Greenfield Growth. For many observers, the appearance of new luxury homes on the outskirts of a metropolitan area is a natural and welcome sign of economic growth and urban expansion. The housing industry is a key sector of the economy in Canada and the United States, and market-watchers eagerly anticipate the release of quarterly data on building permits, housing starts, and sales prices. Photograph July, 2010 (Elvin Wyly).

Housing Markets and Neighborhood Change

Geography 350, *Introduction to Urban Geography*
November 5, 2012
Elvin Wyly

In the past generation, the humanities and social sciences have been transformed in many ways by the rise of critical social theory, and its challenge to mainstream thinking. A key part of this change involves raising questions about the standard, taken-for-granted categories used in mainstream thinking. Critical social theory has shown how many of the simplest categories, concepts, and words we use to describe our world -- race, gender, nation, city -- are not as simple and unproblematic as they might at first appear. Such concepts should not be accepted as taken-for-granted realities, but instead as *social constructions*. Social categories and constructs are neither natural nor inevitable. Our attempts to understand the social world are thus inseparable from the analytical categories and constructs that we develop, individually and collectively, to help us perceive and organize observations about that world.

In the case of urban housing and neighborhoods, this constructivist perspective is at once obvious and paradoxical. Asserting that housing is socially constructed involves turning the self-evident into something that's almost a joke, a play on words. Yet there is almost no other realm of urban geography where categorizations, assumptions, and constructions are more powerful in naturalizing particular ways of understanding space and place. Housing and neighborhood change evoke deep-rooted understandings of home, community, commonality, difference, opportunity, change, security and insecurity. Think of the phrases people commonly use to describe home and neighborhood. "It's a brand-new house, in the best neighborhood." "This place isn't what it used to be." "This neighborhood is at a turning point." "The neighborhood is going downhill."

Emptying Out: Detroit, July 2010 (Elvin Wyly). This image shows the same metropolitan area as the one on the previous page. This is just west of Downtown Detroit, while the image on the previous page shows the wealthy suburbs north of the city. In the middle of the twentieth century, there were occupied single-family homes on nearly every single lot in this neighborhood. Thanks to deindustrialization and slow growth for the metropolitan region as a whole, however, suburban housing growth has steadily drawn households and economic activity out of the urban core.

How and why do neighborhoods change? How do housing markets shape the internal structure of the city? Today, we'll first consider the meanings and functions of housing. Then we'll examine a theory of neighborhood 'life cycles' that has played a decisive role in how many people think about local growth and decline. Next, we'll examine the interaction of supply and demand in the way 'housing space' interacts with 'social space,' and carves out distinct spatial sub-markets within metropolitan regions. Finally, we'll consider a case study of a useful way of analyzing local housing markets -- the hedonic pricing model.

The Meanings of Housing

Housing plays many roles in individual lives and in society. Five roles stand out as most important.

The meanings of housing

Use value:

1. Shelter and privacy.
2. Status and privilege.
3. A physical and social environment.
4. Accessibility to opportunities in the broader urban and regional landscape.

Exchange value:

5. The opportunity to build and store financial wealth. This opportunity is only available to owners, and is determined by rules on property rights, subsidies, and taxation.

First, housing provides **shelter and privacy**. Housing provides a setting for individual and family life outside the realm of work.

Second, housing serves as **an expression of status and privilege**. Getting the 'right' house, in the 'right' neighborhood, offers a sign of achievement, arrival, upward mobility, and prestige.

Third, housing provides a specific **physical and social environment**, based on the characteristics of the immediate vicinity of a housing unit. A suburban single-family house, for instance, might provide a spacious lot with a well-groomed front lawn and a dense thicket of trees in the backyard. A downtown apartment in a high-rise building, by contrast, might offer the opposite: the *absence* of a yard, and hence the *absence* of yard-work. For families with children, the suburban single-family house will typically provide neighbors who also have children, whereas the downtown apartment or condo might bring a mixture of young professionals, childless couples, and elderly residents.

Fourth, housing offers **accessibility** to the broader urban and regional landscape of employment opportunities, schools, shopping districts, and other amenities. As cities and metropolitan regions spread out across space, they create dramatic unevenness in accessibility. The result is a fine-grained spatial kaleidoscope of choices and trade-offs. The suburban single-family house, for instance, might provide access to nearby open space -- farm fields, forests, nature trails -- and perhaps a nearby shopping mall with large retailers who can offer the lowest prices by operating at vast economies of scale. But the tradeoff might be a long commute to get to a good job. The city apartment might offer quick access to downtown jobs, and a large selection of local restaurants, but at the tradeoff of higher prices compared to the distant, inaccessible suburban 'big-box' retailers.

Taken together, the four functions described above can be considered part of a 'bundle of housing services.' "The net utility of these services is generally referred to as the use value of housing. Because it depends a great deal on the needs and preferences of particular households, the **use value** attributed to a particular dwelling will tend to vary according to socioeconomic background, household type, lifestyle, and so on."[1]

But the final crucial aspect of housing services involves the

(5) treatment of the home as a source of stored financial wealth:

> "Equity (for owners) -- the financial return on an investment in housing (specifically, the difference between the market value of the dwelling and the amount of any outstanding mortgage debt on the property) that is (for owner-occupiers) tax-free. In this context, we should note that the equity value of housing, along with that of other real estate investments, ebbs and flows with economic long waves. ... The potential for gaining unearned income through equity increases, together with the use value of a dwelling, will determine its **exchange value** in the marketplace."[2]

Urban housing markets are shaped by the interplay of factors that influence use value and exchange value. In almost all cities, housing constitutes the single largest category of land use; therefore, patterns of neighborhood differentiation and change are tied closely to the dynamics of housing markets.

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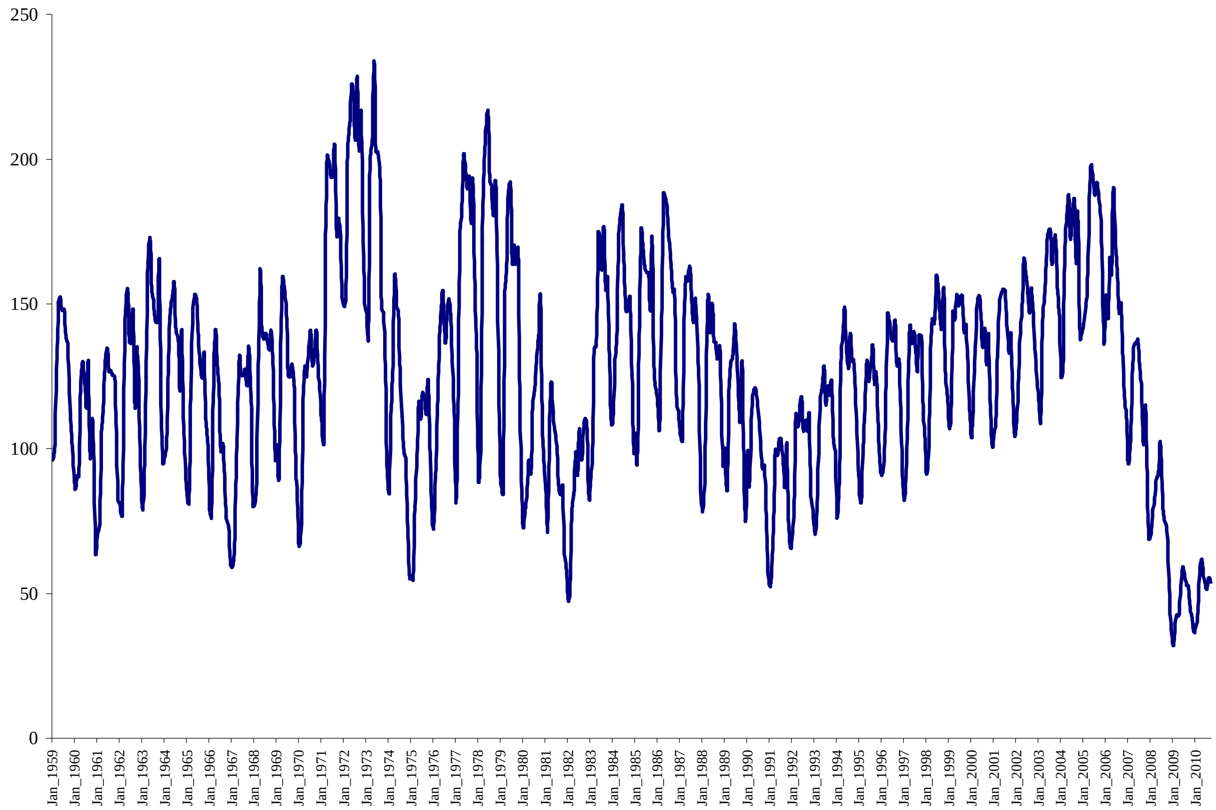
[1] Paul Knox and Linda McCarthy (2005). *Urbanization.* Upper Saddle River, NJ: Prentice-Hall, p. 346.
[2] Knox and McCarthy, *Urbanization*, p. 346.



