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Market Efficiency, Uncertainty And Risk Management in Real Estate Valuation – How Hedonics May Help

The 2007-2008 subprime mortgage crisis has profoundly modified the way investment and management risks are perceived by economic agents. In particular, both private and institutional players in the property sector are now being compelled to follow more stringent rules and to display greater transparency in their management of risk issues and of lending practices. In that context, analytical tools based on statistics and econometric modelling are increasingly resorted to as risk-containment devices.
The purpose of the paper is to look at how real estate appraisal practitioners and related professionals may benefit from a greater recourse to statistics and, more precisely, to econometric modelling, in their search for market value. As brought out in the real estate literature, the very definition of market value lends itself to a statistical approach, the latter reaching its full meaning with the hedonic price (HP) method which is shown to be an extension of the traditional sales comparison approach.

Key word: *Property asset valuation, Fair market value, Hedonic price method.*

Introduction – Setting the context

According to the International Real Estate Exchange Group (IREX, 2011, p. 1), real estate is the world's largest asset class and comprises over 54% of global financial wealth. Consequently, its economic importance cannot be overstated. A key disadvantage of holding property in a portfolio though is that it is illiquid when compared with other assets such as stocks or bonds. In that respect, the introduction of the US real estate investment trust (REIT) regime in the early sixties can be considered as a major breakthrough for improving the liquidity of real estate assets and, consequently, the supply of capital for property development and investment. Hence the worldwide development of REITs that followed and which is still underway in 2011, in spite of the slowdown experienced in the midst of the economic turmoil of the past few years[1].

In addition, the sustained trend toward the securitization of real estate assets over the last few decades also contributed to enhance their liquidity. As discussed by Patel (2007), securitization was initiated by the US government as an attempt to

[1] According to a recent study by PwC (2011), the year-end market value of publicly traded US REITs was more than US$300 billion in 2010, off from its peak ofUS$438 billion in 2006. Unlisted REITs, a fast-growing segment of the REIT market, held an additional US$70 billion in assets.

liberalize the secondary mortgage market in the 1970s and can be defined « *as the process of transforming illiquid assets, traditionally held in bank portfolios until maturity, into liquid assets that can be sold in the securities market (Wolfe, 2000)* ». For that reason, securitization has become a strategic, and increasingly popular, tool for mortgage originators throughout the world, with Mortgage Backed Securities (MBS) as the backbone of the mortgage lending business; that is, until the global housing bubble bust triggered off the collapse of the whole system in July 2007.

According to Arestis and Karakitsos (2009), while the root of the financial crisis remains the creation and subsequent developments in the subprime mortgage market, three main forces that had been operating for quite some time have contributed to the crash of the financial sector worldwide; these are: *financial liberalization*[2], *financial innovation* and *easy monetary policy*.

Thus, it is the combination of (i) financial liberalization, (ii) unregulated financial engineering resulting in the massive proliferation of highly volatile instruments – such as collateralized debt obligations (CDOs) backed, for a large part, by subprime mortgages –, (iii) the mismanagement of real estate assets linked with the lack of transparency as well as predatory lending practices and (iv) the low interest rate, easy credit, policy that prevailed throughout the 2000-2006 period which fueled the housing market boom while boosting debt-financed consumption. Finally, yet another factor may be brought forward as an explanation for the financial crisis that shook the world: the recourse to flawed theories and measures of risk assessment (Duguay, 2009; Dominique, 2010; Dominique *et al.*, 2011).

With the 2007-2008 subprime mortgage crisis as the background and while both private and institutional players in the property sector are now being compelled to follow more stringent rules and to display greater transparency in their management of risk issues, this paper looks at how real estate appraisal practitioners and related professionals may benefit from a greater recourse to statistics and, more precisely, to econometric modelling, in their search for market value. Starting with a discussion on the concepts of market efficiency and risk management as they apply to real estate, the statistical nature of market value is then addressed, followed by a brief introduction to the potential applicability of the hedonic price (HP) framework to real estate. Two hedonic applications are then developed based on recent research dealing with residential and retail real estate in Canada. The paper concludes by a discussion on the risk management issue in the context of property valuation practices.

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[2] In the US, the passing of the 1977*Community Reinvestment Act* (CRA) – meant at helping "risky" borrowers to become homeowners through a loosening of mortgage credit conditions – and of the *Financial Services Modernization Act* of 1999 – also known as the *Gramm–Leach–Bliley Act* (GLB) – which repealed part of *1933 Glass-Steagall Act*, thereby allowing commercial banks, investment banks, securities firms, and insurance companies to consolidate, are considered to have paved the way for the financial disaster that followed.

1. Market efficiency, uncertainty and risk management – the role of statistics in real estate appraisal

According to the efficient-market hypothesis (EMH), financial markets are "informationally efficient" in that, once adjusted for risk, excess returns cannot be systematically achieved, given the information available at the time the investment is made (Fama, 1970). This said, market efficiency can be "weak", "semi-strong", and "strong". According to the weak EMF, prices on traded assets (*e.g.,*stocks, bonds, mortgages or property) internalize all past publicly available information whereas, under the semi-strong EMH, new public information is also reflected in prices. Finally, the strong EMH additionally claims that even hidden, or "insider", information is instantly reflected in prices. Whether the weak and semi-strong EMHs actually apply remains debatable. In contrast, there is powerful evidence against strong EMH.

This is particularly the case with real estate assets since they are transacted on imperfects markets and are often subject to asymmetric information (Akerlof, 1970) in favor of sellers – *e.g.* in the presence of "hidden" urban externalities – and to information uncertainty (Byrne *et al.*, 2010). Property assets – held individually or within a portfolio – are also affected by numerous risks. In economics, the distinction between risk and uncertainty is well documented since the seminal work of Knight (1921): basically, in the Knightian sense, risk is measurable whereas uncertainty is not. According to Hubbard (2007) though, uncertainty can be measured by assigning a set of probabilities to a set of possible outcomes while risk is only present where some of these possibilities actually involve a quantifiable loss. Finally, according to modern portfolio theory, MPT (Markowitz, 1952), financial risk is an umbrella term that includes various types of risks[3] associated with any form of financing and is measured as the standard deviation of total portfolio returns[4].

While the financial crisis belongs to the past, its consequences are still putting a strain on the weakened economies of formerly leading countries. With the US economy experiencing an anemic recovery and the sovereign debt issue affecting several Western European states, uncertainty and risk will most likely dominate the economic scene for quite some time. In line with the sustained pressure toward mark-to-market accounting which requires that the value of assets and liabilities be based on their current market price, asset-risk management has unsurprisingly become in recent years a major issue in the property sector. As argued by Duguay (2009)[5] though in his presentation before the Toronto Chapter of the Risk Management Association, reliance on inadequate or

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3 These include *credit* risk, *market-related* risks, *liquidity risks* and *operational* risks.

4 According to post-modern portfolio theory, PMPT (Sortino, F. and S. Satchell, 2001), risk is known as the "downside risk" and is expressed as the standard deviation of annualized below-target portfolio returns.

5 Pierre Duguay was Deputy Governor of the Bank of Canada from 2000 through 2009.

inappropriate market valuations may turn out to be detrimental to financial stability in times of market stress as it amplifies the boom and bust cycle in credit and asset prices. This is notably the case in real estate with institutional property investors, fund managers and mortgage lenders increasingly looking for efficient value-setting tools and procedures to help them monitor and contain financial risk. In that respect, statistical analysis – notably econometric modelling is gaining popularity in real estate appraisal since it is viewed as an efficient means for enhancing information transparency and a most useful device for handling the risk management issue.

As brought out by Kummerow (2000), market value is essentially a probability derived from a distribution of possible prices. As for the degree of precision of a price estimate, it depends on the variance of that distribution: the larger the variance, the less precise the estimate and the larger the sample of comparables needed to obtain a reliable market value. The statistical nature of the market value concept is already enshrined in its most widespread definition, which states that "market value is the *most probable* price a particular property should sell for in a competitive and open market…etc." The statistical definition of value proposed by Kummerow (2002) goes a step further and rests on four elements: (i) the *parameter estimates* of a subject property's sale price distribution; (ii) *estimates of errors* in the parameter estimates; (iii) *forecasts of the stability of the estimates* over a relevant future period; and (iv) *statements of assumptions about the circumstances of the sale* that may influence the price distribution.

