(Un-)affordability of Homes From a Resident's Point of View in Two Mid-Sized Canadian Cities 30 Years Apart

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Abstract

A new theoretical criterion of housing affordability is defined as a mismatch between where a resident likes to live if preferences are unconstrained, and where they can afford to live if preferences are budget constrained. This study theorizes and quantifies the compensatory amounts of money to be spent to reduce these mismatches by acquiring unconstrained most preferred attributes' levels of homes. Compensatory amounts are quantified with the predicted implicit prices of almost 3,000 sold single-detached(-like) homes in each of two mid-sized Canadian cities. The analysis predicts approximately one-half of up to 74 respondents in each city in 1987 and 2020 will experience a residential mismatch if they choose their budget-constrained most preferred home. Unaffordable compensatory expenditures are especially predicted for non-managerial or professional workers if they want to afford their unconstrained most preferred attributes' levels of house type and size, house age and exterior finish, basement condition and home renovations, and lot size and garage. Moreover, average predicted compensatory expenditures exceed loans or grants in four past and current public policies in Canada for subsidizing prices of these four attributes or increasing the wealth of homebuyers.

Keywords: residential utility, house price, compensatory expenditure, housing affordability

1. Introduction

How much a resident likes or desires a characteristic or attribute of a home is an expression of their residential preferences. For example, most residents prefer more living space than less living space, a friendly neighbourhood and neighbours rather than unfriendly ones, and accessible location to useful places instead of inaccessible one. A resident's ideal home will have their most preferred attributes, for example, of house type and size, neighbourhood environment and neighbours, and accessibility. The predicament is when a resident cannot choose this available home with most preferred attributes' levels. Even if available, they may be constrained from buying or renting it by their insufficient current income, savings, and assets, including borrowed finances from institutions and/or family, and without scrimping on other necessities of life. They will have to choose a less preferred home, or stay where they are, until they can afford to buy the ideal home or rent it. This will produce a mismatch between where they prefer to live and where they can afford to live.

This study quantifies this mismatch between where people prefer to live and where they are constrained to live, by translating it into a compensating monetary amount for a loss of utility. Operationalization requires a resident's social utilities for attributes' levels of homes in the local real estate market, and their implicit prices in the same place at the same time. These respectively correspond with those of up to 74 respondents and approximately 3,000 single-detached(-like) homes in each of two mid-sized Canadian cities of Saskatoon SK in 1987 and Windsor ON in 2020. After superimposing search prices for new homes on social utilities, a resident can calculate how much more to spend on housing for reducing a mismatch by a specific percentage.

In the end, this study's substantive conclusion is pessimistic from a linear regression analysis of respondents' losses of utility, owing to the sizeable compensatory expenditures needed for affording unconstrained most preferred attributes' levels. Rates of change in losses of utility naturally differ for different-valued compensatory expenditures in 1987 and 2020. They also differ for respondents with managerial or professional occupations, or not. Regardless, current and past public subsidies' amounts do not and did not compensate for predicted price mismatches between residents' most preferred homes' attributes and their affordable ones.

2. Literature Review

Everybody complains about mismatches between attributes of homes where they currently live and where they would like to live: A home may be too big or too small, inconveniently located, or too expensive to maintain or too depreciated to be bothered with (Schwanen & Mokhtarian, 2004). These mismatches will naturally occur through time not only as buildings get older, but also as a resident's needs and desires evolve, for example, through their life course or in response to societal trends. Mismatches will deliberately occur if the current home aligns with future needs and desires. Most relevantly for this study, mismatches will regrettably occur from first day of residence if a resident is constrained from choosing their most preferred home, and they are stressed by their loss of utility from having to do this.

Spending more money will reduce a mismatch between a resident's preferred and affordable homes if this additional expenditure enables acquisition of more preferred attributes, and thereby compensates for a loss of utility. A loss of utility is experienced when a resident cannot afford their unconstrained most preferred attributes' levels of a home, and instead chooses their affordable most preferred attributes' levels. A loss of utility is a percentage difference between a resident's social utilities for these attributes' levels. A compensatory expenditure is a more intuitive amount that they can spend to acquire unconstrained most preferred attributes' levels.

These predicted compensatory expenditures will be useful not only for a resident contemplating spending more on a more preferred home, but also a real estate professional advising them to spend more, or not (Fuster & Zafar, 2016; 2021). Both the resident and the practitioner will know the increase (or decrease) in utility for a home after spending more (or less) on its attributes. A knowledgeable practitioner may then advise about how a resident can personally reduce a mismatch between a preferred and an affordable home within budget. They can exploit savings for attributes' conditions under their control, such as by renovating the home, building an addition or a garage, or planting trees.

Inability to afford these compensatory expenditures is another explanation than unfamiliarity with a new housing market as to why a long-distance mover may move again a short distance (Clark & Huang, 2004): An affordable original home may turn out to be too small etc., until a settled household soon finds a better one. It is also another explanation than social links between residents' lives as to why young people move in and out of the parental home (Coulter, van Ham, & Findlay, 2015): An independent home on a tight budget may be too expensive to maintain or too depreciated to be bothered with, while a return to the parental home provides time to find a replacement.

2.1 Policies for More Affordable Owned Homes in Canada

Together, these two elements of a resident's loss of utility from not affording a home's most preferred attributes' levels, and their predicted expenditure to compensate for this loss of utility, combine as a new theoretical criterion of housing affordability. This new criterion "distinguish[es] between the individual's conception of what is and is not affordable and society's judgement" (Hancock, 1993). It subsumes the normal practical criterion of an affordable home if its occupant consumes more than the minimally acceptable standard of housing within a prescribed amount of their budget (Stephen Ezennia & Hoskara, 2019; Thalmann, 1999). This amount may be measured as a maximum percentage of their current income, such as 30% allocated to housing expenditures. It alternatively may be measured by their minimum (residual) income for housing after subtracting expenditures for other necessities of life (Stone, Burke, & Ralston, 2011). Methodological questions about specifying these percentage or dollar amounts include the economic basis for a particular percentage, or the composition and prices of the necessities of life aside from housing (Meen & Whitehead, 2020).

A theoretical question is about the application of this practical criterion to an established homeowner who perceives unaffordability of housing from their point of view in a mid-sized Canadian city. For example, "middle-income households also find it increasingly difficult to afford housing in central, metropolitan areas with good jobs, transport and cultural facilities. This is not a problem of poverty: they can afford to buy or rent further from the metropolitan centre, but rather indicative of increasing spatial inequalities in access to city resources" (Haffner & Hulse, 2021, p. 70). And, "other homebuyers may be forced to compromise on some dimension of housing services to find a less expensive property. In particular, constrained homebuyers may purchase a smaller home, or a home in a less desirable neighborhood (e.g., lower school quality or longer commute), or some combination thereof" (Park, 2021, p. 347).