New Housing Starts in the United States, Monthly, Thousands, January 1959-September 2010. *Data Source:* U.S. Bureau of the Census (2010). *New Privately Owned Housing Units Started, by Month, Not Seasonally Adjusted.* Washington, DC: U.S. Department of Commerce.

Neighborhood Change and Neighborhood Life Cycles

A neighborhood is the product of present conditions and the accumulated history of past choices by individuals, institutions, and powerful collective forces of investment, disinvestment, and urbanization. Every neighborhood is changing: even places that appear to be stable, secure, and perhaps even 'timeless' in their appearance and character, are sites of dynamic restructuring and turnover. In these cases, the interplay of various kinds of change are simply in balance, producing an equilibrium that is easily mistaken for a lack of change.

Neighborhood change involves four distinct components:

1. The ongoing physical deterioration of housing units and public infrastructure,
2. Flows of investment and disinvestment,
3. The mobility of households and individuals, and
4. changes affecting households and individuals "in place."

Understanding neighborhood change requires that we be careful to separate these distinct components – while also recognizing that they are interdependent. One of the most important signals people use to decide whether their neighborhood is changing in good or bad ways, for example, involves paying careful attention to the characteristics of who is moving in, and who is leaving. In turn, people who are considering moving into a neighborhood will pay close attention to the quality and consistency of physical maintenance of the housing stock and public infrastructure. Unfortunately, the interwoven roles of housing as an expression of prestige and (for owners) a store of financial value creates innumerable opportunities for cultural conflict, class polarization, and racial and ethnic exclusion.

The components of neighborhood change play out over time and space at multiple scales; in the case of time, scales of change can sometimes be observed from year to year, but even places that seem to be unchanging are always in flux. Even if only five percent of households move each year, for example (an extremely low estimate), it is safe to assume that after five years a quarter of a neighborhood's residents will be different. Moreover, the built environment -- the entire ensemble of housing units and public infrastructure in a neighborhood -- does not last forever. Knox and McCarthy suggest that "Although it is not uncommon for fragments of the urban fabric to last for 100 years or more, 50 to 60 years can be considered to be a reasonable life expectancy in most circumstances in the United States."[3] Clearly, such benchmarks are deeply contextual: fragments of European, Asian, and Middle Eastern cities are aged several centuries, while even in Canada and the United States we can uncover enormous regional variation in the 'life expectancy' of neighborhoods.[4]

Components of neighborhood change

1. Aging and physical deterioration of the built environment.

2. Flows of investment and disinvestment.

3. The mobility of households and individuals -- people moving in and out of the neighborhood.

4. Changes affecting households and individuals <u>in place</u>.

But in North America, a deeply influential perspective took hold in the twentieth century based on the notion of a neighborhood life expectancy. According to the "neighborhood life cycle" model, all of the complex forces of use value and exchange value that drive community change can be summarized in broad and fairly predictable trajectories.

The model has five main stages:

1. *Development:* construction of new upscale houses for higher-income households.

2. *In-filling:* construction of multifamily rental complexes increases density and reduces the upper-class exclusivity of the neighborhood.

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[3] Knox and McCarthy, *Urbanization*, p. 342.

[4] My first impression of some of Vancouver's neighborhoods is best summarized by a scene from *LA Story*, Steve Martin's (1991) satire of urban life and society in Southern California. Taking a visitor through some of the bland, anonymous suburbs of Los Angeles built in the 1960s and 1970s, he describes the neighborhood with a sense of awe and astonishment: "You know, some of these houses are *twenty years old*!"

3. *Downgrading:* long-term aging of houses and people. Deteriorating housing typically encourages higher-income households to move out, and lower-income households to move in.

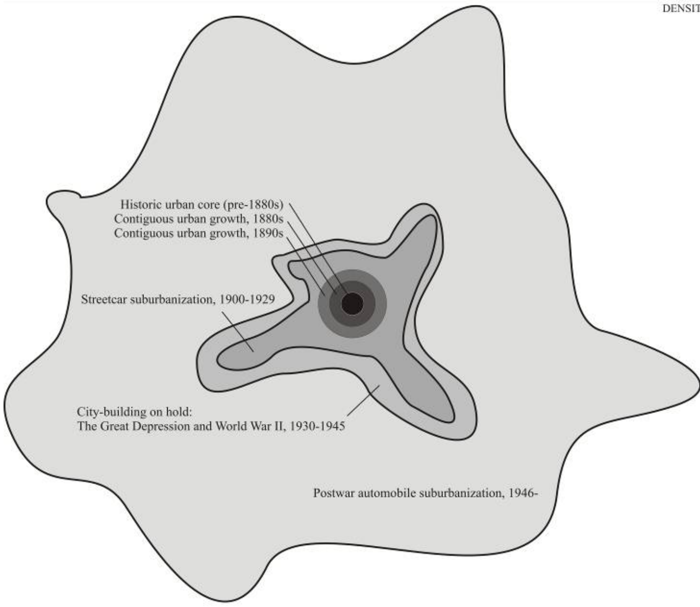
4. *Thinning out:* accelerated decline and deterioration, followed by rapid turnover, and the demolition of the oldest housing.

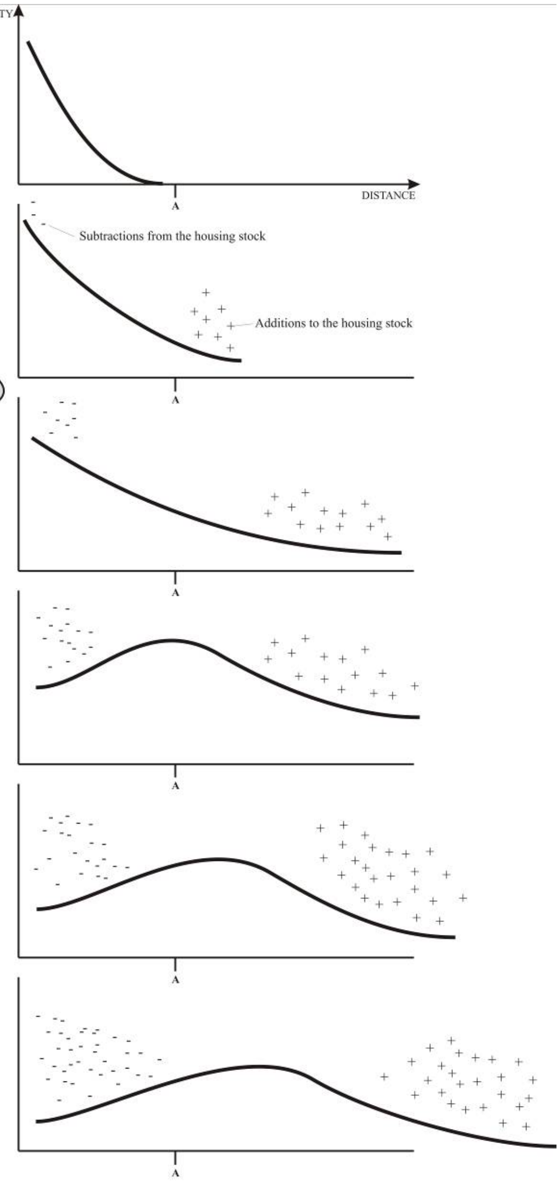
The neighborhood life cycle:

1. Development.
2. In-filling.
3. Downgrading.
4. Thinning out.
5. Renewal and redevelopment.

5. *Renewal and reinvestment:* after a period of severe decline, reinvestment begins a new life cycle for the neighborhood. Redevelopment creates new luxurious housing units for higher-income households, sometimes displacing an existing population of poor and working-class residents.

This sequence is a generalization, and so it does not offer precise predictions for what will (or should) happen to particular cities or neighborhoods. The model, in fact, was developed by looking back through urban history, and generalizing from the experience of particular cities. The cities that received the most attention were U.S. and Canadian cities from the industrial age, from the late nineteenth century onward. Typically, the industrial city of the 1870s had a very steep density gradient, with tightly-packed working-class housing around centrally-located factories. In the latter years of the nineteenth century, urban growth was contiguous -- as cities expanded, new homes built on the edge simply expanded the existing boundaries of the built-up area without changing its shape. In the early years of the twentieth century, however, the streetcar began to alter the shape of new urban growth. New residential development expanded faster along the corridors where efficient transportation allowed faster commutes over longer distances. More households gained access to houses on more spacious lots, and a growing number of working-class residents moved farther away from the central factories; at the same time, the factories themselves were decentralizing. The result was a shift in the density profile from the city center out to the suburban fringe. When the Great Depression hit, however, housing construction came to an abrupt halt. World War II revived industrial demand, but the military focus of the economy continued to restrict housing production -- leaving a very narrow band of homes built between 1930 and 1945. The postwar years, however, brought a spatial explosion. Increasing automobile ownership and major investments in road improvements and national highway systems allowed the metropolis to burst forth -- with residential subdivisions spreading out at ever-greater distances from the historic urban core.





