	0.1017	0.0962a	0.0161a	0.0585a	-0.1079	0.0583a	-0.0327a	-0.0134a	0.0595a	0.0377a
Frame	-0.112	0.1021	0.0221a	-0.0039a	-0.1928	-0.0334a	-0.1216	0.0733a	-0.0543a	-0.4057	0.2001	0.0438a
Brick & Wood	0.0102a	0.1168	0.1094	0.0225a	0.0186a	0.0439	-0.0335a	0.0363a	0.0044a	0.0094a	0.1076	0.0623a
Brick & Alum.	0.0308a	0.1143	0.1194	0.0459a	0.0535	0.0917	-0.0036a	0.0366a	0.0131a	0.0201a	0.171	0.1011
Solid Masonry	-0.0046a	0.1298	0.0969	0.0533a	0.0479a	0.1049	-0.0075a	0.0149a	-0.0039a	0.0201a	0.197	-0.138
Unemployed	-0.0049a	-0.0065a	-0.0026a	-0.0057a	-0.0068a	-0.0055a	-0.0055a	-0.0011a	-0.0033a	-0.0146	-0.0028a	-0.0045a
Incld. Pov.	0.0002a	0.0004a	0.001a	0.001a	0.0013a	-0.0022a	-0.0013a	0.0008a	-0.0003a	0.0001a	-0.0013a	-0.0052
CBD (inv)	0.0200	-0.0065a	0.0141a	-0.0332	0.0017a	0.0223a	0.0168a	-0.0203	-0.0137a	0.0129a	-0.011a	0.0394a
CBD (log)	0.0417	-0.0296	0.0085a	-0.0371	0.0055a	0.0382a	0.0085a	-0.0116a	-0.0386	0.0191a	-0.0396a	0.0009a
Indust (inv)	-0.0076a	-0.0116	-0.0082a	-0.0141a	-0.009a	0.0089a	-0.0061a	-0.0144	-0.014	-0.0047a	0.0112a	0.0042a
Indust (log)	-0.0175a	-0.0229	-0.0241a	-0.0351	-0.0198a	0.0205a	-0.0125a	-0.0252a	-0.0222	-0.0178a	0.0224a	-0.0132a
Pop. Den.	0.0007a	-0.0021	-0.0016a	-0.0003a	-0.0009a	0.0007a	0.0009a	-0.0025	-0.0012a	-0.0005a	-0.0027a	0.0041a

Note: a indicates that the estimated parameter is not significant at the 5 percent level.