Whereas adopting such a statistical definition of value require that appraisers get familiar with statistical methods and approaches, it supplies real estate professionals with tools that allow analytical rigor, estimate reliability and interpretative nuance, all of which are lacking in traditional approaches. As argued by Kummerow (2006), resorting to structured and detailed protocols enhances the benefits accruing from the statistical approach. Since it is based on sale price distribution and thus focuses on price variability, the statistical definition of value also lends itself to probability statements about value estimates, and hence to risk measurement, while it could be extended to include forecasting features as a partial response to market inefficiency. As discussed above, the latter constitute major, and highly marketable, advantages for valuation firms that contemplate developing and selling market monitoring as well as risk assessment products and services to property portfolio managers, mortgage lenders and other public and private institutions involved in real estate.

The statistical approach to value paves the way for hedonic modelling which can be shown to be an extension of the traditional comparison approach in real estate appraisal. This said, while the latter relies on subjective – and highly fluctuating opinions for adjusting values so as to account for differences in size, quality, location, etc., the former provides greater objectivity and reliability in explaining property values and predicting prices.

2. The Hedonic Price Method – Conceptual Framework, Potential and Limitations

2.1 The Conceptual Framework[6]

Based on solid theoretical and empirical grounds, the *hedonic price (HP) method* rests on multiple regression analysis (MRA), a long tested econometric tool that combines calculus and the probability theory and allows breaking down a given phenomenon into its explanatory components. MRA has been extensively used for decades by researchers from all fields, notably by economists and social analysts, for handling a great variety of issues. As for the hedonic theory which underlies the HP method, it owes its conceptual soundness to Rosen (1974) and assumes that the market price of a complex, or heterogeneous, good such as housing is a direct function of the utility, or satisfaction[7], derived from the quantity of the *n* attributes it is composed of, provided these are known to economic agents. Thus, for a given level of income and a given structure of preferences, and where supply and demand are in equilibrium, each attribute is assigned an *implicit*, or *hedonic*, price that reflects its market value and which is also assumed to be the buyer's willingness-to-pay (WTP) for the attribute.

Considering that property is the complex good *par excellence*, the popularity of the HP method among real estate analysts and professionals, triggered by the joint development over the past decades of microcomputing facilities, user-friendly statistical software and large databases, is not surprising and is reflected in the vast, and still growing, literature on hedonic studies. While housing, and single-family houses in particular (Des Rosiers *et al*., 2007), clearly dominate the hedonic literature, the hedonic framework has also been successfully applied for investigating other segments of the property market such as rental housing (Sirmans and Benjamin, 1989 & 1991; Jud and Winkler, 1991; Des Rosiers and Thériault, 1996; Hoesli*et al.*, 1997) and retail real estate (Benjamin *et al.*, 1990; Sirmans and Guidry, 1993; Mejia and Benjamin, 2002; Des Rosiers *et al.*, 2005; Des Rosiers *et al.*, 2009). Finally, because of its substantial advantages over traditional approaches in terms of analytical rigor, transparency, reliability and cost-effectiveness, the HP method is gathering momentum in the appraisal community as well.

2.2 Potential and Limitations of the HP Approach

The hedonic approach is now used worldwide for a variety of purposes, from measuring the market value of urban externalities to assessing the value of a

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[6] Readers interested in a more detailed description of the HP method and its empirical potential are referred to Des Rosiers, F. and M. Thériault, Mass Appraisal, Hedonic Price Modelling and Urban Externalities: Understanding Property Value Shaping Processes, in Kauko, T. and M. D'Amato, Ed. *Mass Appraisal Methods – An International Perspective for Property Valuers*, Chapter 6, pp. 111-147, Wiley-Blackwell Publishing Ltd., U.K. 2008, 360 pages.

[7] The term "hedonic" has its root in ancient Greek, "hēdonē", which means "pleasure", and refers to the utility derived from the consumption of the complex good attributes.

mortgage portfolio to developing price indices as part of a risk management strategy. For appraisers, the HP method is viewed as the ideal device for identifying the contributory value of specific housing attributes and for assessing property values for local tax purposes[8].

A major feature of the HP method is that it enhances market intelligence while providing the analyst with a highly powerful, and adaptable, investigation tool that not only generates objective indications of value based on a direct reading of market forces, but also assesses their reliability via an array of specially designed statistical tests. In particular, it lends itself to numerous analytical extensions when used in combination with geographic information systems (GIS), with the latter being increasingly imperative for adequately addressing spatial issues.

Powerful though it might be, the HP approach also has its limitations. From a conceptual point of view, and as argued by Rosen (1974), the hedonic function is an amalgamation of supply and demand factors, which leads to the so called *identification problem* when it comes to estimating marginal contributions to value. A second potential problem stems from the *linearity of the hedonic function* used to measure phenomena that are known to follow nonlinear patterns. Thirdly, according to the hedonic theory, reliable estimates of buyers' willingness-to-pay for housing attributes may only be derived from *homogeneous markets* (Tyrvainen, 1997).

These drawbacks can be quite easily remedied for though. Indeed, after decades of hedonic studies, distinguishing supply from demand determinants is no longer a problem while appropriate transformations on either the dependent or the independent variables, or both, will most of the time overcome non-linearity issues. As for heterogeneity in the data, various regression procedures (*e.g.* Geographically Weighted Regression, GWR - Fotheringham*et al*, 2002) and modelling approaches (*e.g.* interaction terms – Casetti, 1986) may be used for handling the issue and generating context-specific implicit prices for property attributes.

Finally, the most stringent limitation of the HP method used to lie with the relatively large volume of information it requires, in contrast with traditional appraisal techniques. However, while several hundreds – or even thousands – of sales may be necessary for building a reliable hedonic price model, the rapid development of high-quality, GIS-driven, multi-level databases that are now currently available to real estate researchers and professionals lessens the extent of such a limitation.

2.3 Structure of Paper

In the following section, two applications of the HP method are presented. Both applications, which deal with the housing and retail markets, respectively,

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[8] The use of hedonic regressions and other automated valuation models for real estate appraisal purposes, which falls under the Uniform Standards of Professional Appraisal Practice (USPAP), is treated as essentially a statistically robust form of the sales comparison approach.

are drawn from recent pieces of research conducted in the Canadian context. In the first case study, we show that, in spite of their methodological differences, the hedonic theory and the traditional sales comparison approach stem from a similar paradigm with respect to how house prices are determined. In order to control for non observable, nearby influences, peer effects a highly popular concept among education and labour economists are included in the hedonic equation, in line with the conformity principle appraisers are familiar with. The second application deals with retail rent modelling in shopping centers and investigates the impact chain affiliation and store prestige have on rent setting strategies by landlords. Following result presentation, the paper concludes by a discussion about the potential of hedonic modelling as a risk management device for the property sector.

3. Applying the Hp Method to the Residential Market – Peer Effects as a Determinant of House Prices[9]

3.1 The Peer Effect Concept and Its Application to Real Estate Appraisal

Under traditional appraisal standards, comparable sales of nearby properties are assumed to bear greater resemblance to a subject property than sales located further away and are consequently given more weight for establishing market value.While more explicit about price determinants and their marginal contribution to property values, the hedonic approach may, under its classical form, underestimate the actual influence that surrounding properties exert on nearby house sales. This said, innovative spatial econometric approaches have developed over the past few decades which allow taking neighbourhood effects into account when estimating hedonic prices; this is notably the case with spatial autoregressive (SAR) procedures (Dubin *et al.*, 1999; Pace *etal.*, 1998b) designed at handling spatial autocorrelation (SA) in the model residuals and with Geographically Weighted Regression (GWR – Fotheringham *et al.*, 1998 & 2002). The latter though is not exempt from methodological flaws, as brought out by Bitter *et al.* (2007). This is where peer effects come into play.

Peer effects can be defined as the influence that members of a group exert on a given individual in the group. The importance of social interactions with respect to the individual choice process is brought out in the pioneering work by Asch (1956) and by Becker and Becker (1998). But it is the publication, in 1966, of the Coleman report (Coleman *et al.*, 1966) on student performances that sparked off this new paradigm for peer effects by stating that peer characteristics remain the best predictor of school performances. Since then, several authors have resorted to peer effect models for analyzing school performances (Hallinan and Sørensen,

[9] For a thorough analysis of the peer effect concept as applied to real estate appraisal, interested readers are referred to Des Rosiers *et al.* (2011-a) whichthe material used in this section is drawn from.