Housing Construction Cycles and Waves of Investment. A new neighborhood on the suburban fringe at **A** is overtaken by successive outward waves of investment, migration, and removals from the housing stock. Eventually, **A** winds up in the heart of the disinvested inner city. *Source:* Modified and adapted from John S. Adams and Barbara J. VanDrasek (1993). *Minneapolis-St. Paul: People, Place, and Public Life.* Minneapolis: University of Minnesota Press, p. 99.

The distinctive economic conditions and transportation innovations of different time periods etched themselves into the urban landscape. And these housing construction cycles also reshaped the environment of choices available to households, in distinct spatial housing *submarkets*. New investment on the suburban fringe generally targeted higher-income households, and their moves triggered a cascade across the rest of the metropolis. The highest-status households moved into the highest-status, newly-constructed homes; in turn, the houses left-behind by these elite movers became available to middle-class households; and these middle-income movers left homes that could then be occupied by moderate- or low-income households. As George Galster summarizes the logic,

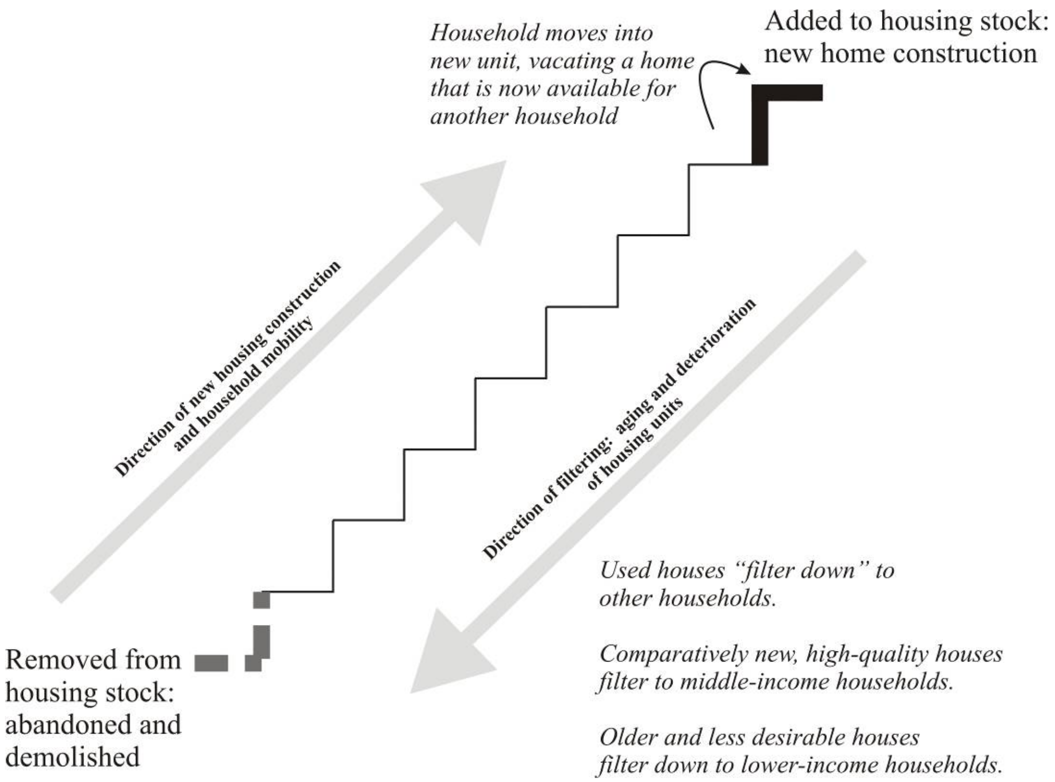
> "The central phenomenon that the specification of sub-markets was intended to illuminate was the dynamic of dwelling price and quality changes and

households' associated moves. This dynamic has been generally described as 'filtering.'"[5]

Housing filtering is like a downwardly-moving escalator: new houses at the top lure higher-income households, creating spaces for households farther on down to take a step up.

Filtering happens with any kind of durable commodity that has a significant resale market. People who can afford to, buy the new products, and then the used ones "filter" down to others who buy used cars, refrigerators, sofas, books, computers, and so on. When applied to the housing market, filtering can be likened to an escalator. When a new step appears at the top, upwardly-mobile households take a step up -- making space for the household on the next lowest step to move up. Older and less desirably housing units filter down to lower-income groups, until at the very bottom of the market, homes are abandoned and demolished.

Filtering was introduced as a purely descriptive concept. But its broader implications should be clear: the theory portrays the housing market as a trickle-down affair, in which new construction at the very top of the market will help everyone, because housing opportunities will 'filter down' to successively lower-income households.



Housing Filtering as an Escalator. Source: Graphic by Elvin Wyly, modified and adapted from John S. Adams (1993). *Metropolitan Analysis.* Minneapolis: Department of Geography, University of Minnesota.

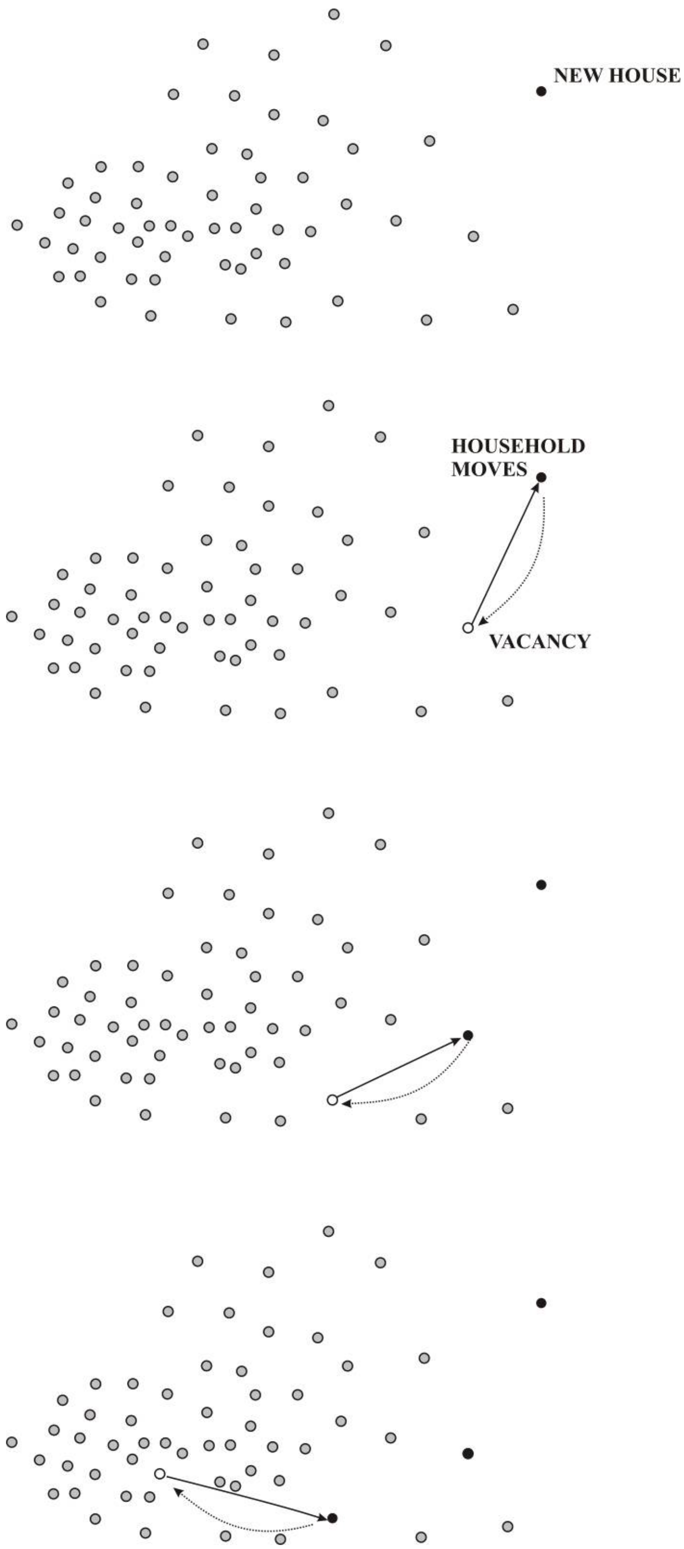
[5] George Galster (1996). "William Grigsby and the Analysis of Housing Sub-Markets and Filtering." *Urban Studies* 33(10), 1797-1805.