Table AIIa

Variable Means by Quarter for All Houses

Quarter	1	2	3	4	5	6	7	8	9	10	11	12
No. Observations	927	1186	1003	809	1086	844	869	783	863	592	543	351
Ave. Sale Price	128144	134211	136589	143835	155375	163612	159901	164924	167694	169198	160852	158888
Bedrooms	3.14	3.18	3.14	3.16	3.22	3.20	3.16	3.16	3.13	3.16	3.13	3.15
Other Rooms	3.60	3.45	3.61	3.48	3.48	3.58	3.45	3.51	3.54	3.50	3.45	4.41
Lvg Area ('000 sf)	1.13	1.16	1.14	1.18	1.20	1.21	1.20	1.18	1.18	1.20	1.16	1.19
$(\text{Lvg Area})^2$	1.37	1.43	1.40	1.48	1.57	1.58	1.55	1.51	1.51	1.56	1.47	1.53
Lot Area ('000 sf)	6.44	6.54	6.27	6.46	6.39	6.30	6.02	6.33	6.13	6.37	5.99	6.20
$(\text{Lot Area})^2$	55.67	58.85	46.73	56.94	52.10	51.81	45.35	61.58	47.67	56.43	49.11	56.28
Large Lot	.38	.32	.10	.29	.27	.29	.19	.49	.27	.46	.34	.26
Recreation Room	59.55	60.96	63.61	62.05	62.71	63.39	64.67	62.84	65.24	67.23	59.85	62.68
Family Room	29.45	29.26	28.71	31.27	34.53	33.18	31.76	32.06	33.49	33.11	30.39	32.76
Games Room	1.08	1.35	2.29	2.47	2.76	3.08	1.96	2.68	2.32	1.69	2.21	2.85
Den	4.42	6.16	7.18	6.55	7.83	8.41	8.06	7.54	5.56	7.60	8.10	10.26
Laundry Room	0.65	1.77	2.89	3.58	2.76	3.08	5.41	3.83	5.33	5.07	4.05	4.56
Second Kitchen	1.29	1.18	1.69	1.73	3.04	2.37	2.19	2.43	1.85	2.36	2.21	2.56
Full Bathroom	1.49	1.47	1.48	1.47	1.49	1.49	1.49	1.52	1.50	1.50	1.49	1.56
Half Bathroom	0.52	0.54	0.46	0.57	0.53	0.57	0.53	0.52	0.54	0.54	0.53	0.53
Basement(unfinish)	44.98	43.51	30.41	37.58	27.99	29.62	29.00	28.22	28.39	27.53	30.20	24.22
Basement(W/O)	5.61	5.48	11.17	8.16	10.77	10.66	11.85	10.22	10.31	10.64	8.66	11.40
Garage(one)	42.39	41.06	42.47	41.66	44.38	40.05	42.46	38.44	43.45	44.59	42.17	42.45
Garage(Two +)	23.09	25.21	22.93	25.22	24.59	25.00	22.78	23.75	21.32	23.48	20.07	25.64
Fireplace	47.14	48.06	46.76	49.32	47.24	50.47	46.49	43.81	45.77	45.10	43.46	45.01
Pool Inground	2.91	2.45	0.60	2.84	4.24	4.98	4.72	2.81	3.36	4.73	1.84	0.28
Pool Above Ground	6.69	3.54	6.38	3.83	2.03	1.66	1.27	1.92	1.62	1.52	5.16	8.26
UFFI	0.97	0.93	0.70	0.99	1.01	1.07	0.69	1.02	1.27	0.84	1.29	0.85
UFFI (removed)	0.76	0.67	1.89	1.48	1.29	0.59	0.92	1.66	1.39	1.69	1.10	0.57
Central Air Cond.	14.46	14.25	16.15	15.20	19.61	22.04	22.67	22.86	24.45	30.07	27.44	25.07
Electric BaseBoard	2.48	2.78	0.40	3.46	4.24	4.62	5.18	4.60	5.68	4.56	1.10	0.28
Oil Heat	15.43	17.12	14.46	15.20	15.47	14.81	15.77	17.24	15.53	15.03	13.81	13.39
Bungalow	19.63	20.24	19.64	20.40	19.89	17.42	18.53	20.18	21.55	19.26	19.15	20.23
1½ Storey	9.92	10.46	10.97	10.38	9.58	9.72	10.93	12.39	9.04	10.14	11.97	11.68
2 + Storey	29.99	32.29	31.70	33.25	36.10	36.73	33.37	33.21	30.01	34.12	32.23	31.62
Side Split	7.12	7.25	7.68	6.06	7.55	7.23	7.02	4.47	6.95	6.76	5.89	7.41
Back Split	11.87	10.03	10.57	8.03	8.38	8.41	10.47	7.28	11.36	9.97	7.37	10.26
Semi-Detached	13.70	11.21	12.16	12.11	10.59	12.44	11.97	13.79	13.79	12.33	16.76	11.68
Age (1 - 5 years)	14.89	17.79	17.15	18.05	16.67	18.01	20.94	19.28	22.48	20.44	21.18	17.95
Age (6 - 15)	27.29	24.54	27.82	25.22	23.85	23.70	21.86	20.31	22.36	21.79	19.71	22.22
Age (16 - 30)	20.39	20.15	20.54	21.38	23.94	23.70	23.13	22.22	23.99	22.64	23.57	23.65
Age (31 - 50)	13.16	14.00	13.76	13.47	13.44	14.93	15.54	17.37	14.37	16.72	14.73	15.38
Age (51 +)	8.31	11.97	11.96	10.51	12.06	12.91	11.74	12.52	10.43	11.32	11.97	10.83
Brick Veneer	29.13	31.03	28.61	30.04	29.47	20.38	22.55	24.39	23.29	17.23	22.47	25.36
Vinyl/Aluminium	5.07	4.47	5.98	5.07	4.14	4.27	4.26	5.24	5.21	5.24	5.16	5.98
Stone Masonry	1.73	1.77	2.09	1.36	1.66	2.13	1.50	2.43	2.32	2.36	0.37	0.28
Frame	1.51	0.84	1.79	1.24	0.83	2.37	1.15	0.77	0.93	1.01	0.55	1.14
Brick/Wood	10.14	9.61	10.77	10.14	10.04	11.97	11.16	8.68	8.92	10.47	11.23	8.55
Brick/Aluminium	43.37	42.75	40.98	43.76	45.76	51.07	53.51	48.53	51.45	51.86	52.30	55.56
Solid Masonry	5.83	7.25	6.38	5.07	5.71	5.57	4.37	6.13	4.63	7.77	6.63	0.57
Unemployed Rate	5.44	5.55	5.56	5.53	5.53	5.57	5.46	5.47	5.38	5.60	5.45	5.50
Incidence of Pov.	10.40	10.60	10.61	10.96	10.54	10.93	10.36	10.85	10.78	11.08	11.12	10.88
Central Bus. (inv)	0.79	0.82	0.83	0.81	0.82	0.85	0.89	0.91	0.80	0.82	0.79	0.79
Central Bus. (log)	0.55	0.49	0.48	0.51	0.48	0.46	0.46	0.42	0.51	0.48	0.51	0.52
Indust (inv)	1.82	1.74	1.85	1.70	1.74	1.83	1.84	1.90	1.86	1.91	1.77	1.79
Indust (log)	0.07	0.10	0.04	0.11	0.12	0.06	0.04	0.01	0.04	-0.00	0.07	0.05
Population Density	8.38	8.87	9.00	8.85	8.77	8.75	8.83	8.72	8.51	8.64	8.28	8.53