Application of a more general criterion of housing affordability than the practical one is furthermore confirmed by subsidies to owners of homes with more preferred attributes' levels than minimally acceptable ones in Canada. Private housing providers and public policymakers have tried to adjust local prices of attributes' levels or amounts of

housing wealth necessary for residents' affording more preferred homes (Careless, 2020; Case, Quigley, & Shiller, 2012; Quigley & Raphael 2004; Varady, 2010).

Examples of the former in Canada include private housing providers' discounting prices of homes in response to reduced development fees and standards, or prospective financial assistance for renovations (Burby, Salvesen, & Creed, 2006). Municipal development fees of approximately $23,000 have been waived for building a new single-detached home in Windsor's inner-city neighbourhoods since 2016 (Pearson, 2016). The Canadian government's residential rehabilitation assistance program has applied to on-reserve housing since 2018. It previously provided forgivable loans up to $16,000 to low-income homeowners for rehabilitating houses lacking basic facilities or in need of major structural, electrical, plumbing, heating, or fire safety repairs (Canada Mortgage and Housing Corporation, 2005).

Examples of the latter in Canada for increasing people's wealth for housing include transferring public funds to homeowners via mortgage payment relief. A provincial program in the province of Saskatchewan, beginning in 1982 for a couple of years until interest rates declined, will have saved a homeowner up to approximately $13,000 in mortgage payments over five years by reducing the annual interest rate to 13.25% for a $50,000 mortgage, for example, down from its fixed rate maximum at 19.5%.

More recently since 2018, the Canadian government's first-time home buyer's incentive program will save $19,000 in mortgage payments over 25 years at 6% annual interest rate, for example, if a participant buys a used home for $200,000 after making a minimum 5% down payment from savings as well as 5% more loaned from the incentive program (Government of Canada, 2018). Coincidentally, a lump sum loan (with deferred repayment until after subsequent sale of the home or the next 25 years) should have a larger effect on residents' willingness to pay for a home than either reduced minimum down payment or reduced annual interest rate for a mortgage (Fuster & Zafar, 2021; Lundy, 2021). Note these public subsidies are summarized as benchmarks for predicted price differences at two different times in two historically affordable real estate markets, and not in advocacy of them.

2.2 Residential Utility and Price Theory

A resident's compensatory expenditure for a loss of utility is formally derived from their unconstrained and budget-constrained utilities and the marginal implicit prices for attributes' levels of homes. Following Phipps (2022a; 2022b), the n^{th} resident is assumed to have a desirability for, or like or dislike of, a j^{th} level of an i^{th} attribute of a home scaled as an unconstrained utility, $u_n^t(x_{ij})$. They will have a corresponding budget-constrained utility for this attribute's level if its price, $p_n^t(x_{ij})$, is less than or equal to their search price for alternative homes at time *t*, $p_n^t(x_{ij^*})$. No utility will be assigned to unaffordable attributes' levels, or at least lower utility than somebody who can afford them. Hence, a home's attributes are evaluated in terms of unconstrained utilities if prices of attributes' levels are affordable,

$$\forall_i \; if \; p_n^t(x_{ij}) \leq \; p_n^t(x_{ij^*}), u_n^t(x_{ij^*}) = u_n^t(x_{ij}) \tag{1}$$

Otherwise,

$$if \; p_n^t(x_{ij}) > p_n^t(x_{ij^*}), \lim_{j^* \to 0} \left(u_n^t(x_{ij^*})\right) = 0 \tag{2}$$

Values of budget-constrained utilities therefore depend upon not only a resident's preferences for homes' attributes' levels but also prices in the local real estate market. Dissimilarities between them will probably always occur due to locally or temporally different residential preferences and prices of homes. Differences between a resident's unconstrained and budget-constrained utilities for an attribute's levels, $u_n^t(x_{ij}) - u_n^t(x_{ij^*})$, will produce a special loss of utility, $\Delta u_n^t(x_{ij^1})$, if the former is the unconstrained most preferred j^1attribute's level, and the latter is the budget-constrained most preferred j^* one.

A resident can 'compensate' for this loss of utility for a j^{th} attribute by paying an amount of money, $\Delta p_n^t(x_{ij^1})$, equal to the difference between the respective prices, $p^t(x_{ij^1})$ and $p^t(x_{ij^*})$, of these unconstrained and budget-constrained most preferred levels of the attribute,

$$\Delta p_n^t(x_{ij^1}) = \; p^t(x_{ij^1}) - \; p^t(x_{ij^*}) \tag{3}$$

A compensatory expenditure is therefore the amount of money to upgrade from a budget-constrained most preferred attribute's level of a home to the unconstrained most preferred one. Operationally, this amount of money is a

difference between marginal prices of these attribute's levels of the J^{th} home at time t that are predicted from its overall sale price in the local real estate market (Des Rosiers, Dubé, & Thériault, 2011; Malpezzi, 2002). These differences in prices between all attributes' levels for a J^{th} home at a particular time may be cumulated for an overall compensatory expenditure,

$$\Delta p_n^t(X_{J^1}) = \sum_{i=1}^{12} \Delta p_n^t(x_{ij^1}) \quad (4)$$

Another partial compensatory expenditure in a resident's mind may be for the attribute needing the most money to compensate for the difference between its unconstrained and budget-constrained most preferred levels' prices,

$$\Delta p_n^t(X_{J^1}) = max_{i=1}^{12} \Delta p_n^t(x_{ij^1}) \quad (5)$$

Amounts of overall compensatory expenditures or 'maximum' ones are functions of not only marginal implicit prices of attributes' levels, but also a resident's utilities for the same attributes' levels as well as their budgets for housing. Different attributes' prices will thus generate different compensatory expenditures, while different residents will experience different ones for the same attributes. For example, compensatory expenditures may be larger for attributes with wide-ranging affordable and unaffordable marginal prices such as those of the house type and size, house age and exterior finish, basement condition and home renovation, and lot size and garage (Malpezzi, 2002).

Compensatory expenditures may also be larger for non-managerial or professional workers who may have similar ways of evaluating attributes' levels even while they are not necessarily lower income residents with lower search prices. Coincidentally, workers who are managerial or professional, or not, have the sole correlated characteristic of respondents with differences in budget-constrained utilities in another study (Phipps, 2022a). Remaining characteristics including gender, age and family composition, and length of residence and knowledge of the housing market are not statistically significantly correlated with utilities for attributes' levels. Consequently, these types of workers' cumulative compensatory expenditures and cumulative utility losses are disaggregated in a linear regression analysis. Regression coefficients predict percentage gains of utility for each compensatory dollar of expenditure from the data in the next section.