Closely tied to the idea of housing filtering is the model of the "vacancy chain." When a newly-created housing unit is completed and occupied, the household that moves in has, obviously, left behind a previous home. Unless this is a new household, the move into the new unit has created a vacancy; when this other unit is occupied, it will have created another vacancy, and so on.[6] As households move into new homes that better suit their needs, resources, and circumstances, vacancy chains move in the opposite direction. It is possible to use survey research methods to trace housing vacancy chains, and there is a rich housing literature built on hundreds of studies in scores of cities. Vacancy chains can be traced by households moving into all kinds of housing, but there is especially intense interest in housing vacancy chains that are created by the construction of new housing. New housing built at the 'top' of the market -- the highest quality and highest price units, often built in new, outlying suburbs -- are believed to filter down and in. If they stretch far enough, these cascading vacancy chains will eventually allow people to move "up and out" of the lowest-income neighborhoods near the urban core.

When households move one way, vacancy chains move the opposite direction.

Vacancy chains suggest a "trickle-down" view of the housing market.

[6] F. Kristof (1965). "Housing Policy Goals and the Turnover of Housing." *Journal of the American Institute of Planners* 31, 232-245.



Households Move Out, Vacancy Chains Move in. New upscale construction on the urban fringe lures wealthy households to move out, creating a vacancy that is then fiilled by an upper-middle income mover. Households move out, while vacancy chains move in the opposite direction. *Source:* Modified and adapted from John S. Adams (1993). *Metropolitan Analysis.* Minneapolis: Department of Geography, University of Minnesota.

Social Space and Housing Space

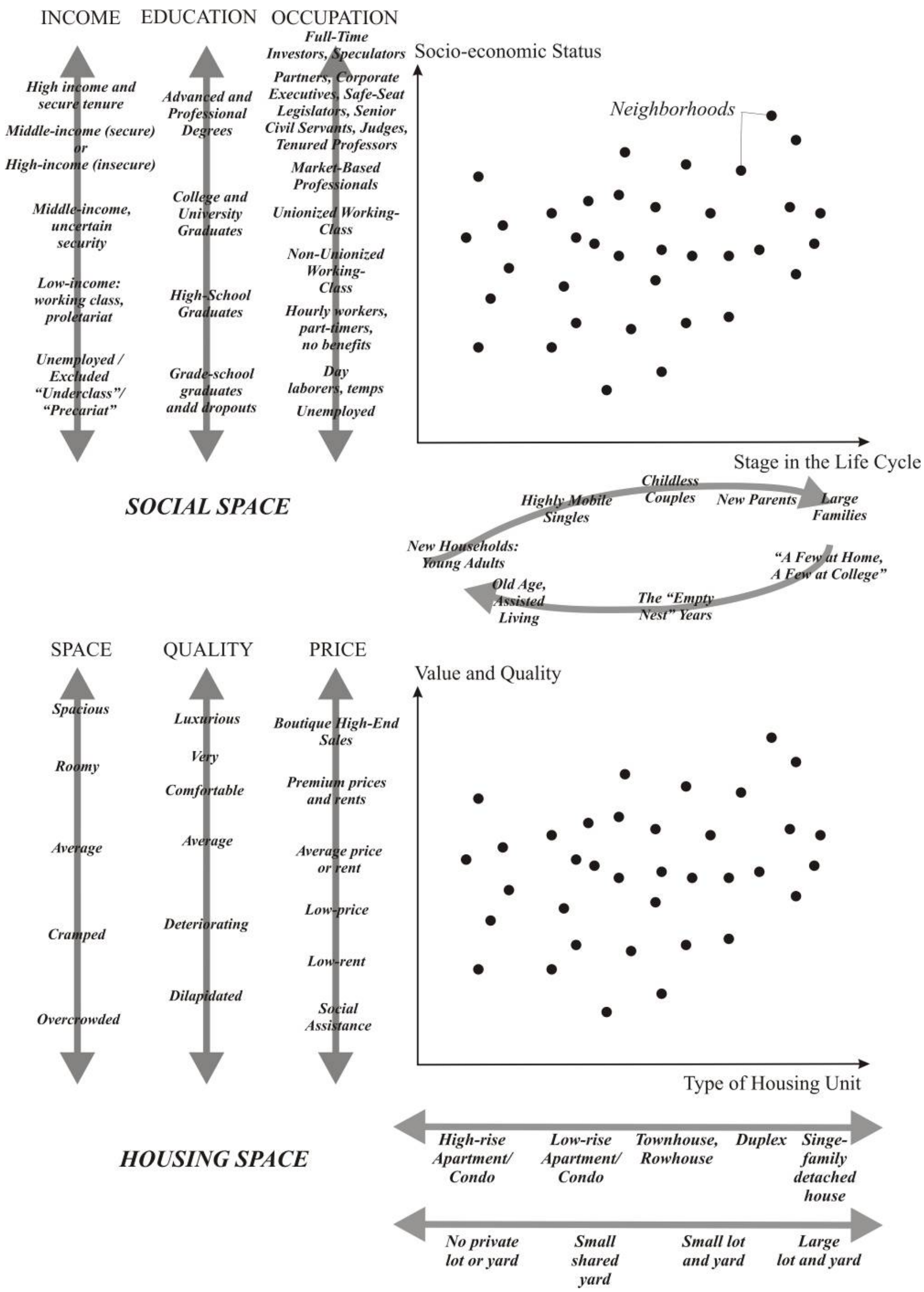
While new housing construction is changing the shape of cities and neighborhoods, society is changing too. Divisions of social and economic class are expressed in urban space -- blue collar and white-collar neighborhoods, poverty ghettos and elite gated estates. Different places in the city also develop as communities attractive to people at various stages of the life cycle - from young adults just looking for their first apartments, to late middle-age large families with many children.

The "social space" of class and life-cycle differences can be mapped onto "housing space": varying submarkets divided by space, quality, price, and type of housing unit.

All of these factors come together in urban space. Social divisions become housing *submarkets*. Social space becomes housing space. Over time, social change evolves with changes in housing space. New construction initiates waves of filtering and vacancy chains. Neighborhoods evolve as they experience shifts in the separate components of physical deterioration, investment/disinvestment, household and individual mobility, and changes in place among families and inviduals. The result is a systematic partitioning of the metropolis into distinct spatial housing submarkets, each suited to a particular grouping of social class and stage in the life cycle:

> "The housing process can be defined as a set of households in a place living in the housing units located at that place. Each household has a set of attributes which relate to its housing needs and wants. A household's housing requirements vary systematically throughout the household's life cycle. The housing stock in a place depends on the construction history of a place. Consequently the attributes of the housing units are created to a large extent independently of the present households. Yet when several household classes purchase and occupy the different kinds of housing available in a city, a series of distinctive housing usage patterns is the outcome."[7]

[7] Ronald Abler, John S. Adams, and Peter R. Gould (1971). *Spatial Organization.* Englewood Cliffs, NJ: Prentice-Hall, p. 171. Key elements of the social space and housing space models were developed in Brian J.L. Berry and P. H. Rees (1969). "The Factorial Ecology of Calcutta." *American Journal of Sociology* 44(5), especially p. 464,



Social Space and Housing Space. *Source:* Modified and adapted from Ronald Abler, John Adams, and Peter Gould (1971). *Spatial Organization.* Englewood Cliffs, NJ: Prentice-Hall, pp. 173-174.

Implications

These models and metaphors became deeply influential in North American urban geography, and also in public policy. They provide rich, vivid descriptions of paths of changes in who lives where, and how neighborhoods are changing. They represent a powerful way of thinking about home, neighborhood, community, and change; for many analysts, and for many people who are involved in dealing with problems and possibilities in city and neighborhood organizations, they provide a basic reference point for understanding local trends and outcomes. Nevertheless, these models have fundamental limitations with far-reaching implications. Five issues are crucial.

First, the neighborhood life-cycle model is neither natural nor inevitable. Yet soon after variations on the life-cycle model were devised, they found their way into key elements of public policy affecting cities and housing. Descriptive theory became legitimation and catalyst for policy decisions that *precipitated* the transition from infilling to downgrading to thinning out to renewal. Explanatory theory became causal driver of neighborhood change. John Metzger, for example, offers a detailed policy history of the life-cycle concept and the ways it became the basis for "planned abandonment."

> "Disparate patterns of metropolitan growth and decline in the United States are the legacy of economic racism, decisions on industrial locations, and the suburban bias of federal highway and housing programs.... These disparities have been exacerbated by the neighborhood life-cycle theory, an evolving real estate appraisal concept used as a basis for neighborhood planning decisions. Planners constrained by fiscal and political conditions have used this theory to encourage the 'deliberate dispersal' of the urban poor, followed by the eventual reuse of abandoned areas."[8]

The most provocative elements of Metzger's argument involved the way the life-cycle concept was used after the urban uprisings in the inner-city neighborhoods of many U.S. cities in the late 1960s. "Postriot urban policy can be understood as a dialectical process of social change. 'Triage' planning was used to depopulate areas of social unrest."[9]

Second, the relationship between social space and housing space -- that conceptual mapping of the different housing needs of different kinds of individuals and families -- is socially contextual. The individual and family "life-cycle" is a construct that involves key definitions and assumptions. Indeed, demographers and sociologists now describe *life-course* changes rather than *life-cycle* changes: there are many paths of change in the lives of individuals and families that were never recognized or considered in the simplest life-cycle models used in the 1950s and 1960s. These teleological models portrayed an inevitable progression (young adult, marriage, children, middle-age, empty-nesters, retirement) that ignored single mothers and fathers, divorced parents, widows and widowers, gay and lesbians with and without children, single people who never marry or have children, and many other people who are balancing their individual lives with the needs and desires of those whom they care about.