Note: in this table proportions of observations with a characteristic are given as percentages.

Table A11b
Unconstrained hedonic regressions results
for all single and semi-detached houses

Quarter	1	2	3	4	5	6	7	8	9	10	11	12
Obs.	927	1186	1003	809	1086	844	869	783	863	592	543	351
$\bar{R}^2$	.8159	.8505	.8100	.8303	.8379	.8401	.8329	.8538	.8161	.8548	.7913	.8003
Intercept	11.34362	11.51271	11.55775	11.27580	11.52892	11.68453	11.62814	11.57304	11.73786	11.69156	11.40246	11.67564
Bedrooms	0.05179	0.02220	0.04866	0.03294	0.03476	0.02462	0.03336	0.02485	0.01743	0.04215	0.04554	0.04058
Other Rooms	0.01739	0.01667	0.01506	0.02780	0.02323	0.01611	0.02282	0.01056	0.01089	0.00124a	0.00833a	-0.00387a
Living Area	-0.06127a	-0.06164a	-0.18970	0.29296	0.00722a	0.03379a	0.08012a	0.26267	-0.00352a	0.08397a	0.07577a	-0.08647a
Living Area^2	0.09471	0.10206	0.14478	-0.03790	0.05713	0.05747	0.01956a	-0.03892	0.06731	0.04179	0.05119	0.10276
Lot Area	0.01630	0.01131	0.00556a	0.01555	0.01829	0.01584a	0.02062	0.00797	0.01835	0.01236	0.01477	0.02159
Lot Area^2	-0.00027	0.00004a	0.00054a	0.00016	-0.00019a	-0.00028a	-0.00041	0.00021	-0.00087	0.00009a	-0.00009a	-0.00053
Larage Lot	0.00371a	-0.00298a	-0.00538a	0.00044a	0.00006a	0.00274	-0.00421a	-0.00803	0.01373	-0.00785	-0.00625a	0.01743
Recreation	-0.02068	-0.01932	-0.01051a	-0.04208	-0.01084a	-0.02758	-0.03122	-0.03069	-0.02406	-0.03448	0.00248a	-0.05196
Family Room	-0.00738a	0.01504a	0.01004a	0.00319a	0.01523a	0.04851	0.01631a	0.01632a	0.03319	0.02054	0.02864a	0.00341a
Game Room	-0.02520a	0.01089a	0.02270a	-0.03965a	-0.03047a	-0.03350a	-0.00485a	-0.06085	0.00920a	0.02259	0.02211a	-0.07036a
Den	0.04925	0.05758	0.06800	-0.00241a	0.04156	0.02715a	-0.01016a	0.05311	0.04562	0.04487	0.02509a	0.03289a
Laundry	-0.00527a	0.01880a	-0.03914a	-0.01034a	-0.03568	0.02815a	-0.00639	a0.02199a	-0.03923	-0.02535	0.01270a	0.00852a
Kitchen(2)	-0.00619a	0.02127a	-0.07263	-0.04208a	-0.06507	-0.04006a	-0.06390	-0.00485a	0.03017a	0.03184	-0.03964a	-0.05231a
Full Bath	0.06283	0.05609	0.05112	0.04831	0.05038	0.04040	0.04705	0.05289	0.06928	0.03205	0.04954	0.06127
Half Bath	0.03880	0.04655	0.03989	0.03716	0.03995	0.04834	0.02289	0.02600	0.04764	0.03369	0.02306	0.04976
Basement(unf)	0.00140a	-0.00221a	-0.01171a	-0.00696a	0.01453a	-0.00903	-0.01149a	0.00719a	0.00081a	-0.01024a	0.00438a	-0.04414
Basement W/O	0.01660a	0.00000a	-0.01075a	0.01265a	0.04864	0.03205	0.01688	-0.00707a	0.02696	0.02400a	-0.02253a	0.04020
Garage (one)	0.04733	0.03289	0.05761	0.04200	0.03845	0.02341	0.03225	0.05183	0.02830	0.01540a	0.02875	0.05125
Garage (2/3)	0.12997	0.14177	0.15782	0.15834	0.14710	0.11810	0.13760	0.17871	0.12628	0.11343	0.10681	0.12408
Fireplace(#)	0.05404	0.05676	0.05732	0.05545	0.03545	0.05980	0.05605	0.04785	0.04924	0.06203	0.05083	0.05515
PoolInground	0.06173	0.04281	0.01941a	-0.00060a	0.00240a	0.04775	0.05244	0.08947	0.04624	0.02728a	0.00901a	-0.04429a
PoolAbove	-0.01093a	0.01897a	0.01299a	0.00792a	-0.00151a	-0.07299	-0.01097a	0.04949	-0.00503a	-0.03208a	0.07138	0.07628
UFFI	-0.04456a	-0.00094a	-0.06690a	-0.08736	-0.00298a	-0.06463a	-0.00867a	-0.00255a	-0.02729a	-0.09310	-0.00133a	-0.19461
UFFI(remove)	-0.02441a	-0.01607a	-0.02512a	0.02908	-0.01239a	-0.01715	-0.00306a	0.00968a	0.04996a	-0.07868	-0.07033a	0.09284a
Central Air	0.02206	0.03062	0.03508	0.06232	0.02711	0.02477	0.04802	0.02001	0.03677	0.03795	0.05175	0.03686