1983; Sacerdote, 2001; Zimmerman, 2003) or productivity at work (Ichino and Maggi, 2000; Nanda and Sørensen, 2008).

According to Manski (1993), three factors lead the member of a group to adopt a behaviour which is similar to that of the other members: (i) *endogenous interactions*; (ii) *exogenous interactions*; and (iii) *correlated effects*. Applied to residential real estate, endogenous interactions – or peer effects can be identified with the main, typical features of nearby, and most similar, properties used under the comparable sales approach. As for exogenous, or contextual, interactions, they refer to influences linked to the socio-economic profile of homeowners (average income, educational level, household composition, level of criminality, etc.) as well as to neighbourhood and environmental attributes (individual mobility, access to services and infrastructures, presence of mature trees, etc.). Finally, correlated, or latent, effects stem from non-observable spatial influences that can be brought forward as an explanation for the presence of SA in the model residuals (Pace *et al.*, 1998a; Can, 1990; Can and Megbolugbe, 1997; Anselin and Griffith, 1988; Anselin and Rey, 1991).

Thus, social interaction models may serve to handle empirical issues encountered in urban and real estate economics, including appraisal. As a matter of fact, they have already been used as a basis for modelling urban housing markets (Meen and Meen, 2003). Moreover, the idea that some latent spatial determinants are at stake in the price determination process is widely accepted in real estate modelling research. In contrast to exogenous and correlated effects which have attracted much attention in the hedonic literature, the impact of endogenous effects on property prices still needs being investigated.

3.2 Inserting Peer Effects in the Hedonic Equation

Following Manski (1993), the peer effect model is obtained by regressing the dependent variable for an individual I belonging to the group g, termedY_{ig}, not only on the individual's attributes, X_{ki}, and on the contextual characteristics of the group (excluding individual i), X_a, but also on the mean value of the endogenous variable for the group, Y_a, with individual $i$being excluded from the calculation. Thus, we can write:

$$Y_{ig} = \gamma_0 Y_g + \beta_1 X_{ki} + \beta_2 X_g + \varepsilon_{ig}, \qquad (1)$$

where the γ_0, β_1 and β_2 parameters measure the endogenous, individual-specific and exogenous (or contextual) effects, respectively, while ε is the error term.

Equation (1), it is to be recalled, only differs from the traditional HP model by the presence of an endogenous component, Y_a, meant at capturing peer effects. Indeed, under a house price model framework, X_{ki} accounts for the property's structural features while X_a becomes the vector of all neighbourhood – socio-economic as well as environmental attributes. The originality of this hedonic price equation thus lies with the addition of the endogenous effect variable which, in this research, is expressed as the mean sale price, computed over the previous quarter[10], of houses surrounding property *i*, that is, located within any given previously defined submarket, with property *i* sale price being excluded from the computation.

3.3 Database and Regression Procedures

The database used for this research includes 15,729 single-family detached houses (*i.e.* "bungalows", or single-storey units, and "town-cottages", or multi-storey units) sold over the former Quebec Urban Community (QUC) territory – now Quebec City between January 1990 and December 1996, with prices ranging from $50,000 (Can.) to $250,000.For the purpose of this research, the territory under analysis is divided into seven submarkets – derived from a discriminant analysis reflecting Quebec City's historical development stages as well as major features of its social fabric and built environment (Voisin*et al.*, 2010; see *Figure 1*). While other approaches may be used for market segmentation, the latter proves to perform better than mere administrative boundaries.

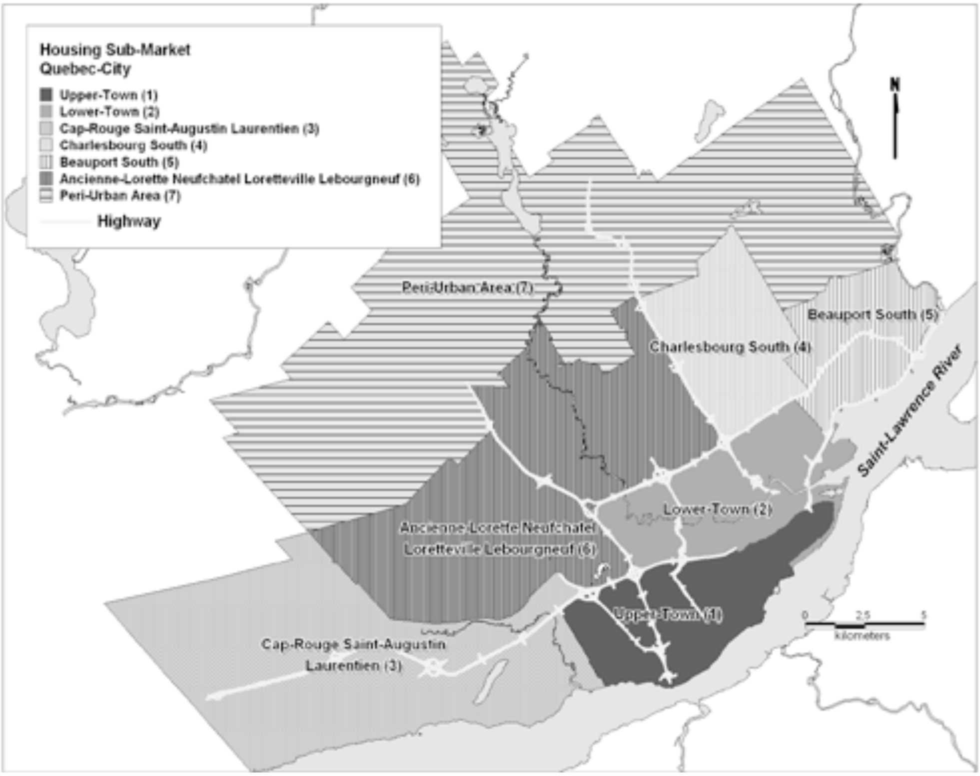
The database provides reliable information on sale prices as well as on major property attributes, notably: building type and age, living area and lot size, interior quality descriptors, presence of specific features (a fireplace, a finished basement, hardwood floors, a garage, etc.) and access to local water and sewerage systems. A trend variable is also included in the model. So are the socioeconomic (average household income and percentage of university degree in the neighbourhood) and demographic (number of single-parent families) dimensions, based on Canada's 1996 census. Finally, access – in minutes to regional services by car is accounted for through a factor score derived from a principal component analysis, or PCA (Thériault *et al.*, 2003).

Hedonic price modelling is performed using a semi-log, log-linear functional form, with liveable area, building age and lot size also being applied a logarithmic transformation[11]. Model calibration is obtained using two regression procedures, that is the Ordinary Least Squares (OLS) and the Spatial Autoregressive Error Model (SEM) methods. The peer effect model specification adopted in Equation 1 can be viewed as a partial substitute for the usual Spatial Autoregressive, Lagged-variable (SAR-Lag) model used to correct for the presence of spatial autocorrelation (SA) among residuals. It differs from the latter though in that the peer effect variable, , is not built using a spatial weight matrix based on pure geographic distance but, instead, is computed using the mean sale price over a given sub-market. Considering that latent spatial effects may still be significant in the residuals

[10] Confining sale price computation to the quarter preceding property *i* sale makes sure that only past prices can influence current market values.

[11] Regression coefficients for these three variables ought to be interpreted as elasticity coefficients.

Figure 1. Residential Submarket Delimitation for Quebec City.



Source: Voisin, M., J. Dubé, M. Thériault et F. Des Rosiers. 2010. Les découpages administratifs sont-ils pertinents en analyse immobilière? - Le cas de Québec. *Cahiers de géographie du Québec*, 54(152): 249-274.

even where endogenous effects are accounted for, resorting to a SEM procedure is advisable. This leads to the following hedonic equation:

$$Y = X\beta + \lambda We + u, \tag{2}$$

where λ is the spatial autoregression coefficient, W is the spatial weights matrix, β is a vector representing the slopes associated with the explanatory variables in the original predictor matrix X, and u is the usual error term independently and identically distributed (iid) while e is the spatially autocorrelated error term.

3.4 Regression Results and Discussion

Regression results are reported in *Table 1*. The first model (*Model A*), referred to as the Base Model, includes all property, neighbourhood, time, access and so-

Table 1. Regression Results – Peer Effect Model Using Both Ordinary Least Squares (OLS) and Spatial Autoregressive Error Model (SEM) Procedures.