The suburban single-family house is labor-intensive, and this work is gendered.

In the Vancouver region, one sixth of women age 15 and over spend 30 hours or more per week on unpaid housework. This is three times the proportion for men in the same age group.

Quite simply, anytime we see a discussion of "family values," we must immediately consider the deeply political tensions over *how family is defined, and which kinds of families are valued*. These issues matter in housing markets. Recall that the implicit story of the social space - housing space theory is that the best, high-status housing is the detached, single-family house on

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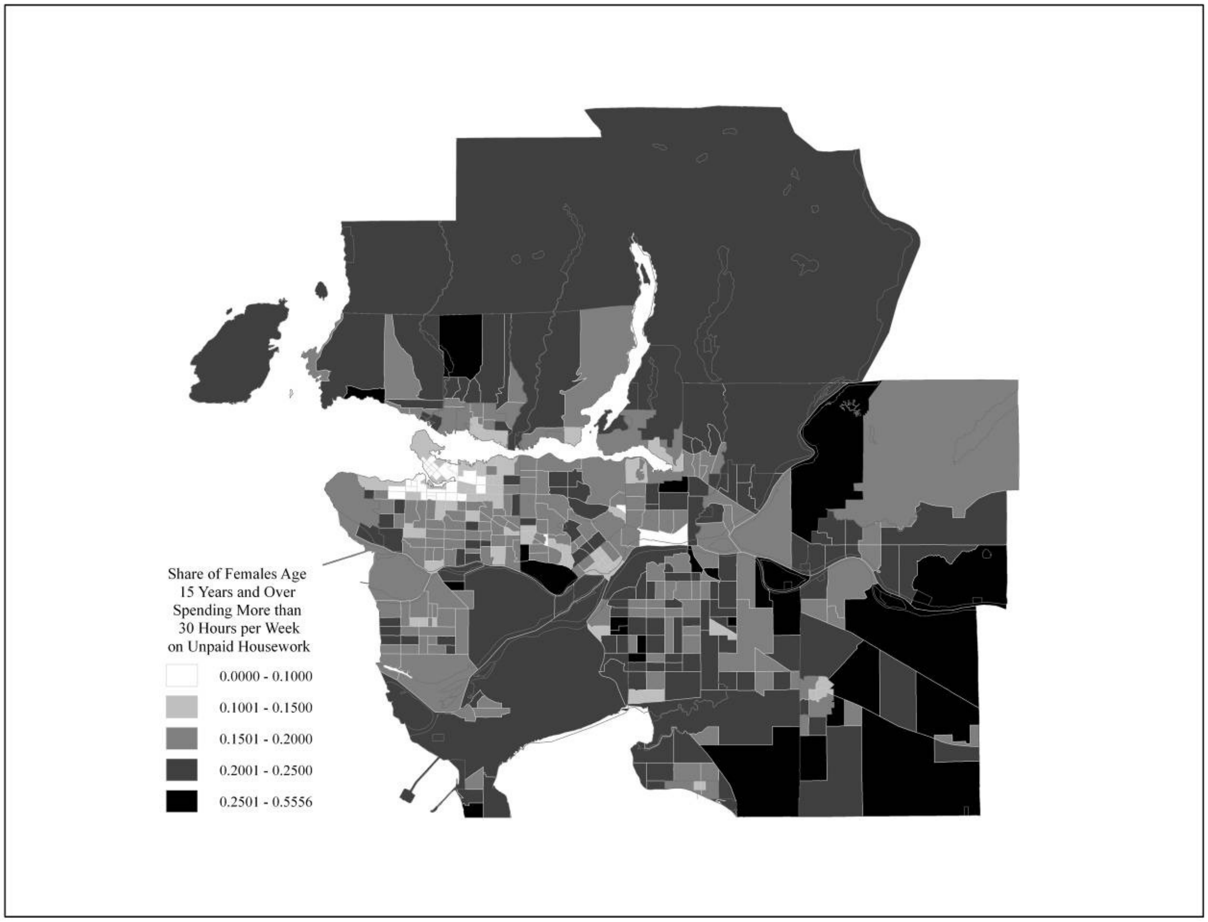
[8] John T. Metzger (2000). "Planned Abandonment: The Neighborhood Life-Cycle Theory and National Urban Policy." *Housing Policy Debate* 11(1), 7-40, quote from p. 7.

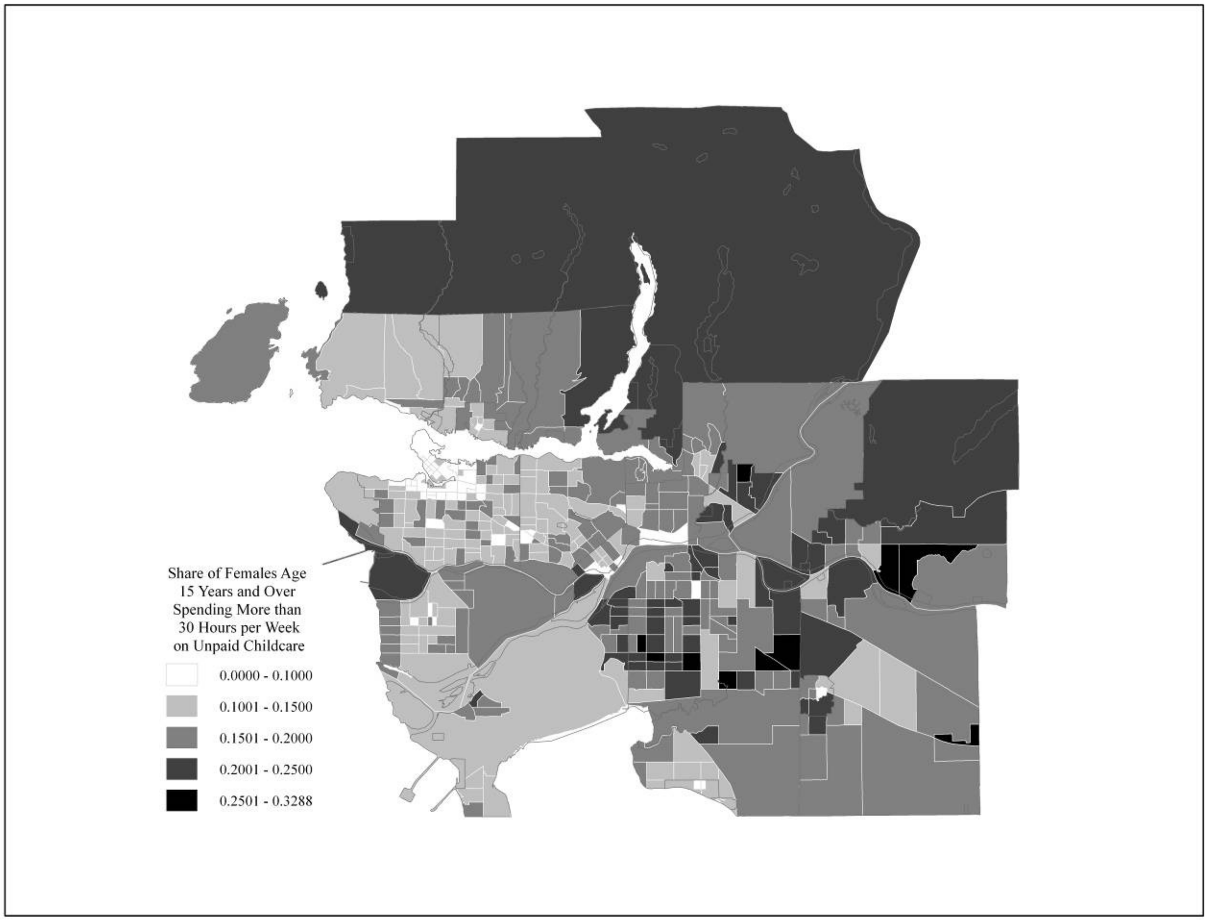
[9] Metzger, "Planned Abandonment," p. 7.

its own private yard. Perhaps. But this housing style requires a lot of labor, and most of this labor is unpaid and hidden from most official economic discussions. It is also gendered. In the Vancouver metropolitan area, more than 162 thousand women age 15 and over spend more than 30 hours per week in unpaid housework. This is one-sixth of all women -- a proportion three times the rate for men. The spatial pattern of women working full-time in unpaid housework -- and unpaid childcare -- is a very suburban pattern. Neighborhoods dominated by single-family houses (but where families don't have enough money to hire paid house cleaners or child-minders) require huge investments of women's unpaid work. Suburban patterns like these are part of the reason Betty Friedan likened the suburban house to a prison, and the urban planner Dolores Hayden wrote a chapter asking, "What Would a Non-Sexist City be Like?"[10]



Women's Unpaid Household Labor in the Vancouver Metropolitan Area. Data Source: Map by Elvin Wyly, derived from Statistics Canada (2008). *Cumulative Profile for Census Tracts, 2006 Census*. Ottawa: Statistics Canada.