3. Methodology

Compensatory expenditures derived from prices of homes' attributes' levels, and losses of utility from not affording unconstrained most preferred attributes' levels, are calculated with three interrelated datasets described in this section. The first dataset contains up to 74 respondents' utilities for homes' attributes' levels in each of Saskatoon SK in 1987 and Windsor ON in 2020. The second dataset has additional data about personal characteristics of respondents and their search prices for a home if they looked for one tomorrow. The third dataset has marginal sale prices of homes' attributes' levels in each local real estate market. (Fuller descriptions of these datasets are in the technical appendix.) Analysis and interpretation of compensatory expenditures are in the next section following this one.

3.1 Experimental Measurement of Utilities for Homes' Attributes

A resident's utilities for homes' attributes are measured for 12 generic attributes including three each of the dwelling unit, represented by its type and size (x_1), house age and exterior finish (x_2), and basement condition and home renovations (x_3); the neighbourhood environment, represented by its lot size and garage (x_4), neighbourhood's landscaping (x_5), and neighbouring homes' types and repair (x_6); the neighbours, represented by their ages, ethnic group and education, and mobility (x_7, x_8 and x_9); and a home's accessibilities to work and retail stores, schools, and parks or waterfront (x_{10}, x_{11} and x_{12}) (Phipps, 1987; 1989; 2021; Phipps & Clark, 1988). Displayed attributes' levels differ slightly between the 1987 and 2020 experiments, as displayed in Table 1. (See also the technical appendix.) These are measured attributes of owned single-detached(-like) homes that may be augmented to apply to rented homes.

Table 1. Attributes' levels of displayed homes, and losses of utility and compensatory expenditures

		Windsor 2020				Saskatoon 1987			
Attributes' Levels[a]		**Predicted house price (2018)**	**Number of respondents with loss of utility**	**Mean loss of utility[b]**	**Mean compensatory expenditure[c]**	**Predicted house price (1986)**	**Number of respondents with loss of utility**	**Mean loss of utility[b]**	**Mean compensatory expenditure[c]**
House Type and Size	Bungalow or one-and-a-half storey house. [With less than 950 sq. ft floor space.] Two bedrooms.	$167,520	9	0%	$0	$62,243	9	37%	$18,812
	Bungalow. [With 1,050 sq. ft. floor space.] Three bedrooms.	$166,185	11	7%	$23,341	$68,980	18	7%	$16,860
	Two-storey house. [With 1,250 sq. ft. floor space.] Three-and-a-half bedrooms.	$192,790	15	1%	$788	$88,750	9	4%	$8,926
	Two-storey house. [Split- or bi-level with 1,400 sq. ft. floor space.] Four bedrooms.	$204,609	10	0%	$0	$89,821	16	4%	$11,883
	Two-and-a-half storey house. [With 1,700 sq. ft. floor space.] Four-and-a-half bedrooms.	$230,811	3	0%	$0	$108,834	12	0%	$0
House Age (and Exterior Finish)	Less than 5 years old. (Brick or stucco exterior finish.)	$276,884	16	0%	$0	$87,893	29	0%	$0
	Between 5 and 30 years old. (Vinyl or wooden siding exterior finish.)	$212,003	5	0%	$0	$72,394	17	4%	$5,470
	More than 30 years old. (Brick or stucco exterior finish.)	$192,790	27	7%	$32,301	$62,591	18	7%	$8,346
Basement Condition and Home Renovations	No basement or a partial one. No [some] central air conditioning and outstanding features if it is newer; or no [some] central air conditioning and major renovations if it is older.	$111,453	1	0%	$0	$66,580	10	20%	$10,376
	An unfinished or partly finished full basement. No central air conditioning and outstanding features if it is newer; or no central air conditioning and major renovations if it is older.	$119,893	12	7%	$70,392	$70,626	4	0%	$0
	An unfinished or partly finished full basement. Some modern features including central air conditioning if it is newer; or some renovations, such as central air conditioning, new wiring, plumbing, windows and roof if it is older.	$192,790	18	4%	$8,586	$72,125	5	4%	$6,809
	An insulated, completely finished full basement. Some modern features including central air conditioning if it is newer; or some renovations, such as central air conditioning, new wiring, plumbing, windows and roof if it is older.	$204,507	10	0%	$0	$79,790	6	1%	$282
	An insulated, completely finished full basement. All modern features including central air conditioning if it is newer; or	$288,761	7	0%	$0	$81,483	34	0%	$0

	central air conditioning and extensive interior/exterior renovations if it is older.								
Lot size (and Garage)	Small, about 400 sq. m. or 30 ft. by 120 ft., and so the house is close to neighbouring houses. (No front driveway or garage.)	$149,993	4	9%	$26,046	$69,570	9	24%	$8,559
	Medium, about 500 sq. m. or 55 ft. by 110ft., and so the house (is separated from neighbouring houses) [has space for a driveway at its side]. (Single attached or detached front garage.)	$177,184	21	3%	$5,929	$74,539	10	1%	$532
	Large, about 700 sq. m. or 60 ft. by 125 ft., and so the house is separated from neighbouring houses. (Double attached or detached front garage.)	$202,085	15	0%	$0	$79,864	38	0%	$0
Landscaping	Newly planted, with sparse shrubs and thin trees.	$137,908	1	0%	$0	$71,810	1	0%	$0
	Maturing, with lawns and some trees and shrubs.	$149,993	12	0%	$0	$72,968	18	2%	$395
	Mature but overgrown and in need of replanting or pruning.	$156,427	7	0%	$0	$74,145	5	0%	$0
	Very mature, with lawns, large trees and dense shrubs.	$163,136	20	0%	$0	$75,341	27	0%	$0
Neighbour-ing Home Types (and Repair)	Almost all single-detached houses with owner-occupiers. (No houses in need of major repair.)	$149,843	21	0%	$0	$69,374	56	0%	$121
	Single- and semi-detached houses with mostly owners and some renters. (Some houses in need of major repair.)	$149,993	6	0%	$0	$72,531	0	0%	$0
	Includes some nearby modern walk-up rented-apartment or owned-condominium buildings. (Quite a few houses in need of major repair.)	$148,649	7	0%	$0	$77,857	0	0%	$0
	Includes some nearby high-rise rented-apartment or owned-condominium buildings. (No houses in need of major repair.)	$158,791	6	0%	$0	$76,150	1	0%	$0
Ages of Neighbours	Youthful single-person households [and mature families]. No children at home.	$167,682	5	0%	$0	$72,986	12	0%	$0
	Middle-aged residents. Elementary school-aged children at home.	$172,789	17	0%	$0	$73,848	29	0%	$47
	Middle-aged residents. Teenaged children at home.	$172,789	15	0%	$0	$74,646	4	1%	$140
	Elderly residents [and older families]. With or without children at home.	$171,069	2	0%	$0	$75,208	4	0%	$0
Ethnic Group and Education of Neighbours	Working people with high-school education. Most are from same ethnic group as you.	$172,687	10	0%	$0	$62,224	13	4%	$5,672
	Working people with high-school education. Most are from different ethnic	$162,630	5	0%	$0	$63,557	10	2%	$5,466