Electric BB	-0.01972a	-0.02492a	-0.07221a	-0.01819a	-0.03024a	-0.06817	-0.03607	-0.02135	-0.00551a	-0.00392a	0.02232a	0.09756a
Oil Heat	-0.04766	-0.01047a	-0.01559a	-0.01181a	-0.00718a	-0.01723a	-0.01428a	-0.00591	-0.01545a	-0.02658	0.00814a	-0.02694a
Bungalow	0.02294a	-0.01793a	-0.00047a	0.00919a	0.00995a	-0.02053a	0.01235a	0.01027	0.00838a	0.00809a	0.04725	0.02893a
1½ Storey	-0.00782a	-0.05651	-0.03849a	-0.03682a	-0.01737a	-0.05324	0.00110a	-0.05243	-0.05652	-0.01262a	0.01486	0.03516a
2+ Storey	0.07604	0.04141	0.05590	0.06232	0.05736	0.03444	0.04744	0.04090	0.05408	0.04659	0.09346a	0.06048
Side Split	0.03752	-0.00038a	0.02300a	0.01433a	0.05114	-0.00805a	0.01140a	0.01319	0.03739a	0.03050a	0.09047	0.03197a
Back Split	0.01063a	-0.02579a	-0.00644a	-0.01910a	0.00507a	-0.02744a	-0.01008a	0.00276	-0.02049a	-0.01609a	0.03984	-0.02563a
SemiDetached	-0.09441	-0.13037	-0.09802	-0.06649	-0.09369	-0.08533	-0.06575	-0.05918	-0.08352	-0.09328	-0.04073a	-0.05748a
Age (1 - 5)	-0.05978	-0.10187	-0.10453	-0.08310	-0.09034	-0.11640	-0.09878	-0.08821	-0.10518	-0.11046	-0.08021a	-0.07435
Age(6 - 15)	-0.12310	-0.16016	-0.18158	-0.15442	-0.15288	-0.19601	-0.17811	-0.16886	-0.16331	-0.17369	-0.15775	-0.14276
Age(16 - 30)	-0.10304	-0.15559	-0.15370	-0.14042	-0.14189	-0.16936	-0.16214	-0.15325	-0.15746	-0.18835	-0.16493	-0.11296
Age(31 - 50)	-0.18565	-0.23424	-0.18999	-0.15848	-0.16463	-0.18680	-0.22373	-0.15823	-0.18369	-0.20904	-0.16202	-0.16304
Age(51 +)	-0.28350	-0.32127	-0.30276	-0.22605	-0.26112	-0.29711	-0.31829	-0.23746	-0.23906	-0.27939	-0.22472	-0.22474
Brick Veneer	-0.00134a	0.07347	0.07049	0.02656a	0.04978	0.03249a	-0.00473a	0.01225a	0.01743a	0.03627a	0.11847	0.08111
Vinyl/Alum.	-0.04750	0.02585a	0.02789a	-0.05515	-0.01151a	0.00381a	-0.11241	-0.03940a	0.02413a	-0.01406a	0.08102a	0.02553a
Stone	0.09048	0.11822	0.05011a	0.02295a	0.03321a	0.05408a	0.01568a	0.08418	0.07545	0.04320a	0.07122a	-0.11575a
Frame	-0.12559	0.01105a	0.01600	-0.02439a	-0.01521a	-0.07580	-0.07588	-0.11549a	-0.00305a	-0.47182	0.11825a	-0.18185
Brick/Wood	-0.01107a	0.05666	0.05564	0.02258a	0.00931a	0.00359a	-0.02474a	0.02284a	0.00768a	-0.00293a	0.07313a	0.06401a
Brick/Alum.	-0.00742a	0.06213	0.04734	0.01103a	0.03200a	0.02670a	-0.02113a	0.00763a	0.01232a	0.02551a	0.11250	0.09387
Solid Mason	0.03464a	0.08569	0.06034	0.03204a	0.06144	0.05362	0.00560a	0.02105a	0.02824a	0.05854	0.13165	-0.05969a
Unemploy (%)	-0.00401a	0.00224a	-0.00791	-0.00568a	-0.00285a	0.00035a	-0.00128a	0.00132a	-0.00203a	-0.00467a	-0.00765a	-0.00166a
Incid./Pov.	0.00093a	-0.00125	0.00040a	0.00047a	-0.00052a	-0.00224	-0.00061a	0.00119a	0.00047a	-0.00094a	0.00142a	-0.00377
CBD (inv.)	-0.01422a	-0.02291	-0.01238a	-0.01839	-0.02240	-0.01415a	-0.00049a	-0.00983a	-0.01485	0.01182a	-0.00339a	-0.01738a
CBD (log)	-0.04162a	-0.06510	-0.03276	-0.02450a	-0.01310a	-0.01290a	-0.00386a	-0.00847a	-0.02341	0.00261a	-0.01098a	-0.05380
Indust (inv)	-0.00812a	-0.01477	-0.00988a	-0.00350a	-0.01521	-0.01271	-0.01890	-0.01958	-0.01590	-0.00943	-0.00428a	-0.01889
Indust (log)	-0.01425a	-0.02824	-0.02564	-0.00849a	-0.03098	-0.02486a	-0.03531	-0.03596	-0.03067	-0.02793	-0.00632a	-0.04910
Pop. Density	-0.00149a	-0.00231	-0.00176a	-0.00131a	-0.00322	-0.00136a	-0.00120a	-0.00424	-0.00215	-0.00097a	-0.00166a	-0.00403