[10] Betty Friedan (1963). *The Feminine Mystique*. New York: W.W. Norton. Dolores Hayden (1981). "What Would a Non-Sexist City be Like? In Catherine M. Stimpson et al., eds., *Women and the American City*. Chicago: University of Chicago Press, 167-184.

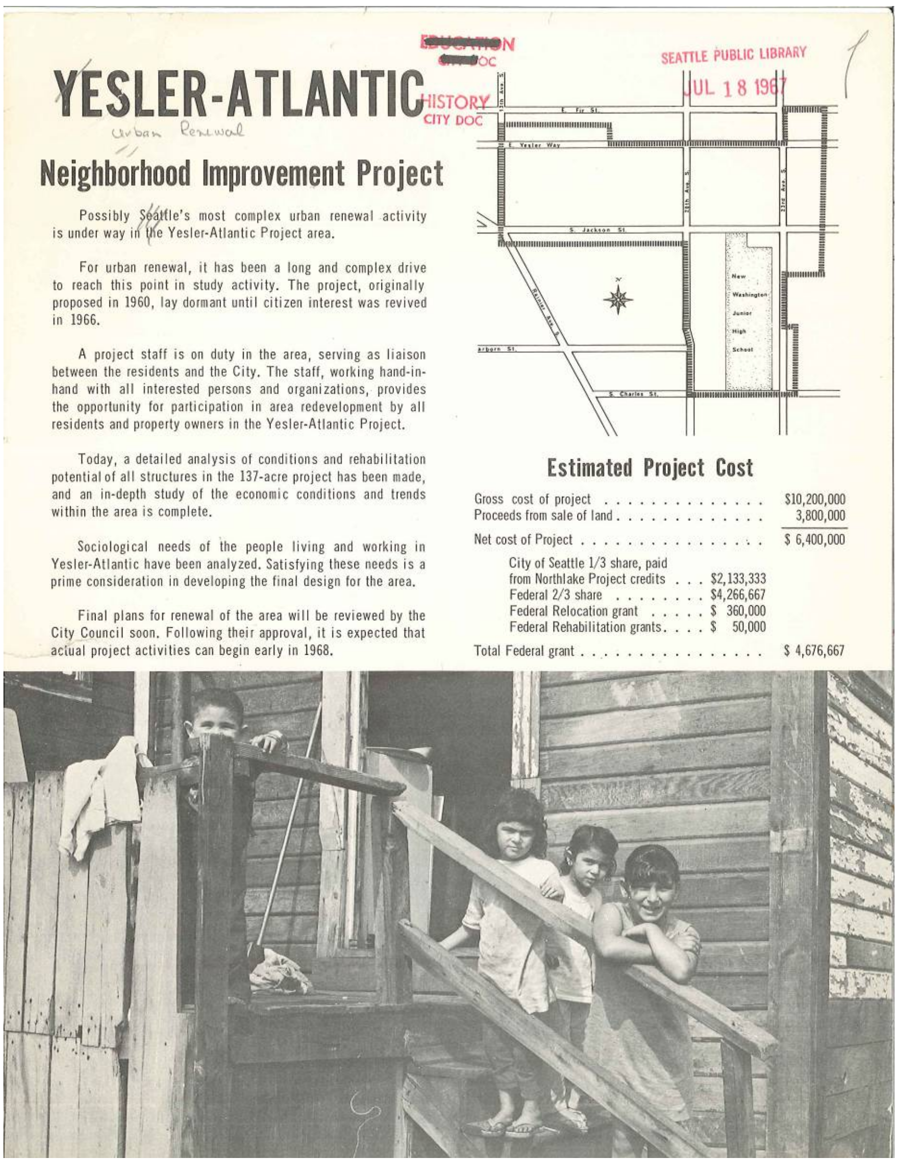


Women's Unpaid Childcare Labor in the Vancouver Metropolitan Area. Data Source: Map by Elvin Wyly, derived from Statistics Canada (2008). *Cumulative Profile for Census Tracts, 2006 Census*. Ottawa: Statistics Canada.

Third, the relationship between social space and housing space is geographically contextual. Even when we are able to map individuals, households, and families in terms of their needs, and even when we are able to map out the kinds of housing needs that correspond to different life circumstances, the spatial and geographical configuration that results will depend on preferences for new vs. old housing; centrally-located high-density living vs. low-density spacious lots; and homogeneous blocks of similar homes and similar people vs. preferences for diversity and mix. The housing filtering and vacancy chain models were devised at a time when these spatial patterns were comparatively simple; in some cities, policy has kept the incentives such that the models still work. In many others, especially places like Vancouver, they do not.

Fourth, the elegance of filtering and vacancy models, and the generation of detailed survey-based quantitative research they inspired, should not blind us to the rich human, social, and political tensions at each stage of these geometric representations. A large cast of characters is involved in designing, creating, selling, and buying housing units on the top end of those filtering and vacancy chain models; but many are involved at the very bottom end, too. Even the most dilapidated housing, and housing that is being destroyed to make way for new elements of the landscape that will fulfill conventional notions of the neighborhood life cycle has a crucial human geography. Jason Reblando, a freelance photographer working in Chicago, provides a vivid illustration in his project, “Outside Public Housing,”

> “an examination of the matrix of people that are involved with public housing, but don’t necessarily live in the housing itself. These photographs are not meant to ignore the desperate conditions of public housing residents. My intent was to photograph the efforts of those that are trying to empower residents as well as those that are trying to disperse residents. One person’s livelihood was often another person’s despair.”[11]



YESLER-ATLANTIC

Neighborhood Improvement Project

Possibly Seattle's most complex urban renewal activity is under way in the Yesler-Atlantic Project area.

For urban renewal, it has been a long and complex drive to reach this point in study activity. The project, originally proposed in 1960, lay dormant until citizen interest was revived in 1966.

A project staff is on duty in the area, serving as liaison between the residents and the City. The staff, working hand-in-hand with all interested persons and organizations, provides the opportunity for participation in area redevelopment by all residents and property owners in the Yesler-Atlantic Project.

Today, a detailed analysis of conditions and rehabilitation potential of all structures in the 137-acre project has been made, and an in-depth study of the economic conditions and trends within the area is complete.

Sociological needs of the people living and working in Yesler-Atlantic have been analyzed. Satisfying these needs is a prime consideration in developing the final design for the area.

Final plans for renewal of the area will be reviewed by the City Council soon. Following their approval, it is expected that actual project activities can begin early in 1968.

Estimated Project Cost

Gross cost of project		$10,200,000
Proceeds from sale of land		3,800,000
Net cost of Project		$ 6,400,000
City of Seattle 1/3 share, paid from Northlake Project credits	$2,133,333	
Federal 2/3 share	$4,266,667	
Federal Relocation grant	$ 360,000	
Federal Rehabilitation grants	$ 50,000	
Total Federal grant		$ 4,676,667

The Human Face of Filtering. There are real human experiences in every abstract stage of the neighborhood life cycle, and in every abstract rendering of escalators and vacancy chains. Sadly, these human experiences are often misinterpreted and misrepresented. Selective images of blight, and selective images of local residents, were often used to justify urban renewal and displacement. *Source:* Seattle Municipal Archives (2011). *Yesler-Atlantic Urban Renewal Fact Sheet, 1967.* Seattle: Seattle Municipal Archives, via Creative Commons Attribution 2.0 license, via Wikimedia Commons.

[11] Jason Reblando (2005). *Outside Public Housing*. http://www.invisibleinstitute.com/media/jasonreblando/outsideph/index.html, accessed November 7.

Fifth, housing filtering and vacancy chains are powerful models, but they can too easily conceal the political economy of capital, and the struggle of individuals and institutions to respond to changes in the exchange value of housing, land, and hence neighborhoods. Neil Smith has shown that over time, urban growth and development create powerful incentives for redevelopment of neighborhoods traditionally understood as near the "end" of a life-cycle. This is nothing *natural*, however: Smith demonstrates that over time, the mismatch between capitalized ground rent (what a land parcel can command on the market given its present use) and potential ground rent (the possible market return associated with redevelopment to a "higher" use) becomes large enough to make reinvestment a lucrative economic decision.[12] Smith developed this theory out of frustration with much of the urban literature in the 1970s, which portrayed many cities as undergoing a 'renaissance' as middle-class people seemed to be moving "back to the city" and renovating formerly run-down inner-city districts. Smith agreed that this was a back to the city movement -- but it was a movement by capital, not people. Smith has subsequently extended this theory to understand the fortunes of once-thriving suburbs that are now facing many of the problems of sagging property values and obsolescence that was once seemingly confined to old, big cities.