	groups than you.								
	Skilled and white-collar workers with high-school or technical-college education. Most from same ethnic group as you.	$172,789	8	0%	$0	$71,862	20	0%	$0
	Skilled and white-collar workers with high-school or technical-college education. Most are from different ethnic groups than you.	$162,726	12	0%	$0	$73,401	3	0%	$0
	Professional workers with university or college degree. Most are from same ethnic group as you.	$176,384	4	0%	$0	$80,378	18	0%	$0
Mobility of Neighbours	Few neighbours move each year.	$176,279	19	0%	$0	$72,988	47	0%	$0
	Several neighbours move each year.	$172,789	15	0%	$0	$74,025	2	0%	$0
	Lots of neighbours move each year.	$169,367	5	0%	$0	$75,076	0	0%	$0
Stores and Work Access	Within easy driving- or walking-access, up to 10 [15] minutes to major stores and/or work.	$152,933	29	0%	$0	$74,661	46	0%	$0
	Not too far from major stores and/or work, up to 20 [30] minutes by car or bus.	$135,537	8	0%	$0	$73,807	3	0%	$0
	Far from major stores and/or work, at least 30 [up to 60] minutes by car or bus.	$120,121	4	0%	$0	$72,963	2	37%	$1,698
Schools Access	Within 10 minutes walking to a school.	$140,379	27	0%	$0	$74,023	45	0%	$0
	About 20 minutes walking or 10 minutes driving to a school.	$135,537	11	0%	$0	$73,920	2	0%	$0
	Up to 25 to 30 minutes drive or bus ride to a school.	$130,353	3	0%	$0	$73,816	2	0%	$0
(Riverbank) or [Park] Access	(On the Detroit riverbank.) [Down the street to a neighbourhood park.]	$179,549	32	0%	$0	$74,355	41	0%	$0
	(About 10 minutes walking or a few blocks to the Detroit riverbank.) [Within 15 minutes walking or 5 minutes driving to a neighbourhood park.]	$135,537	6	0%	$0	$73,248	4	0%	$0
	Not conveniently close to (the Detroit riverbank) [a park.]	$100,811	3	0%	$0	$72,157	6	12%	$733

[a] Windsor's possible new description of an attribute's level is in parentheses, and Saskatoon's possible alternate description is in square brackets.

[b] Difference between utilities of unconstrained most preferred level and budget-constrained most preferred level if attribute's level is budget-constrained most preferred.

[c] Difference between implicit prices of unconstrained most preferred level and budget-constrained most preferred level if attribute's level is budget-constrained most preferred.

A respondent rated their desirability or like or dislike for up to 18 hypothetical homes composed of combinations of these attributes in two similar conjoint choice experiments in Saskatoon SK in late-1986 and early-1987, and Windsor ON in late-2019 and early-2020. A respondent's unconstrained utilities for attributes' levels of homes are calculated with the non-metric WADDALS conjoint scaling program in the standalone personal computer experiment in 1987 (Takane, Young, & de Leeuw, 1980), or multiple linear regression functions in the online webpage experiment in 2020 (Rosetta Code, 2020). (More information about the computer-interactive measurement of residential preferences is in the technical appendix.)

3.2 Samples of Residents

Respondents in two cities have similar combinations of personal characteristics that are possibly related to their

budgets for housing (Table 2). For example, most of 70 respondents in Saskatoon and 74 respondents in Windsor have numeric search prices measured in dollars in 1987 and classified dollar ranges in 2020 that are in the middle range of their respective observed houses' prices. For example, approximately one-half have a search price less than a middling $90,000 in Saskatoon, or $200,000 in Windsor. Most Windsorites also have a familiarity with the local housing market, as more than two-thirds knew a neighbour who listed a house or property for sale during the past two years, or did this themselves.

Table 2. Summary characteristics of samples of residents

Characteristic	Response[a]	1987 Saskatoon Respondents		2020 Windsor Respondents[b]	
Gender	Male	26	37%	36	49%
	Female or other	44	63%	37	51%
	Total	70		73	
Age	[16 years old and younger] (Children at home)	49	70%	23	34%
	Less than [36] (40) years old	38	54%	40	60%
	Total	70		67	
Owner or renter of current home	Owner	60	86%	46	65%
	Total	70		71	
Length of current residence	Five years or less	51	73%	37	51%
	Total	70		73	
Occupation(s) of wage-earner(s)	Managerial or professional	37	51%	23	33%
	Total	70		70	
Price range for new home if started	Up to [$90,000] ($200,000)	37	53%	27	45%
looking tomorrow in [1987] (2020)	More than [$90,000] ($200,000)	33	47%	33	55%
	Total	70		60	
Knowledge of housing market	I don't know anybody who listed their house or property for sale			20	29%
	I listed and/or I know a neighbour who listed their house or property for sale during the past two years			49	71%
	Total			69	

[a] Windsor's possible new wording for a survey response is in parentheses, and Saskatoon's possible alternate wording is in square brackets.

[b] Windsor's total numbers of respondents exclude those with missing data for a characteristic.

Otherwise, almost equal numbers of them are self-identified male or female, whereas almost two-thirds of them are women in Saskatoon. The latter are members of mature traditional affluent families who recently moved into or might be moving out the current owned home. Approximately one-half or more of each city's respondents are less than 36 or 40 years old; are owner-occupiers, especially in Saskatoon; and have lived in the current home for five years or less. More than one-half of Saskatonians have managerial or professional occupations, in comparison with approximately one-third of Windsor's inner-city respondents. (Selection of respondents is described in the technical appendix.)

3.3 House Prices

After measuring two samples' utilities for attributes' levels, the same attributes' levels' marginal implicit prices are calculated with regression coefficients of a hedonic housing price model of sale prices of almost 3,000 inhabitable single-detached(-like) homes in each city (Phipps, 1987; 2020). Each regression model includes independent

variables representing 12 attributes' levels of displayed homes in each city's conjoint choice experiment. (Analysis of these homes and their attributes is more fully explained in the technical appendix.) Six attributes' levels constructed from MLS and census data in the city of Saskatoon and inner-city Windsor almost exactly correspond with descriptions in the conjoint choice experiments. These are displayed attributes' levels of house type and size, age of construction, basement condition and renovations, lot size and garage, landscaping, and neighbours' mobility (Table 1). Correspondences are more approximate in a second group of five attributes of neighbouring home types and repair, neighbours' ages, ethnic group and education, and accessibilities to schools and parks in Saskatoon or riverbank in Windsor. The least corresponding attribute is work and stores accessibility.