	Model A – Base Model OLS Procedure		**Model B- Peer Effect Model OLS Procedure**		**Model C – Peer Effect Model SEM Procedure**	
Property Attributes	**Regression Coefficient**	**Sig.**	**Regression Coefficient**	**Sig.**	**Regression Coefficient**	**Sig.**
Ln_Liveable Area (m²)	0.4339	***	0.4293	***	0.4072	***
Ln_Lot Size (m²)	0.0752	***	0.0744	***	0.0967	***
Ln_Building Age (years)	-0.1033	***	-0.1053	***	-0.1133	***
Cottage	-0.0549	***	-0.0503	***	-0.0441	***
Attached	-0.1548	***	-0.1487	***	-0.1441	***
Quality Index	0.1148	***	0.1145	***	0.1155	***
Nb. of Bathrooms	0.0416	***	0.0397	***	0.0401	***
Finished Basement	0.0435	***	0.0443	***	0.0441	***
Brick Facing (51% +)	0.0180	***	0.0183	***	0.0202	***
Nb. of Fireplaces	0.0433	***	0.0448	***	0.0445	***
Superior Quality Floors	0.0202	***	0.0188	***	0.0199	***
Hard Wood Staircase	0.0401	***	0.0392	***	0.0434	***
Sup. Quality Kitchen Cabinet	0.0190		0.0239		0.0244	
Inferior Luminosity	-0.0193	***	-0.0186	***	-0.0200	***
Cathedral Ceiling	0.0331	***	0.0334	***	0.0297	***
Central Vacuum	0.0431	***	0.0438	***	0.0452	***
Simple Attached Garage	0.1123	***	0.1101	***	0.0952	***
Double Attached Garage	0.0920	***	0.0933	***	0.0898	***
Simple Detached Garage	0.0320	***	0.0346	***	0.0237	***
Double Detached Garage	0.0586	***	0.0620	***	0.0543	***
Presence of a Terrace	0.0329	***	0.0320	**	0.0197	*
Excavated Pool	0.0908	***	0.0934	***	0.0942	***
Access to Water&Sewage	0.1238	***	0.1216	***	0.1206	***
Local Tax Rate	-0.0756	***	-0.0421	***	-0.0572	***
Year 1991	0.0232	***	0.0101	*	0.0104	**
Year 1993	0.0632	***	0.0420	***	0.0412	***
Year1994	0.0604	***	0.0400	***	0.0392	***
Year 1995	0.0430	***	0.0320	***	0.0321	***
Year 1996	0.0438	***	0.0245	***	0.0250	***
Regional Accessibility Index	0.0535	***	0.0455	***	0.0127	*
Local Accessibility Index	0.0335	***	0.0334	***	0.0214	***
Nb. of Lone-parent Families	-0.0060	***	-0.0088	***	-0.0051	***
Median Household Income	0.0080	***	0.0103	***	0.0102	***
% of University Degree Holders	0.0058	***	0.0040	***	0.0036	***
Endogenous Effects	-		***0.2478***	***	***0.2623***	***
Intercept	8.9648	***	6.1428	***	5.9887	***
Lambda	-		-		***0.9713***	***
N	15,729		15,729		15,729	
R-Squared	0.7666		0.7720		0.7852	
RMSE	0.1564		0.1546		0.1499	
AIC	-13,691.68		-14,055.03		-14,429.40	
Moran's *I*	0.0919	***	0.0446	***	0.0006	*

N.B. :Signif. Level : * p<0.05; ** p<0.01; *** p<0.001.

cio-economic descriptors but excludes endogenous effects which enter the second model (*Model B*). Hedonic prices obtained with either version of the model prove to be consistent in both sign and magnitude and are in line with theoretical expectations. While adding in peer effects modifies the size of some coefficients (local tax rate, time dummies and socio-economic descriptors), implicit prices of housing attributes remain quite stable in the process. Furthermore, the peer effect variable emerges as highly significant. Its inclusion in the equation also substantially lowers the extent of SA present in the residuals, with the Moran's *I* dropping from 0.919 to 0.446.

Turning to *Model C*, obtained with a SEM – as opposed to an OLS procedure, it can be seen that some property descriptors (liveable area, lot size, some garage types, presence of a terrace, local tax rate, accessibility indices as well as the number of lone-parent families) experience a sharper variation in their coefficient magnitude. This said, hedonic prices are, by and large, quite similar under either regression approach. More important though, the marginal contribution to value of endogenous effects, as measured by the peer effect variable, is only slightly affected by the shift in regression procedure. Thus, findings suggest that roughly 25% of mean house price in the neighbourhood is captured in the market value of any home. As can be seen from Table 1 statistics, the SEM procedure yields slightly better model performances than the OLS one. However, it clearly outperforms the latter with respect to handling SA in the residuals, as the Moran's *I* drops to a mere 0.0006 while displaying a sharp fall in statistical significance.

3.5 Conclusion on Peer Effect Models Applied to Property Valuation

This research suggests that peer effects do act as a significant determinant of property values. Furthermore, when used in combination with exogenous attributes in the hedonic price equation, they prove quite efficient at reducing the extent of spatial dependence in the model residuals.

Finally, even where a spatial autoregressive procedure is applied so as to explicitly account for spatial autocorrelation influences, the peer effect variable parameter still emerges as being highly significant and contributes to lessen SA still further.

This said, further research is still needed to address the submarket optimal size issue. Indeed, one may question the relevance of using only seven submarkets as a basis for measuring peer effects and wonder about the impact of designing smaller, and more numerous, spatial segments on peer effect influences. In order to assess the sensitivity of peer effect model results with respect to submarket delimitation, Model B has been re-estimated using seventeen (17), as opposed to seven (7), submarkets. As a consequence, the regression coefficient of the endogenous variable undergoes a sharp decrease, dropping from 0.2478 to 0.1066 while still remaining statistically significant at the 0.001 level. Whether increasing the number of submarkets *necessarily* lessens the explanatory contribution of peer effects to house value cannot be determined at this point and calls for further investigation.

4. Hedonic Modelling and Rent Setting Strategies in Shopping Centers[12]

The residential sector is not the only one to potentially benefit from hedonics from a risk-management perspective. In the case study that follows, we show how the hedonic price (HP) method may be applied to handle the rent setting process in shopping centers, thereby helping owners and managers of retail property assets to improve financial performance and contain the risk associated with tenant mix strategies.

4.1 Retail image, Store Brand and Chain Affiliation

Over the past decades, several authors have studied the determinants of shopping center rents with respect to a large array of issues. One of these is *retail image* (Houston and Nevin, 1981; Mazursky and Jacoby, 1986; Ghosh, 1990; Osman, 1993; Bloemer and De Ruyter, 1998; Birtwistle*et al.*, 1998; Newman and Patel, 2004) which results from the highly complex combination of several store and/or shopping center attributes (Houston and Nevin, 1981; Mazursky and Jacoby, 1986). Marketing strategies are also shown to boost shopping center image (Grewal*and al.*, 1998) while positively affecting sales level (Brown, 1992; Kirkup and Rafiq, 1994; Anikeeff, 1996).

Looking at neighbourhood center image, Hardin and Wolverton (2000 &2001) find that anchor store brand only appears to affect nonanchor-store rents upward where primary trade area purchasing power is excluded from the model, thereby suggesting that neighbourhood center image simply reflects the consumer market the anchor chain chooses to serve. Their work on the impact of micro-market attributes on retail rent rates also corroborates that of Hardin *et al.* (2002) on community shopping centers and suggests that primary trade area purchasing power as well as the presence of nearby higher order shopping nodes do exert a significant, positive influence on rent levels. As for Hardin and Carr (2006), they highlight the detrimental effect that lower-income households living in the vicinity of a community center exert on its rent rates.

So far, few studies have focused on the impact of *chain affiliation* on shopping center rent levels. According to Benjamin *et al.* (1992), tenants with a national affiliation as well as local chain stores seem to experience a lower level of risk because of their higher creditworthiness, operational experience and traffic enhancement potential. Mejia and Benjamin (2002) state that shopping center owners have aclear preference for acknowledged retail chains due to their stronger attraction power, greater financial stability and better profitability compared with independent stores. According to Golosinski and West (1995), the latter tend to rely on chain stores' attraction for boosting their sales. Authors also bring out the fierce competition for shopping center space that chain stores must face, which often results in an upward pressure on unit rents.