Note: a indicates that the estimated parmaeter is not significant at the 5 percent level

Table A12
Repeat Sales Regression Results For Condominiums

Variable	Parameter Estimate	Standard Error	t Statistic
QRPTD2	0.028733	0.02608486	1.102
QRPTD3	0.082968	0.02342163	3.542
QRPTD4	0.095374	0.02538274	3.757
QRPTD5	0.172172	0.02364332	7.282
QRPTD6	0.228919	0.02550363	8.976
QRPTD7	0.252839	0.02510611	10.071
QRPTD8	0.298832	0.02401357	12.444
QRPTD9	0.341460	0.02312216	14.768
QRPTD10	0.301254	0.03237436	9.305
QRPTD11	0.260056	0.02716297	9.574
QRPTD12	0.255051	0.02884390	8.842

n = 136
R^2 = 0.8343

Repeat Sales Regression Results For Single and Semi-Detached Houses

Variable	Parameter Estimate	Standard Error	t Statistic
QRPTD2	0.009117	0.01743617	0.523
QRPTD3	0.066125	0.01642697	4.025
QRPTD4	0.090298	0.01864336	4.843
QRPTD5	0.171095	0.01697158	10.081
QRPTD6	0.220888	0.01776175	12.436
QRPTD7	0.234812	0.01784008	13.162
QRPTD8	0.238130	0.01723528	13.816
QRPTD9	0.295147	0.01859536	15.872
QRPTD10	0.293797	0.01720186	17.079
QRPTD11	0.241181	0.01814721	13.290
QRPTD12	0.238377	0.02285160	10.432

n = 428
R^2 = 0.7086