4. Results

Hedonic housing price models predict average cumulative compensatory amounts of $47,373 (in 2020 Canadian dollars) for respondents in Windsor and $21,255 (in 1987 Canadian dollars) for respondents in Saskatoon. These amounts need to be spent on average to afford unconstrained most preferred attributes' levels over budget-constrained most preferred ones; and they are disaggregated in the next subsection. Respondents' corresponding predicted losses of utility for attributes of single-detached(-like) homes are also summarized in the next subsection; they are described in detail in another study (Phipps, 2022a). They cumulate to an average 11% loss of utility for respondents in Windsor, and 23% in Saskatoon if they cannot afford their unconstrained most preferred attributes' levels.

Note that a loss of utility is a percentage difference in utility units along the full 0/'totally disliked' to 5/'totally liked' utility scale in 2020 and a derived -2/'very undesirable' to 2/'very desirable' one in 1987. Neither a loss of utility nor a compensatory expenditure is therefore calculated with the range between a respondent's minimum and maximum utility or price for an attribute's levels. This is because their minimum or maximum utility and price may not equate with an attribute's truly totally disliked or totally liked levels, and least expensive or most expensive levels, respectively.

A multiple linear regression in the second subsection correlates respondents' overall percentage losses of utility with their overall cumulative compensatory expenditures from attributes' levels' price differences (Table 3). This regression model with R-squared of 67% has statistically significant coefficients at 0.1% level for an independent variable and a dummy variable for respondents' overall compensatory expenditures, as well as at 2% level for the sole statistically significant characteristics' variable of managerial or professional occupation or not. These coefficients predict higher compensatory expenditures for zeroing-out average losses of utility than amounts paid by four summarized public subsidies in the introduction.

Table 3. Multiple linear regression of respondents' losses of utility

Variable	Mean	Std. Deviation	Unstandardized Coefficients		t	Significance
			B	Std. Error		
Cumulative loss of utility (%)	17.8%	29.1%				
Managerial or professional occupation (0=No, 1=Yes)	0.47	0.5	-8.195	3.3	-2.5	0.02
Cumulative compensatory expenditure ($000s)	$33.000	$58.270	0.155	0.03	5.4	0.001
Cumulative compensatory expenditure dummy (0=Windsor in 2020, $000s=Saskatoon in 1987)	$12.038	$21.671	0.902	0.08	12	0.001
Intercept			5.656	2.7	2.1	0.04
R-Squared			67%			
Number of observations			113			

4.1 Observed Losses of Utility and Differences in Attributes' Levels' Prices

Predicted losses of utility principally for four attributes cumulate to the average 11% loss for respondents in Windsor, and 23% in Saskatoon if they cannot afford their unconstrained most preferred attributes' levels. For example, 11 respondents in Windsor, or one-quarter of those who can afford the attribute's level, and 18, or one-third of those who can afford it in Saskatoon, will experience average 7% losses of utility if choosing their budget-constrained most preferred bungalow [with 1,050 sq ft. floor space] and three bedrooms – and not choosing their unconstrained most preferred house type and size (Table 1). (Saskatoon's alternate description of attribute's level is in square brackets.) Respondents' respective average price differences are $23,341 and $16,860 between this budget-constrained most preferred house type and size and their unconstrained most preferred levels.

The average compensatory expenditure of $16,860 for house type and size in Saskatoon makes up most of the average overall one of $21,255 between all 12 unconstrained and budget-constrained most preferred attributes' levels for Saskatonians. A second-largest average cumulative loss of utility and compensatory expenditure is for a more-than-30-years-old house (with brick or stucco exterior finish): Respective losses and price differences are 7% and $8,346 for 18 respondents in Saskatoon, or more than one-quarter of those who can afford it; and 7% and $32,301 for 27 respondents, or more than one-half of those who can afford it in Windsor. (Windsor's additional description of attribute's level is in parentheses.)

A third-largest average loss of utility and compensatory expenditure is 24% and $8,559 for 9 respondents in Saskatoon, or one-quarter of those who can afford it; and 9% and $26,046 for four respondents, or one-tenth of those who can afford it in Windsor. These losses and expenditures are for respondents' having a small lot, about 400 sq. m. or 30 ft. by 120 ft., and so the house is close to neighbouring houses (with no front driveway or garage). The compensatory expenditure for 'land' in Windsor exceeds $23,000 mentioned in the introduction as the value of a waived municipal development fee in inner-city neighbourhoods.

On balance, the average overall cumulative compensatory expenditure of $47,373 in Windsor is more attributable to price differences for a fourth attribute's levels of basement condition and home renovations. For example, 12 respondents in Windsor, or one-quarter of those who can afford it, will have a $70,392 average price difference but only an average 7% loss of utility if they have a budget-constrained most preferred unfinished or partly finished full basement, with no central air conditioning and outstanding features if it is newer, or no central air conditioning and major renovations if it is older – as opposed to their unconstrained most preferred one. This predicted compensatory expenditure for their unconstrained most preferred basement condition and home renovations far exceeds the forgivable loan of $16,000 to a qualified homeowner in the Canadian government's residential rehabilitation assistance program. In comparison, four respondents, or less than one-tenth of those affording it in Saskatoon, will have no loss of utility and thus no compensatory expenditure for this attribute's level.

Note therefore averages for four attributes as well as those for eight remaining attributes include small or no losses of utility and price differences for some or all attributes' levels. Many of these however might be produced by an environmental limitation in both cities, mentioned in another study (Phipps, 2022a). This limitation is that narrow ranges of predicted marginal prices for each attribute's levels exclude the same respondents who cannot afford any type of neighbours, neighbourhood, or accessibility. In total, 31 Windsorites, or almost two-thirds of the analyzed sample, and 26 Saskatonians, or almost one-half, have no cumulative losses of utility or compensatory expenditures (Figure 1).