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[12] The material developed in this section is drawn from a recent presentation at the American Real Estate Society (ARES) 27th Annual Meeting, Seattle, Wa., April 13-16, 2011 (Des Rosiers *et al.*, 2011-b).

Preliminary findings by Des Rosiers *et al.* (2008) also suggest that prestige stores tend to command rents that are significantly higher than those assigned to standard outlets, with the rent premium ranging from 10.6% to 13.9%.

This section summarizes recent work by Des Rosiers *et al.* (2008 and 2011-b) and investigates whether, and to what extent, *chain affiliation* within regional and super-regional shopping centers affects store rent levels. The impact of *store prestige* on rents is also assessed, in light of previous research by Hardin and Wolverton (2000 & 2001), Hardin *et al.* (2002) and Hardin and Carr (2006) on the impact of micro-market attributes on retail rent rates. In this case study, international, national, provincial as well as local chains are considered together with independent stores.

4.2 Database, Variable Design and Analytical Approach

Eleven regional and super-regional shopping centres located in Quebec City (5) and Montreal (6), Canada, are being used in this research, totalling some 6.9 million square feet of gross leasable area (GLA). Six centres are central establishments while the remaining five ones are located in suburban areas. Only non-anchor stores are considered in the study while storage space is excluded from the analysis. Once filtered, the database consists of 1,477 valid leases (836 for Quebec City as opposed to 641 for Montreal) running over the 2000-2003 period. Detailed information is available on both the shopping centre itself (location, age, type and dates of renovations and additions to main building) and individual stores (GLA, retail category, base and percentage rent, lease duration). Thirty retail categories are distinguished and used as dummy variables. A trend variable is also included in the model together with a GLA-based index of retail concentration – whose value may stand anywhere between 0 and 1 - computed for each retail category and each shopping center (Des Rosiers *et al.*, 2009).

As for *chain affiliation* influence, it is accounted for through tailor-made variables based on available information allowing to properly identify international, national, provincial (used as the reference where relevant) and local chains, together with independent stores. A *store level-of-prestige descriptor*(low and high level of prestige) was also designed on the same grounds. Finally, the issue raised by Hardin and Wolverton (2000 & 2001), Hardin *et al.* (2002) and Hardin and Carr (2006) with regard to the impact of micro-market attributes on retail rent rates is also addressed. In order to test whether the socio-economic profile of nearby residents accounts for the rent premium assigned to prestige stores, a *standardized economic potential index* (Stdz EPI) combining the mean yearly personal income of the local working population with the actual customer volume for each retail establishment was computed for each shopping center and included in the model as a rent determinant[13].

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[13] The EPI was computed based on the 2001 Canadian census data and on information from extensive origin-destination (O-D) surveys conducted by public transit authorities for Quebec

Descriptive statistics (not shown here) show that some 79% (1,173) of retail outlets belong to a chain, with the remaining 304 shops (21%) being independent stores. As for the prestige dimension, low- and high-prestige stores are equally represented in the sample, each category accounting for 15.5% of all outlets.

Regression models are calibrated using a log-linear functional form, with the natural logarithm of base rent (Ln_BaseRent) being used as the dependent variable. A similar transformation is also applied to the store size (GLA) variable, considering its skewed distribution.

In its final formulation, the hedonic rent equation can be expressed as follows:

$$\begin{aligned} Ln\_BaseRent = {} & B0 + B1^{*}\, Ln\_Size + B2^{*}\, Age + B3^{*}\, Duration + B4^{*}\, Percent \\ & + B5^{*}\, Time + B6^{*}\, Mix + B7^{*}\, Conc + B8^{*}\, EPI + B9^{*}\, Chain + B10^{*}\, Prest + \varepsilon \end{aligned} \tag{3}$$

where «Size», «Age», «Duration», «Percent», «Time», «Mix», «Conc», «EPI», «Chain» and «Prest» respectively account for store size, shopping center weighted age, lease duration, percentage rent rate, time elapsed since 1971, retail categories, concentration index, standardized economic potential index, chain affiliation and prestige status.

Heteroskedasticity (Breusch-Pagan) and overall comparative performance (Schwartz' Information Criterion, SIC) tests were run on six specifications of the model, with detailed and grouped chain categories being alternately applied to the global sample and to Quebec City and Montreal subsamples. Results show that heteroskedasticity is present, and highly significant, in all six specifications. Consequently, the White (1980) correction was applied to the data[14]. In this paper, only regression results obtained with spatially segmented models calibrated under the grouped chain category specification (*i.e.* single dummy for chain affiliation) are reported in *Table* 2 (*Models A* and *B*).

4.3 Main Regression Findings

Overall explanatory performance (R-squared) reaches 0.625 and 0.695 for Quebec City and Montreal models, respectively. As for predictive performances, as measured through Root MSE statistics, they amount to 0.448 and 0.430, respectively. Such performances are in line with the literature on retail rent models. Finally, both models are free from excessive multicollinearity as most VIF (Variance Inflation Factor) values stand below 2.0, with the largest VIF reaching 4.33.

Unsurprisingly, the GLA variable parameter estimate – expressed as an elasticity coefficient – displays a negative sign and suggests that each 10% increase in

City (2001 survey) and Montreal (2003 survey), in cooperation with the Quebec Ministry of Transport (MTQ).

[14] Referred to as the « sandwich estimator of variance » procedure in the *Stata* software, the correction consists in adjusting the variance-covariance matrix, as suggested by White (1980).

Table 2. Regression Results – Impact of Chain Affiliation and Store Prestige on Shopping Center Rents.

Model A **- Quebec City model with grouped chain store categories (References: Men's Clothing, Not a Chain Store, Neutral Level of Prestige)**				**Dependent variable : Ln_BaseRent**	***Model B*** **- Montreal model with grouped chain store categories (References: Men's Clothing, Not a Chain Store, Neutral Level of Prestige)**			
Regression Coefficient	***t* test**	**Prob.**	**VIF**	**Independent Variables**	**Regression Coefficient**	***t* test**	**Prob.**	**VIF**
6.8195	24.69	***		Intercept	5.9410	15.99	***	
-0.4045	-14.42	***	2.26	Ln_Gross Leaseable Area (sq.ft.)	-0.4100	-15.60	***	2.42
-0.0103	-3.17	**	2.10	Shopping center weighted age	-0.0092	-2.67	**	3.24
0.0148	2.29	*	4.23	Lease duration, in years	0.0091	1.35		3.19
1.1215	1.82	(sig. 0.10)	1.71	Percentage Rent Rate	5.9532	3.97	***	1.93
0.0035	0.53		4.33	Time elapsed since Jan. 1971, in years	0.0171	2.42	*	2.95
0.3003	2.74	**	1.20	Camera and Photographic Supplies Stores	0.1509	1.19		1.2
0.4716	3.29	***	1.08	Beer, Wine and Liquor Stores	0.9165	4.75	***	1.21
0.3924	3.32	***	1.20	Optical Goods Stores	0.2314	1.76	(sig. 0.10)	1.29
0.1236	1.67	(sig. 0.10)	3.63	Women's Clothing Stores	-0.0159	-0.22		3.34
0.0140	0.13		1.24	Children's and Infants' Clothing Stores	-0.1593	-1.11		1.22
0.3002	3.51	***	1.30	Family Clothing Stores	0.0488	0.41		1.69
0.3216	2.52	*	1.38	Clothing Accessories Stores	0.2586	1.77	(sig. 0.10)	1.27
0.1914	2.31	*	2.13	Other (Unisex) Clothing Stores	0.0370	0.43		1.97
0.0764	0.92		2.04	Shoe Stores	0.0373	0.44		2.12
0.2536	1.88	(sig. 0.10)	1.25	Luggage and Leather Goods Stores	0.1276	1.01		1.35
-0.0258	-0.16		1.23	Sporting Goods Stores	0.0790	0.57		1.32
-0.0462	-0.42		1.21	Hobby, Toy and Game Stores	-0.0465	-0.37		1.19
-0.3614	-2.54	*	1.20	Sewing, Needlework and Piece Goods Stores	-0.9520	-6.50	***	1.13
0.4570	2.77	**	1.28	Gambling Industries	0.6520	3.02	**	1.47
0.0042	0.02		1.13	Full-Service Restaurants	0.0254	0.12		1.12
0.1498	1.61		3.40	Limited-Service Restaurants (Fast Food)	0.0668	0.66		3.38
-0.0165	-0.19		1.65	Furniture and Home Furnishings Stores - Gr. 1	-0.1540	-1.92	(sig. 0.10)	1.57
0.0016	0.02		1.29	Electronics and House Appliance Stores - Gr. 2	-0.0855	-0.84		1.43
0.1823	1.28		1.42	Speciality Food Stores - Gr. 3	0.0646	0.43		1.45
0.0018	0.02		1.60	Drug, Health and Personal Care Stores - Gr. 4	-0.0506	-0.57		1.58
0.5353	3.34	***	1.22	Grocery Stores - Gr. 5	0.1705	1.06		1.25
0.2251	2.54	*	1.84	Jewelry and Luggage Stores - Gr. 6	0.1708	1.88	(sig. 0.10)	1.92
0.1860	1.53		1.26	Music and Book Stores - Gr. 7	0.2996	1.52		1.29
-0.2251	-1.13		1.59	Depart. and Discount Depart. Stores - Gr. 8	0.0991	0.61		1.84
0.2784	1.60		1.20	Office Supplies, Stationery and Gift Stores - Gr. 9	0.1523	0.82		1.2
0.4419	2.26	*	1.39	Telecommunications - Gr. 10	0.4476	2.87	**	1.47
0.0869	0.53		1.34	Banking, Fin., Ins. and Real Estate - Gr. 11	0.5878	3.80	***	1.7
-0.1189	-1.06		1.20	Hair, Nail and Skin Care Services - Gr. 12	-0.3717	-2.76	**	1.29
0.0265	0.11		1.16	Travel Agencies - Gr. 13	-0.0555	-0.38		1.17
-0.6598	-2.93	**	1.25	Drycleaning and Footwear Repair - Gr. 14	-0.3601	-1.70	(sig. 0.10)	1.26
-0.3030	-2.95	**	2.83	Concentration Index based on GLA	-0.1776	-1.72	(sig. 0.10)	2.45
-0.0170	***-1.87***	***(sig. 0.10)***	***1.21***	***Stzd. Economic Potential Index***	***0.0291***	***4.52***	***	***3.16***
-0.0489	***-3.17***	**	***1.38***	***Chain Store***	***-0.0598***	***-3.59***	***	***1.67***
-0.0263	***-0.52***		***1.50***	***Low level of prestige***	***-0.0439***	***-0.63***		***1.47***
0.1050	***2.13***	*	***1.33***	***High level of prestige***	***0.1298***	***2.47***	*	***1.48***