> "Equating suburban decline with the characteristics of who moves in and who moves out functions to conceal the important role of class and capital. Recessions are bouts of significant devaluation in local, national, and international economies, and this devaluation has to be localized somewhere. Thus, recessions are times of intense struggle between owners of capital and owners of capitalizable assets (such as a house) interested in deflecting systemic devaluation from their own investments. To the extent that devaluation can be localized in one or several clearly bounded places, other places (and their owners) remain protected. At the urban scale, this means that poorer neighborhoods that are disproportionately minority are especially vulnerable unless community organization can somehow overcome the detrimental power of market devaluation."[13]

Filtering and vacancy chains are powerful tools, but they should not obscure the crucial role of political economy -- the rules of the game of investment and profit in real estate and land markets.

There is nothing natural or inevitable about the neighborhood life cycle.

[12] Neil Smith (1996). The New Urban Frontier: Gentrification and the Revanchist City. New York: Routledge.
[13] Neil Smith, Paul Caris, and Elvin Wyly (2001). "The Camden Syndrome and the Menace of Suburban Decline: Residential Disinvestment and its Discontents in Camden County, New Jersey." *Urban Affairs Review* 36(4), 497-531.

Single-family homes on the East Side of Vancouver, June 2008 (Elvin Wyly)

Hedonic Vancouver

How can we make sense of all these processes in the urban landscape? To explore housing space in Vancouver, we're going to consider one more tool: the **hedonic pricing model.** This model will help us understand the choices made by households as they navigate the changing social space and housing space of different neighborhoods in the metropolis.

Hedonic pricing models provide a way to estimate a separate price for each component of a complex commodity.

Housing is a durable, long-lasting commodity, with lots of older houses for sale alongside brand-new houses just coming on the market for the first time. The mixture of old and new products makes it hard to interpret indicators like sales prices: an increase in average sales prices might result from healthy demand for the existing housing stock; but the same pattern could occur with a deteriorating middle-class market, if there were enough sales of newly-constructed luxury units at the high end. Hedonic pricing analysis is one way of relating observed sales prices to the varied characteristics of a complex commodity.

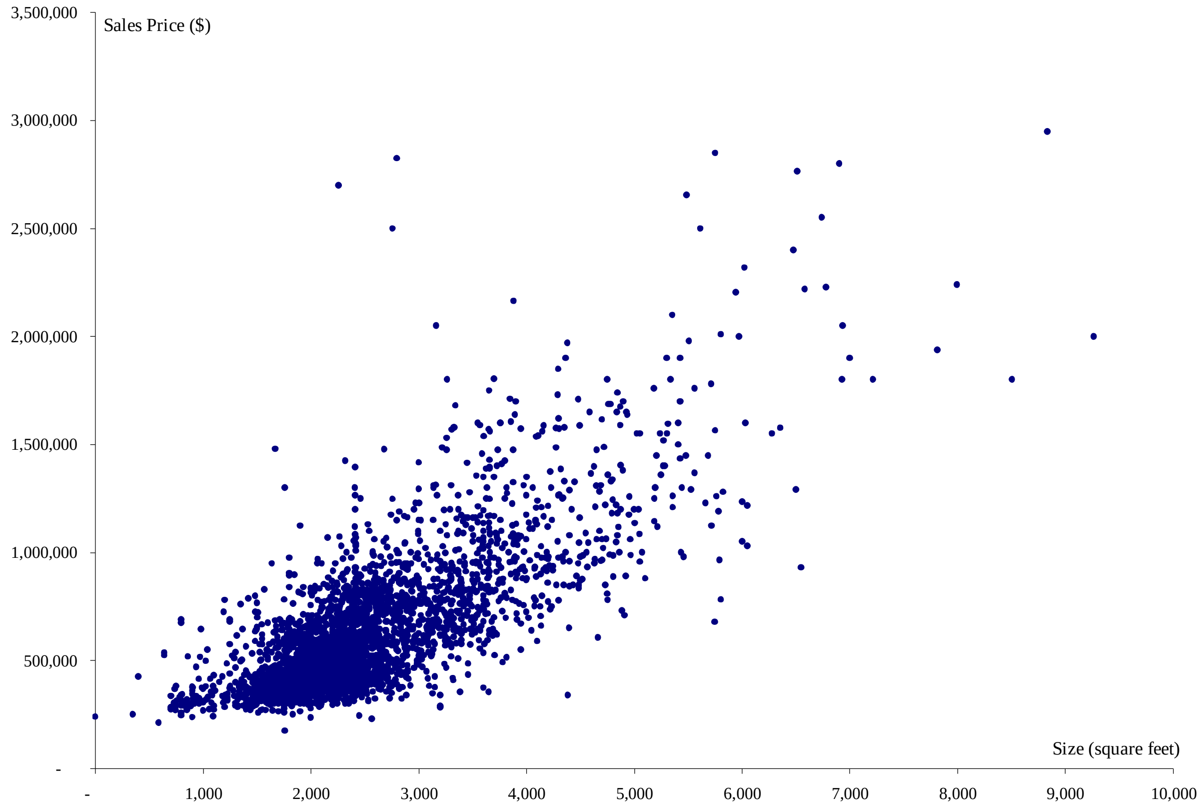
The word hedonic comes from the Greek *hedone* (pleasure) and *hedonikos* (pleasurable): the idea is to observe what kinds of pleasures consumers are willing to pay for on the open market. With information on prices and the characteristics of commodities, each attribute can be assigned its own separate price. The method was first developed in the early twentieth century, when economic researchers realized that the old ways of measuring prices over time for raw commodities (wheat, tobacco, sugar) were unreliable for the new complex, manufactured products of the Fordist industrial age. New products "fabricated from hundreds of separate parts, designed for complex functioning,"[14] require a different method, because consumers are paying for a wide range of features. A researcher at the Automobile Manufacturers Association realized that the problems with simple price indices were most serious with the mixture of old and new cars on the market during a period of rapidly changing technology. His solution was "a multiple regression analysis covering all the various cars offered ... as the dependent observations, and relevant specifications as the independents"; this modeling approach "will give those weights best assigned various specifications in explaining prices" that consumers are willing to pay for various features.[15] The method later became a mainstay of the economic analysis of housing.[16]

Let's begin with a simple example, based on the size and sales prices of single-family detached homes in the City of Vancouver. We know from Alonso (and common sense) that space is valuable, and so it is reasonable to suspect a relationship between prices and the size of homes:

$$\text{Price} = f\,(\text{size})$$

where the fancy f simply means "is a function of..." I was able to obtain sales prices and sizes (in square feet of living space) for a full year of house sales in the city a few years ago -- a total of 3,732 transactions. If we graph prices on the vertical axis, and sizes on the horizontal axis, we can see a fairly clear relationship. The average sales price for all the homes is $612,627, and the averag house has 2,483 square feet of living space. But the cloud of points on the graph slopes up to the right, indicating that larger homes command higher prices. Houses with 5,000 square feet seem to have average prices well over $1 million.

[14] A.T. Court (1939). "Hedonic Price Indices: With Automotive Examples." In *The Dynamics of Automobile Demand*. New York: General Motors / Automobile Manufacturers Association, p. 99.
[15] Court, "Hedonic," p. 108.
[16] Allen C. Goodman (1978). "Hedonic Price Indices and Housing Markets." *Journal of Urban Economics* 5, 474-484.