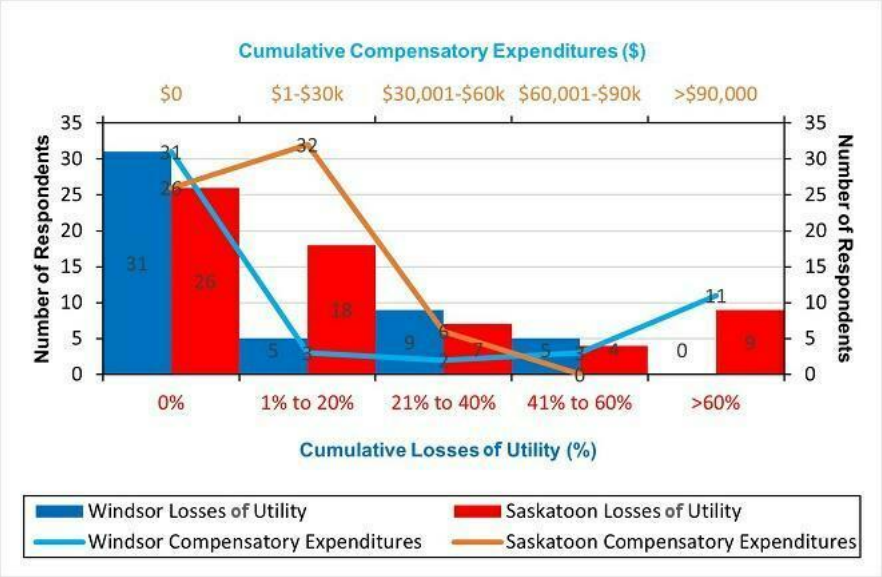

Figure 1. Respondents' classified cumulative losses of utility and compensatory expenditures.

4.2 Predicted Compensation for Losses of Utility by Increased Expenditures

Respondents' losses of utility and compensatory expenditures therefore have positively skewed frequency distributions, but these do not invalidate highly statistically significant linear relationships between the former and the latter (Figure 2). Unstandardized residuals in the multiple regression have an approximately normal frequency distribution; their Durbin-Watson statistic of 2.13 is not statistically significant at 5% significance level for three independent variables and 109 degrees of freedom.

Reciprocals of slope coefficients of 0.155 and 0.9 for cumulative compensatory expenditure and its dummy variable predict respondents can reduce 1% of experienced loss of utility by paying an average compensatory $6,452 in Windsor and $946 in Saskatoon, respectively. Hence, a percentage reduction in loss of utility will have demanded an approximate three-times larger compensatory expenditure for acquiring unconstrained most preferred attributes' levels in Windsor ON in 2020 than Saskatoon SK in 1987. This is the finding after allowing for approximately 220% inflation in the Canadian consumer price index for owned shelter between the two years (Statistics Canada, 2019).

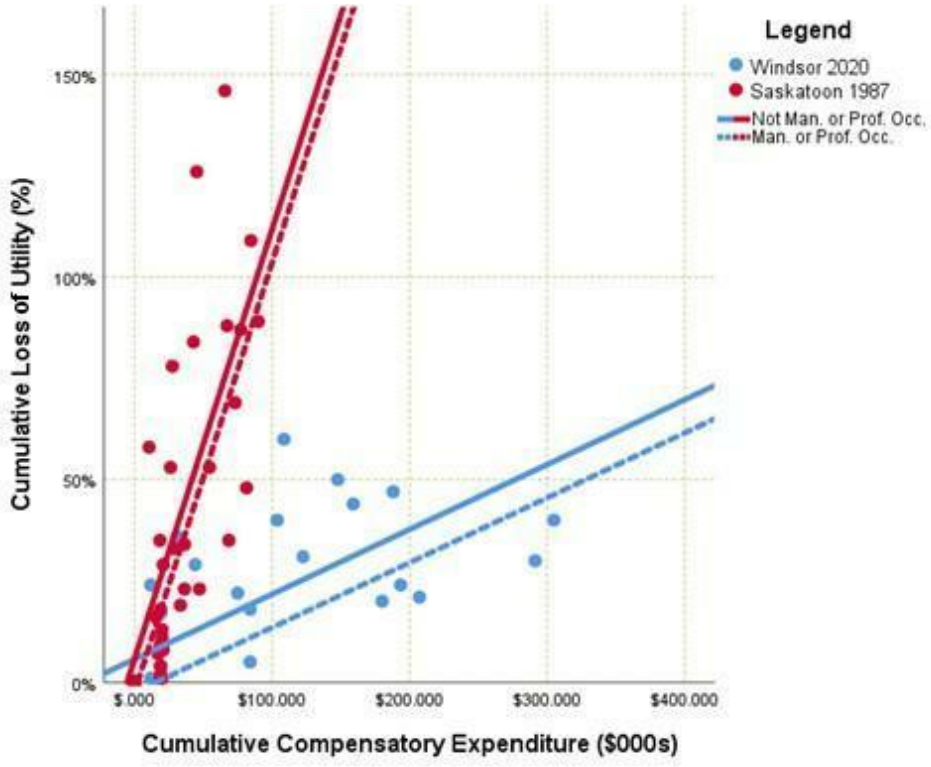

Figure 2. Scatterplot of respondents' cumulative losses of utility

5. Discussion

Linear regression results predict that managerial or professional workers with average 3% and 15% losses of utility in Windsor and Saskatoon will make compensatory expenditures cumulating to $19,355 and $14,191, respectively, for affording unconstrained most preferred attributes' levels rather than budget-constrained most preferred ones. They may afford these by expanding the respective median upper values of their search prices already at $300,000 and $100,000.

In contrast, non-managerial or professional workers in Windsor will pay an average compensatory $109,677 to zero-out their average cumulative loss of utility of 17%; $30,274 and 32% are the former and latter values in Saskatoon. They may only pay these compensatory expenditures with unaffordable expansions of search prices up from their current median upper values of $200,000 and $85,000 in Windsor and Saskatoon, respectively. In other words, their predicted compensatory expenditures are relatively large unaffordable amounts for upgrading to their unconstrained most preferred homes on their own.

The average predicted overall cumulative compensatory expenditure for Saskatonians exceeds the approximate $13,000 in mortgage payment savings during a period of provincial government's subsidization of mortgage interest rates, mentioned in the introduction. Even so, this subsidy for non-managerial or professional workers, similarly to managerial and professional workers, will have enabled them to reduce most or all of their maximum loss of utility (in equation 5) for each of three attributes by paying: either $11,716 for basement condition and home renovations, if no basement or a partial one etc. is budget-constrained most preferred; or $13,424 for house age and exterior finish, if a more-than-30-years-old house is budget-constrained most preferred; or $7,721 for lot size, if a small lot is budget-constrained most preferred. On the other hand, this will not have fully subsidized the compensatory expenditure of $20,247 for non-managerial and professional workers, or that of $22,760 for managerial and professional workers, to reduce their highest loss of utility for attribute's levels of house type and size in Saskatoon.

Indeed, no recent public subsidy will be enough for non-managerial or professional workers in Windsor to afford the unconstrained most preferred levels of any of these four attributes over the budget-constrained most preferred attributes' levels (if everything else stayed the same). Each of their highest average compensatory expenditures of

$27,290 for house type and size, $76,791 for basement condition and home renovations, $31,997 for house age and exterior finish, and $26,046 for lot size and garage, exceeds $19,000 mentioned in the introduction as an example of mortgage savings from the federal government's incentive program for first-time home buyers.