*__N.B.__ : Signif. Level : * p<0.05; ** p<0.01; *** p<0.001*

store size results in a 4.1% drop in unit base rent. Structural depreciation, as measured through the building weighted age parameter estimate, stands at roughly 1.0% per year, which is quite realistic. As for the positive contribution assigned to lease duration (between 0.9% and 1.5% per year), it corroborates previous findings by Des Rosiers *et al.* (2008 & 2009) and highlights the fact that part of the business enterprise value generated by long established tenants is captured by landlords through higher rents (Fisher and Lentz, 1990). Findings from segmented models reported in *Table* 2 also bring out some discrepancies between Quebec City (*Model A*) and Montreal (*Model B*) with respect to the rent setting mechanism in shopping centers. In particular, percentage rent rate is shown to impact heavily on unit base rent in Montreal whereas it proves to be much weaker for Quebec City's retail establishments where the formula is being used more sparingly. Furthermore, the trend variable (Time elapsed since January 1st, 1971) emerges as being statistically significant in Montreal - with a 1.7% yearly contribution on base rent – while it is not in Quebec City.

Looking at retail category coefficients –whose interpretation should be made in relation to men's clothing outlets, used as the reference , most significant and positively signed ones characterize *higher order* goods and services, as defined by Yuo *et al.* (2004). Categories such as "Beer, wine and liquor stores", "Gambling industries", "Banking finance, insurance and real estate" as well as "Telecommunications" are assigned rent premiums (92%, 65%,59% and 45%, respectively, for Montreal establishments) in line with their strategic location, hence profitability, within shopping centers. Other higher order categories which impact significantly on retail rents include: camera and photographic supply stores; optical goods stores; family clothing, clothing accessory and unixex clothing stores; grocery stores as well as jewelry and luggage stores. Higher order categories though impact differently on shopping center rents depending on the submarket considered. For instance, whereas Quebec City establishments benefit from a substantial rent premium (54%) from grocery stores, this is not the case for Montreal centers (17%). The reverse applies to banking and related financial services which generate an excess rent of 59% in Montreal, as opposed to only 9% in Quebec City.

As for *lower order* goods and services, they command negative contributions to rent and include categories such as: sewing, needlework and piece goods stores; hair, nail and skin care services; dry cleaning and footwear repair stores. Here again, discrepancies between Quebec City and Montreal shopping centers are brought out in the analysis. In the first case for instance, the rent discount assigned to Montreal premises (-95.2%) greatly exceeds the one which prevails in Quebec City centers (-36.1%). The reverse is observed for dry cleaning and footwear repair stores. Finally, while *retail concentration* exerts, as expected, a negative influence on retail rents in both subsamples, the magnitude (-0.303) and statistical significance of its coefficient is higher in Quebec City shopping centers, characterized by a lower level of competition among tenants of a given retail category.

This said, the main focus of this research rests with the last four items of Table 2. Firstly, while the *standardized EPI* parameter estimate pertaining to Model A (Quebec City) is negative in sign – a counter-intuitive finding , its statistical significance is too weak for any firm conclusion to be drawn from it. In contrast, the one obtained with the Montreal subsample (Model B, 0.029) is significantat the 0.001 level and in line with theoretical expectations. Secondly, both subsamples yield negative chain store parameters that are highly significant. Thus, regression results suggest that, once controlled for micro-market factors, *the rent discount* *granted by landlords to chain-affiliated outlets ranges from 4.9% (Quebec City) to 6.0% (Montreal)*. Thirdly and finally, the rent premium assigned to high-prestige stores proves to be substantial in spite of the introduction in the analysis of the socio-economic dimension. Based on this research, *the high-prestige rent premium stands at 10.5% for Quebec City shopping centers while it reaches 13.0% for Montreal retail establishments*.

4.4 Chain Affiliation, Prestige and Shopping Center Rents – Concluding Comments

This research, based on financial data from eleven regional and super-regional shopping centers located in Montreal and Quebec City, Canada, aims at testing whether and to what extent, chain affiliation significantly affects retail store rent levels. It also addresses the question as to whether store prestige has any impact on the latter.

Findings suggest that, even when micro-market influences are accounted for, chain-affiliated stores are granted a rent discount by landlords amounting to 4.9% and 6.0% in Quebec City and Montreal establishments, respectively. Thus, as argued by Mejia and Benjamin's (2002), shopping center owners tend to favour chain-affiliated tenants in their retail mix strategy due to their financial stability and higher profitability and because they benefit from a greater clientele attraction power in comparison with non-affiliated stores.

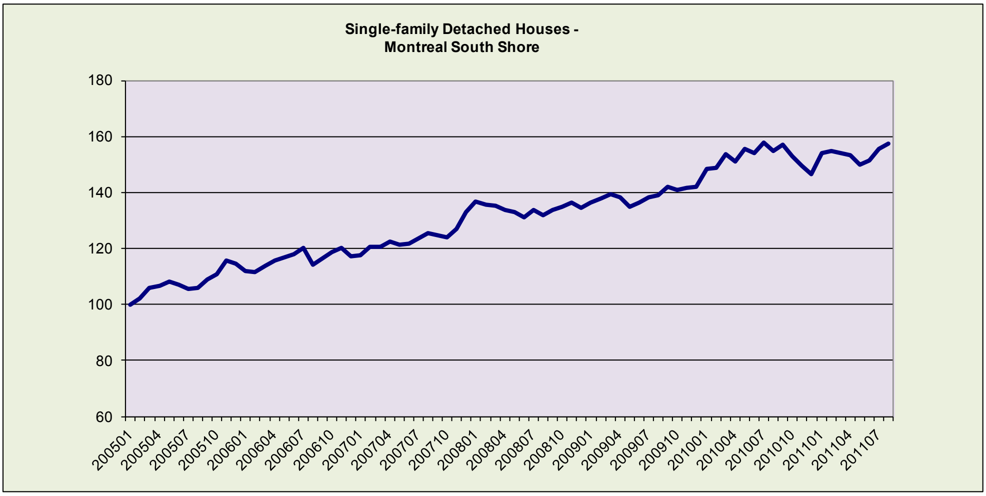
Findings also suggest, in contrast to Hardin and Wolverton's (2001) work, that prestige tenants are willing to pay a substantial rent premium (namely10.5% and 13.0% in Quebec City and Montreal, respectively) in order to find an adequate location within major shopping centers, even where the socio-economic dimension is accounted for. In summary, whereas chain affiliation enhances tenants' bargaining power, high-prestige stores' pull potential is shared among landlord and tenants.

5. Overall Conclusion - Hedonic Modelling and Asset-Risk Management

While the two applications presented above are quite typical of the use made of the hedonic price method in property research, its applicability to real estate asset-risk management issues has rapidly developed in recent years as a consequence of the market uncertainty climate which prevails since the 2008 financial crisis. In that regard, the latter has led to conflicting attitudes with respect to asset – and debt – management practices. On the one hand, it has exposed numerous flaws in the financial markets, among which some shortcomings of using fair value – or mark-to-market accounting as the standard for valuing and reporting financial assets, primarily loans and debt securities, held by financial institutions (PwC, 2009). While most adequate when markets function normally, fair value accounting operates in a procyclical way during illiquid markets, thereby generating volatility in the system. Since banks must write down assets to reflect current market values, selling undervalued assets in order to increase capital tend to feed the downward spiral of asset prices, thereby triggering further writedowns. Furthermore, when transactions are scarce – or inexistent , *implied*, hence subjective and potentially unreliable, market values are estimated through valuation models.

On the other hand, the need for asset-risk management devices has never been so acute and several financial, as well as non-financial, institutions have already developed hedonic-based valuation tools or are contemplating doing so. In Canada, Genworth Financial Canada, the leading private sector supplier of mortgage default insurance, has been using AVM models based on the HP method for several years. Public bodies such as Statistics Canada, the Canadian Mortgage and Housing Corporation (CMHC) as well as the Bank of Canada are also thinking about resorting to hedonics for building residential price indices for Canadian metropolitan areas. Finally, following the City of Vancouver, a new hedonic-based house price index is being tested on Montreal and should eventually be applied nationwide. A preliminary version of the index for the Montreal South Shore area and for single-family detached houses is provided in *Figure 2*.

Figure 2. House Price Index for Single-Family Detached Houses – Montreal South Shore, 2005-2011.



Source: The Altus Group, November 2011.

The growing availability of quality property databases over the past decades has triggered the development of asset-risk management tools for the real estate sector based on statistical methods and econometric modelling. In that respect, the hedonic approach is of prime importance considering its versatility and reliability in estimating property values.

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Bibliography

Akerlof George A. (1970). The Market for 'Lemons': Quality Uncertainty and the Market Mechanism. *Quarterly Journal of Economics*, 84(3): 488–500.

Anikeeff M. (1996). Shopping Center Tenant Selection and Mix: a Review, in J. Benjamin, ed., *Research Issues in Real Estate*, Vol. 3: Megatrends in Retail Real Estate, Norwell : Kluwer Academic Publishers.

Anselin L. and Griffith D.A. (1988). Does Spatial Effects Really Matters in Regression Analysis, *Papers of the Regional Science Association*, 65(1): 11-34.

Anselin L. and Rey S. (1991). Properties of Tests for Spatial Dependence in Linear Regression Models, *Geographical Analysis*, 23: 112-131.

Arestis P. and E. Karakitsos (2009). Subprime Mortgage Market and Current Financial Crisis, *CCEPP WP08-09*, Cambridge Centre for Economic and Public Policy, Department of Land Economy , University of Cambridge, 16 pages.

Asch S. (1956). Studies of Independence and Conformity: A Minority of one Against a Unanimous Majority, *Psychological Monographs*, 70: 416.

Becker G. and Becker G.N. (1998). *The Economies of Life: From Baseball to Affirmative Action to Immigration, How Real-World Issue Affect Our Everyday Life*, McGraw-Hill.

Benjamin J. D., Boyle G. W. and Sirmans, C. F. (1990). Retail Leasing : Determinants of Shopping Center Rents, *AREUEA Journal*, 18(3): 302-312.

Benjamin John D., Boyle Glenn W. and Sirmans C. F. (1992). Price discrimination in shopping center leases. *Journal of Urban Economics*, 32:3, pp. 299-317.

Birtwistle G., Clarke I. and Freathy P. (1998), Customer decision making in fashion retailing: a segmentation analysis. *International Journal of Retail & Distribution Management*, 26 (4), pp.147-154.

Bitter C., Mulligan G.F., Dall'Erba S. (2007). Incorporating spatial variation in housing attribute prices: a comparison of geographically weighted regression and the spatial expansion method, *Journal of Geographical Systems*, 9: 7-27.

Bloemer Josée, De Ruyter Ko (1998). On the relationship between store image, store satisfaction and store loyalty. *European Journal of Marketing*, 32(5/6), pp.499-513.

Brown Stephen (1992). Tenant mix, tenant placement, and shopper behaviour in planned shopping centre. *The Services Industries Journal*, 12(3), pp. 384-403.

Byrne P., P. McAllister and P. Wyatt (2010). Reconciling Model and Information Uncertainty in Development Appraisal. *Working Papers in Real Estate & Planning 03/10*, School of Real Estate &Planning,Henley Business School, University of Reading, 27 pages.

Can A. (1990). The Measurement of Neighborhood Dynamics in Urban House Prices, *Journal of Economic Geography*, 66(3): 254-272.

Can A. and Megbolugbe I. (1997). Spatial Dependence and House Price Index Construction, *Journal of Real Estate Finance and Economics*, 14(1-2): 203-222.

Casetti E. (1986). The dual expansion method: An application for evaluating the effects of population growth on development. *IEEE Transactions on Systems, Man, and Cybernetics*, 16: 29-39.

Coleman J.S., Campbell E.Q., Hobson C.J., McPartland J., Mood A.M., Weinfeld F.D. and York R.L.. (1966). *Equality of Education opportunity*. Washington, D.C.: U.S. Government Printing Office.

Des Rosiers F. and M. Thériault (1996). Rental Amenities and the Stability of Hedonic Prices: A Comparative analysis of Five Market Segments, *Journal of Real Estate Research*, 12(1): 17-36.

Des Rosiers F., M. Thériault and L. Ménétrier (2005). Spatial Versus Non-Spatial Determinants of Shopping Center Rents : Modeling Location and Neighborhood-Related Factors, *Journal of Real Estate Research*, 27(3): 293-319.

Des Rosiers F., M. Thériault, Y. Kestens and P-Y. Villeneuve (2007). Landscaping Attributes and Property Buyers' Profiles: Their Joint Effects on House Prices, *Journal of Housing Studies*, 22(6): 945-964.

Des Rosiers F., Thériault, M. and Gagné M-È. (2008). « Retail Store Affiliation and Prestige and Their Impact on Shopping Center rents - A Case Study", *Working Paper # 2008-013*, Faculty of Business Administration, Laval University, 15 pages.

Des Rosiers F., M. Thériault and C. Lavoie. (2009). Retail Concentration and Shopping Center Rent: A Comparison of Two Cities, *Journal of Real Estate Research*, **31**(2): 165-207.

Des Rosiers F., J. Dubé and M. Thériault (2011-a). Do Peer Effects Shape Property Values?*Journal of Property Investment and Finance*, 29(4/5): 510-528.

Des Rosiers F., M. Thériault and J. Dubé (2011-b).Chain Affiliation, Store Prestige and Shopping Center Rents - A Canadian Case Study. Paper presented at the American Real Estate Society (ARES) 27th Annual Meeting, Seattle, Wa., April 13-16, 20 pages.

Dominique, C-René (2010). Behind The 2008 Capital Market Collapse, *Journal of Business & Economic Studies*, 16(2): 1-13.

Dominique C-René, L. Eduardo Rivera-Solis and F. Des Rosiers. 2011. Determining The Value-at-Risk in The Shadow Of The Power Law: The Case Of The SP-500 Index. *Journal of Global Business and Technology*, **7**(1): 1-23.

Dubin R.A., Pace R.K. and Thibodeau T.G. (1999). Spatial Autoregression Techniques for Real Estate Data, *Journal of Real Estate Literature*, **7**(1): 79-95.