6. Conclusion

This study reaffirms the theoretical and practical necessity of disaggregating a home into its attributes' levels, and then describing those attributes' levels not only with social and environmental characteristics, but also their implicit prices. These detailed attributes' levels' descriptors are for all 12 generic attributes of single-detached(-like) homes, and not just four attributes' causing most losses of utility and compensatory expenditures in two mid-sized Canadian cities in 1987 and 2020. For example, a home's accessibilities may be more salient in larger cities.

The overarching finding is that respondents at two times in two places will have had somewhat different losses of utility and quite different compensatory expenditures if unable to afford their unconstrained most preferred levels especially of four attributes of homes. Predicted compensatory expenditures and losses of utility therefore differ as functions of homes' prices in a local real estate market, and residents' preferences and budgets for those homes.

Nonetheless, a first of four regularities is that unaffordable compensatory expenditures for single attributes will be required by approximately one-half of up to 74 respondents in each of Saskatoon SK in 1987 and Windsor ON in 2020. These potential expenditures are frequently for small losses of utility measured on a conservative percentage scale. Second, average compensatory expenditures will be up to three times higher where single-detached(-like) homes have less affordable wider ranges of attributes' levels' prices in inner-city Windsor than city-wide Saskatoon. Third, unaffordability is probably compounded by the inner-city respondents' individually different social utilities for those attributes' levels in comparison with city-wide recent movers (Phipps, 2021).

Fourth, unaffordable compensatory expenditures are particularly predicted for respondents who are non-managerial or professional workers in Windsor. These workers will need to search in unaffordable higher price ranges for homes having their unconstrained most preferred attributes' levels. They will be unassisted in doing this, as a public subsidy to homeowners in the early-1980s as well as three more recent public subsidies have been lower than predicted average amounts for affording most preferred levels of attributes. Current and past public subsidies' amounts will not compensate for predicted price differences between respondents' most preferred homes' attributes measured with unconstrained residential utilities, and their affordable ones measured with budget-constrained utilities.

In conclusion, the quantification of a compensatory expenditure for a loss of utility will help a resident to know which attributes' levels of homes are causing losses of utility and compensatory expenditures, and then how much to forfeit to reduce a mismatch between preferred and affordable attributes' levels. These compensatory expenditures therefore synthesize budget-constrained utilities and prices of homes' attributes as a new theoretical criterion of housing affordability from a resident's point of view in a particular place at a particular time, as recommended by Hancock (1993). The required data and calculations of this new criterion's elements have been explained. It however has not been answered whether a resident will willingly pay a compensatory amount for reducing loss of utility between preferred and affordable attributes' levels, such as via a survey question (cf. Fuster & Zafar, 2016). Moreover, observed values may underestimate the compensatory amounts to be paid nowadays by a resident, as they are for two affordable places to live in Canada during the 1980s – with Windsor still in that class in late-2019 and early-2020, whereas Saskatoon was less so (Meen & Whitehead, 2020).

Meanwhile, personal innovations may be learned for reducing mismatches between preferred and affordable homes, under the assumption that policymakers will not spend more to reduce losses of residential utility of private homeowners. Respondents' largest losses of utility and compensatory expenditures in both 1987 and 2020 are for the same four attributes of the dwelling's house type and size, house age and exterior finish, and basement condition and home renovations, and its lot size and garage. These four attributes' conditions are coincidentally controlled by a homeowner or house builder who may more practically change their affordability than other social or locational attributes. A resident may utilize their own labour, skills, and materials for more affordable exterior and interior home renovations (Wilson & Kashem, 2017). Mismatched attributes' levels may initially be tolerated for house type and size, and basement condition and home renovations, if the losses of utility can be reduced by a future addition or improvements, respectively. Alternatively, mismatches that they personally cannot alter through time for attributes' levels of house age and lot size, may be minimized from the beginning if housing providers pass along savings to them. House builders may buy land from a municipal land bank such as in Saskatoon for more affordable residential lots (Davis, 1976). This study's predicted compensatory expenditures for recent movers or inner-city residents have been large enough since at least 1987 to justify such innovations in the provision of affordable housing.

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Competing interests/conflict of interests

The author declares that they have no competing interests.

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Technical appendix

These fuller descriptions of this study's utility, price and respondents' data are based on those in three published articles (Phipps, 2020; 2022a; 2022b).

Two study areas

Saskatoon SK and Windsor ON were similar mid-sized Canadian cities during the late 1980s, even though they are 2,500 km apart. They each had a population of approximately 190,000, though this does not include Windsor's surrounding half-as-large-again metropolitan area. Their economies were dominated by blue-collar private sector jobs in resource extraction of potash and agricultural processing in Saskatoon and automotive manufacturing and assembly in Windsor, and white-collar public sector jobs in a university and hospitals in both. Approximately three-quarters of their housing stocks in 1986 were single-detached and semi-detached homes like those displayed in the experiments. Their affordable house sale prices in 1986 predicted by the hedonic housing price models had examples of approximately $54,000 in the city of Saskatoon, and $36,000 in inner city Windsor for a three-bedroom bungalow with all other average dwelling unit, neighbourhood and accessibility attributes.

Residential attributes

The approach was similar for (re-)confirming the attributes of houses and neighbourhoods, and their appropriate levels in two study areas. First, Multiple Listing Service (MLS) real estate catalogues of single-detached(-like) homes for sale are examined to determine the attributes perceived by local realtors to be important in discriminating between houses in the market. Second, these attributes are supplemented with neighbourhood-oriented ones derived from small-area data in the most recent national censuses. And finally, personal knowledge of the researcher and other housing professionals about local housing environments refine the selected sets of attributes. Selected attributes omit irresistibly preferred ones such as a crimefree or tidy neighbourhood, and rare ones such as an isolated or exotic location. They also do not portray the details of a home for which preferences may fluctuate even more than generic attributes in response to faddish marketing or superstitions (Poologasingam & Perera, 2021). Undescribed details include the dwelling unit's room layout and finishing except where implied in the condition of home; and marginal value-adding attributes such as presence of a fireplace, and more than one bathroom.

Otherwise, levels of lot size and garage, landscaping, and neighbouring home types and repair describe the conditions of the 20-or-so properties that are visible down the street. The neighbouring home types portray not only their types of owner or renter occupants but also the structural types of single-detached houses or apartment or condominium buildings. The generalized compositions of familiar neighbours are represented by their household members' ages, ethnic group and education, and mobility. Three accessibility attributes locate homes with respect to work and stores, schools, and the waterfront or parks. Distances and travel times represent those in relatively compact urban areas, within which most intra-city travel by car requires one half-hour or less.

Computer-interactive measurement of residential preferences

Additional images of screen input and output of the human-computer simulation game, and the subsequent online housing survey project are in another study (Phipps, 2022b). A respondent 'played' the simulation game at home on an IBM portable personal computer, with an experimenter present for one hour or longer. The simulation game was computer-programmed from scratch; so too was the online project for eliciting residential preferences in Windsor via the internet. A participant was asked to budget up to one-half hour for browsing webpages in a modern internet browser, and without assistance of or motivation from an experimenter.

A respondent in the first stage of the simulation game indicated their desirability for eighteen combinations of attributes' levels describing dwelling units, fifteen neighbourhoods, twelve neighbours' compositions, and ten accessibilities to work, schools and other facilities. A respondent in the online project rated 12 similarly composed homes. Each home is represented in a first screen or tabbed display by levels of three attributes of the dwelling unit; in a second screen or tabbed display by three attributes' levels of the neighbourhood environment; and so on for three attributes' levels of the neighbours and three of the home's accessibilities. Combinations of attributes' levels for homes are programmed as realistic ones but comprehensive ones; and homes are displayed in random order.

A cosmetic difference between the simulation game and the online surveying project is the latter's automatic slideshow of stock photographs to portray idealized attributes' levels of each displayed home. A more substantive difference is for slightly different displayed attributes' levels of local environments between the 1987 and 2020 experiments, including the replacement of the attribute of access to a park with the more salient access to the riverbank in Windsor's inner-city neighbourhoods. Another substantive difference is in the subsequent scales of measured utilities because a Saskatoon home's desirability is rated on a line scale; while a Windsor home is rated

with between zero and five stars, at half-star increments with labels of totally (dis-)like it, very much (dis-)like it, quite (dis-)like it, somewhat (dis-)like it, and neither like nor dislike it. A respondent in the simulation game rated the desirability of each description by moving the cursor along a continuous 0-to-100-line scale. The desirability scale was approximately 150 mm long, and labelled at the zero end by very undesirable, undesirable at the 25-point, indifferent at the 50-midpoint, and desirable and very desirable at the 75- and 100-points. This line scale design was used consistently throughout the simulation game, with different labels depending on the question. Ratings' data from the experiments will be quite comparable when respondents utilized five labelled points on the simulation game's line scales.

A respondent's utilities for attributes' levels of homes are calculated during each experiment. Their conjoint rating data in the simulation game were decomposed by a compiled redimensioned version of the non-metric WADDALS conjoint scaling program, written in Fortran for originally executing on a mainframe computer (Takane, et al., 1980). The experimenter's presence helped to divert attention from the program's delayed turnaround time for calculating utilities from ratings on the portable PC. Under the assumption no delay is tolerated in an online survey, a respondent's conjoint rating data in the online project were analyzed with three functional procedures written in JavaScript for calculating intercept and slope coefficients of a multiple linear regression (Rosetta Code, 2020). While using dummy independent variables for attributes' displayed levels, utilities are calculated for predicting the like or dislike of each displayed home; and the prediction was instantaneously displayed beside the observed like or dislike of it.

Respondents

Seventy residents in the Saskatoon sample were recruited by means of 280 letters of invitation to newly listed owner-occupants in the annual city directory. The second sample's 74 respondents are residents of Windsor's four inner-city neighbourhoods of Glengarry, Wellington-Crawford, University, and Sandwich (GWCUS), and surrounding areas. This is where Canada Post three-times delivered 5,000 recruitment flyers to single-detached houses, duplexes, and row houses. Another study has an additional table demonstrating Windsor respondents and their households have statistically representative personal characteristics of all residents of dissemination areas encompassing the four GWCUS neighbourhoods in the most recent national census of 2016 (Phipps, 2021). Saskatoon respondents' representativeness of movers or other households was not statistically established at the time of their participation.

Marginal implicit prices of homes' attributes' levels

Marginal implicit prices of homes' attributes' levels are calculated with regression coefficients of a hedonic housing price model for each city (Phipps, 1987; 2020). Each regression model includes independent variables representing the 12 generic attributes' levels of displayed homes in each city's conjoint choice experiment. Saskatoon's hedonic housing price model has data for 2,702 single-family homes listed in MLS catalogues and sold in sample weeks in each spring and fall from fall of 1980 to spring of 1986. Neighbourhood data from the city's 1981 census tract (CT) data for each sampled home's location are merged with its MLS data. Windsor's hedonic housing price model has data for all 2,920 inhabitable single-detached and duplex houses sold through the MLS in two inner-city neighbourhoods in the city. These data are from the beginning of January 1981 in one neighbourhood named Glengarry, and from January 1986 in another named Wellington-Crawford, until the end of December 2018 in each neighbourhood. Merged neighbourhood data are from the 2001, 2006, 2011 or 2016 national census closest to a home's time of sale or resale in one of 25 dissemination areas (DAs) covering the two neighbourhoods. The year 2001 was the first for subdivision of Canadian census metropolitan areas such as Windsor ON into DAs with the small-area data (Statistics Canada, 2016). Note that larger CTs have not only different boundaries but also different variables than DAs.

Six attributes' levels constructed from MLS and census data in the city of Saskatoon and inner-city Windsor almost exactly correspond with descriptions in the conjoint choice experiments: These are displayed attributes' levels of house type and size, age of construction, basement condition and renovations, lot size and garage, landscaping, and neighbours' mobility (Table 1). For example, each level of house type and size is represented by the combination of three or four house styles, and number of bedrooms (and number of bathrooms in Windsor and floorspace in Saskatoon). Slight differences in addition to the scales of house age and basement condition in each city, are more detail about renovations in Saskatoon versus the realtor's summary condition of house in the Windsor; the inclusion of floorspace in the former; and the neighbourhood identifier as a landscaping surrogate in the latter.

Correspondences are more approximate in a second group of five attributes of neighbouring home types and repair, neighbours' ages, ethnic group and education, and accessibilities to schools and parks in Saskatoon or riverbank in

Windsor. The first three attributes depend on proportional data for an intermediate-sized dissemination area or a large census tract applying to a home's small local neighbourhood. The second two accessibility attributes are coded near in Saskatoon if located within a same census tract as a school or park, whereas they have observed distances in Windsor. The last and least corresponding attribute of work and stores accessibility is represented by inverse distance to downtown Windsor in kilometres for homes in two relatively compact inner-city neighbourhoods; and by a similar coding to schools' access for near to and far from major workplaces and stores in Saskatoon.

Neither multiple regression is the most parsimonious model, owing to entry of independent variables for calculating marginal prices of attributes' levels (cf., Phipps, 2020). Each has R-squared of 75%; and seven of 23 independent variables representing attributes' levels in Saskatoon and nine of 30 in Windsor have statistically insignificant coefficients (above 5% significance level). Both also have annual or seasonal dummy variables for time of sale or resale of homes.

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