Duguay Pierre (2009). *Financial Stability through Sound Risk Management*, Risk Management Association, Toronto Chapter, Toronto, Ontario, January 8, 2009.

Fama Eugene (1970). Efficient Capital Markets: A Review of Theory and Empirical Work, *Journal of Finance,*25 (2): 383–417.

Fisher Jeffrey D. and Lentz George A. (1990). Business enterprise value in shopping malls: An empirical test. *Journal of Real Estate Research*, 5(1): 167-175.

Fotheringham A.S., C. Brunsdon C. and M. Charlton (2002).*Geographically Weighted Regression.The Analysis of Spatially Varying Relationships*, Wiley, Chichester, UK, 269 pages.

Fotheringham A.S., Charlton M. and Brundson C.F. (1998). Geographical Weighted Regression: A Natural Evolution of the Expansion Method for Spatial Data Analysis, *Environment and Planning A*, 30(11): 1905-1927.

Ghosh A. (1990). *Retail Management*, 2d ed., The Dryden Press, Chicago, IL.

Grewal D. R., Krishman R., Baker J. and Borin N. (1998). The effect s store name, brand name and price discounts on consumers' evaluations and purchase intentions. *Journal of Retailing*, 74(3), pp. 331-352.

Hallinan M. T. and Sørensen A. (1983). The Formation and Stability of Instructional Groups, *American Sociological Review*, 48: 838-851.

Hardin William G. and Wolverton Marvin L. (2000). Micro-Market Determinants of Neighborhood Center Rental Rates, *Journal of Real Estate Research*, 20:3, pp. 299-322.

Hardin William G. and Wolverton Marvin L. (2001). Neighborhood Center Image and Rents. *Journal of Real Estate Finance and Economics*, 23:1, pp. 31-46.

Hardin William G., Wolverton Marvin L. and Carr Jon (2002). An empirical analysis of community center rents. *Journal of Real Estate Research*, 23:1-2, pp. 163-178.

Hardin William G. and Carr Jon (2006). Disaggregating Neighborhood and Community center Property Types. *Journal of Real Estate Research*, 28:2, pp. 167-192.

Hoesli M. Thion B. and Watkins C. (1997) A hedonic investigation of the rental value of apartments in central Bordeaux.*Journal of Property Research*, 14: 15-26.

Houston M.J. and Nevin J.R. (1981). Retail shopping area image: structure and congruence

between downtown and shopping centres, *Advances in Consumer Research*, 8, pp.677-81.
Hubbard Douglas (2007). *How to Measure Anything: Finding the Value of Intangibles in Business*, John Wiley & Sons, pg. 46.
Ichino A. and Maggi G. (2000). Work Environment And Individual Background: Explaining Regional Shirking Differentials In A Large Italian Firm, *Quarterly Journal of Economics*, MIT Press, 115(3) : 1057-1090.
International Real Estate Exchange Group (2011). *Corporate Brochure*, www.irexgroup.com, 64 pages.
Jud G. D. and D. T. Winkler (1991). Location and Amenities in Determining Apartment Rents: AnInteger Programming Approach, *Appraisal Journal*,59(2): 266–75.
Knight F. H. (1921). *Risk, Uncertainty and Profit*, Chicago: Houghton Mifflin Company, 445 pages.
Kirkup Malcolm and Rafiq Mohammed (1994). "Managing tenant mix in new shopping centers". *International Journal of Retail and Distribution Management*, 22(6), pp. 29-37.
Kummerow Max (2000). Thinking Statistically about Valuations, *The Appraisal Journal*, 68(3): 318-326.
Kummerow Max. (2002). A Statistical Definition of Value, *The Appraisal Journal*, 70(4):407-416.
Kummerow Max. (2006). Protocols for Valuation, *The Appraisal Journal*, 74(4): 358-366.
Manski C. (1993). Identification of Endogcnous Social Effects: the Reflection Problem, *Review of Economic Studies*, 60 : 531-542.
Mazursky David and Jacoby Jacob (1986). "Exploring the development of store images". *Journal of Retailing*, 62(2), pp. 145-163.
Meen D. and Meen G. (2003). Social Behaviour as a Basis for Modelling the Urban Housing Market: A Review, *Urban Studies*, 40(5-6): 917-935.
Mejia Luis C. and Benjamin John D. (2002). What Do We Know About the Determinants of Shopping Center Sales ? Spatial vs. Non-Spatial Factors, *Journal of Real Estate Literature*, 10(1): pp. 3-26.
Nanda R. and Sørensen J.B. (2008). *Workplace Peers and Entrepreneurship*, Harvard Business School, Working Paper # 08-051, 29 pages.
Nevin John R. and Houston Michael J. (1980). "Image as a component of attraction to intra urban shopping areas".*Journal of Retailing*, 56(1), pp. 77-93.
Newman J. Andrew and Patel Darshika (2004). "The marketing directions of two fashion retailers". *European Journal of Marketing*, 38(7), pp. 770.
Osman M.Z. (1993), A conceptual model of retail image influences on loyalty patronage behaviour, *The International Review of Retail, Distribution and Consumer Research*, **3**(2), pp. 133-148.
Pace R.K., Barry R. and Sirmans C.F. (1998a). Spatial Statistics and Real Estate, *Journal of Real Estate Finance and Economics*, 17(1): 5-13.
Pace R.K., Barry R., Clapp J.M. and Rodriguez M. (1998b). Spatiotemporal Autoregressive Models of Neighborhood Effects, *Journal of Real Estate Finance and Economics*, 17(1): 14-33.
Patel Nishkal (2007). *Securitization of Real Estate in Singapore*, Dissertation presented in part of consideration for the Degree of MA in Finance and Investment, Nottingham University, UK., 95 pages.
PricewaterhouseCoopers. (2011). *PwC Worldwide Real Estate Investment Trust Regimes (REIT), Country summaries*, July, 44 pages.
PricewaterhouseCoopers. (2009). *Point of View - A Proposal to Improve Fair Value Accounting*, January, 4 pages.
Rosen S. (1974). Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition, *The Journal of Political Economy*, 82: 34-55.
Sacerdote B. (2001). Peer Effects with Random Assignment: Results for Dartmouth Roommates. *Quarterly Journal of Economics*, 116: 681-703.
Sirmans G. S. and J. D. Benjamin (1989). Determining Apartment Rent: The Value of Amenities, Services and External Factors, *Journal of Real Estate Research,* 4(2): 33–43.
Sirmans G. S. and J. D. Benjamin (1991). Determinants of Market Rent, *Journal of Real Estate Research*,6(3): 357–79.

Sirmans C. F. and Guidry K. A. (1993). The Determinants of Shopping Centre Rents, *The Journal of Real Estate Research*, 8(1): 107-115.

Sortino F. and S. Satchell (2001). *Managing downside risk in financial markets: Theory, practice and implementation*, Butterworth-Heinemann Finance, 2001.

Thériault M., Des Rosiers F., Villeneuve P. and Kestens Y. (2003). Modelling interactions of location with specific value of housing attributes. *Property Management, Special Issue: IRES Part 2,* 21(1): 25-62.

Tyrvainen L. (1997). The amenity value of the urban forest: an application of the hedonic pricing method, *Landscape and Urban Planning*, **37**: 211-222.

Voisin M., J. Dubé, M. Thériault et F. Des Rosiers (2010). Les découpages administratifs sont-ils pertinents en analyse immobilière? - Le cas de Québec. *Cahiers de géographie du Québec,*54(152): 249-274.

Wheaton William C. (2000). Percentage rent in retail leasing: The alignment of landlord – tenant interests. *Real Estate Economics*, 28(2): 185-204.

White H. (1980). A heteroskedastic-consistent covariance matrix estimator and a direct test of heteroskedasticity. *Econometrica,*48: 817-838.

Wolfe S. (2000). Structural effects of asset-backed securitisation ,*The EuropeanJournal of Finance,*6: 353-369.

Yuo T, Shun-Te, Crosby N., Lizieri C. and McCann P. (2004). "Tenant mix variety in regional shopping centres: Some UK empirical Analyses". *University of Reading Business School, Department of Real Estate & Planning*, Working paper series 2004, 29 pages.

Zimmerman D. (2003). Peer Effects in Academic Outcomes: Evidence from a Natural Experiment, *The Review of Economics and Statistics*, 85: 9-23.