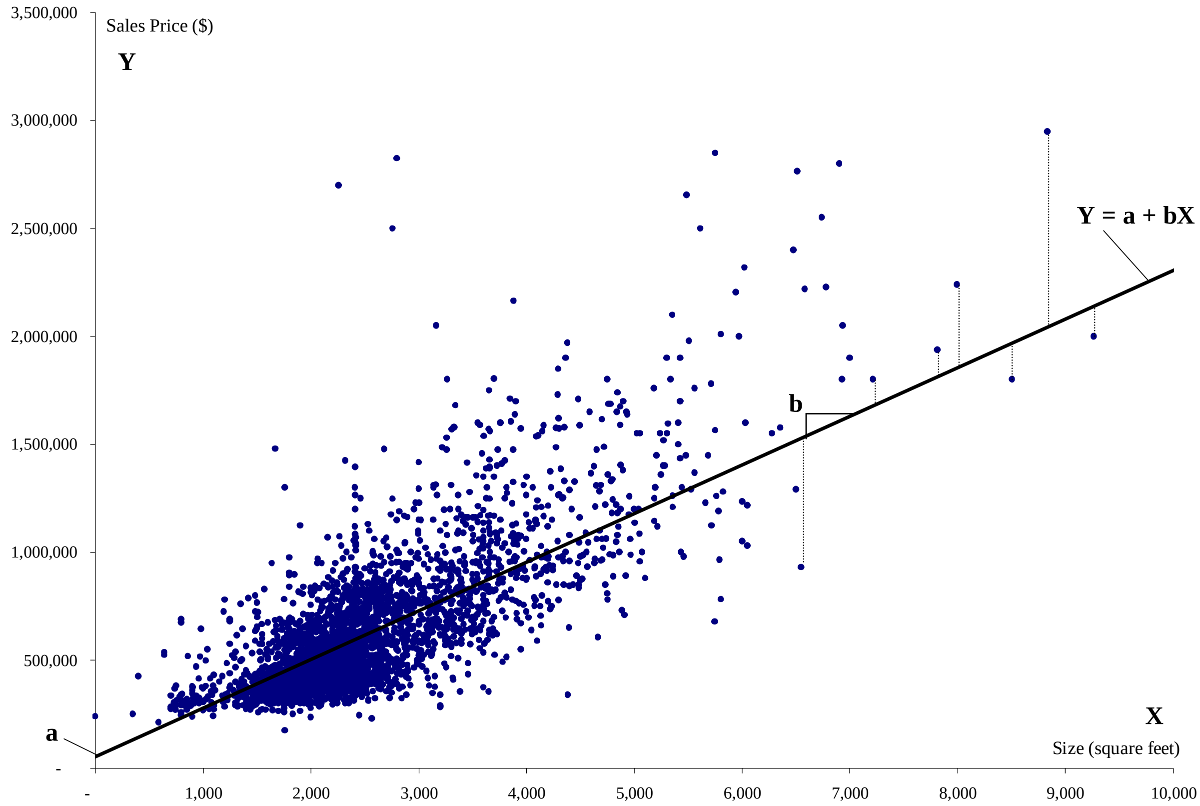


Relating Prices to Living Space. *Data Source:* Modified and adapted from Real Estate Board of Greater Vancouver (2004). *Multiple Listing Service Data.* Vancouver: Real Estate Board of Greater Vancouver.

Is it possible to be more specific about the relationship between price and living space? Regression analysis is a powerful tool in this case. Let's call price our *dependent variable*, because its level seems to depend on something else. We'll call price Y. Living space is the *independent variable* -- a separate phenomenon or process that contributes to variation in the dependent variable. We'll call the independent variable X. The relationship between these two variables can then be specified if we draw a line through the cloud of points.

We could draw any number of lines through these points, but there is one and only one *line of best fit.* This is the line that comes as close as possible to each of the 3,732 points on the graph, as measured vertically. There's a quirk, however, when we try to translate "as close as possible" into specific steps. If we put in a line and add up all the vertical deviations between each of the sales prices and the line, the points above the line (with positive deviations) cancel out the points below the line (with negative deviations). Adding up the vertical deviations thus yields a sum of zero -- and this applies to many of the possible lines we could draw. Fortunately, there's a statistical trick that solves this annoying problem: if we take the deviations and square them, then we always get a positive value (even for the negative ones). For any given set of points, there is one and only one line that minimizes this *sum of squares*. This is called the *line of least squares*. Once we've minimized the squares, then the line can be described by an equation that relates price (Y) to a constant (a) plus the product of a slope coefficient (b) times the independent variable (X):

$$Y = a + bX$$



The Least-Squares Regression Line.

The a term is often called the *intercept*. This is the value of the dependent variable (in this case, price) when the independent variable is zero. In many situations, the intercept does not have any logical meaning: what would you be willing to pay for a house with no square feet of living space? Nevertheless, the intercept is necessary to specify the exact position of the line as it cuts through the cloud of points -- all the other houses that do have lots of living space. The intercept is thus often called a parameter (from the modified Latin, from the Greek *para*, beside + *metron*, measure). A parameter is a variable that is kept constant while others are being investigated.

In this case, that variation is specified by the rate of increase in house price as living space increases: this is measured by b, which is often called a **beta coefficient**, or a **slope coefficient**. The idea of a slope is simple enough: you can imagine walking uphill on that line if you have enough money to buy a more spacious house. In our case, b is 225.29. Each additional square foot of space boosts the sales price by $225.29.

Once we have specified the parameter and coefficient of the regression line, then it is possible to measure the strength of the relationship. This is captured by a *coefficient of determination*, symbolized by R^2. This is the proportion of variance in the dependent variable that can be explained by the independent variable. R^2 always ranges from zero to 1, and in our case the R^2 is 0.498: almost exactly half the variation in house prices can be explained in terms of their living space. We can also use measures to see how reliable the independent variable is as a predictor. If the cloud of points is tightly clustered around the least-squares line, then knowing X (living space) will provide a very reliable estimate of Y (sales price). This is measured by a t-statistic or t-value, which adjusts the slope coefficient according to the accuracy of the estimates. Large deviations between the observed house prices and those predicted by the line reduce the t statistics, while a tight cluster of points keeps the statistic higher. T values that fall below 2.0 are usually regarded as meaningless -- what the specialists call “not statistically significant.”

The fitted regression line allows us to predict the sales price for any size house. For a 6,000 square foot house, the model predicts:

$$Y = a + bX$$

$$\text{Price} = 53{,}177 + (225.29 \times 6{,}000)$$

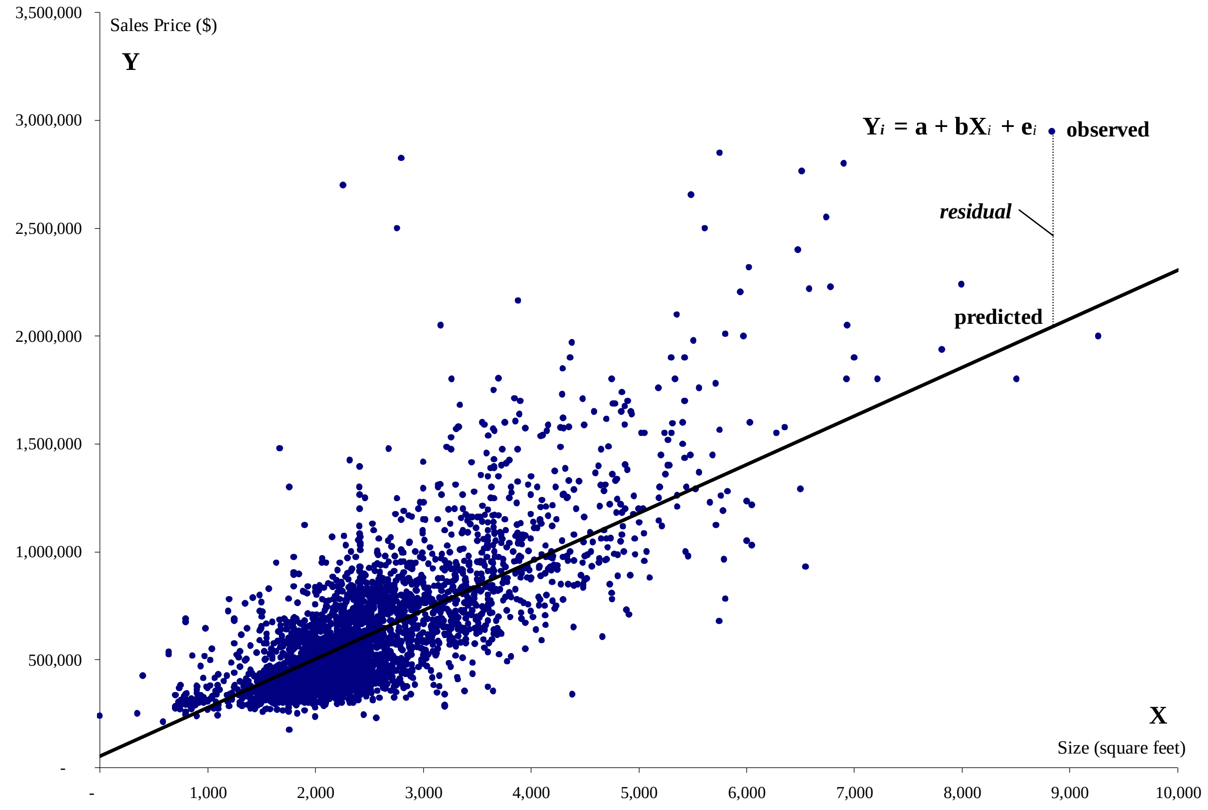
$$= 53{,}177 + 1{,}351{,}740$$

$$= 1{,}404{,}917$$

If you look at the graph, of course, you can see that there is a scatter of points above and below the line where X=6,000. Some houses of this size sold for more than $1.4 million, and some for less: there’s often a bit of error in the model predictions. So the prediction equation should really account for this:

$$Y_i = a + bX_i + e_i$$

which simply says that for any individual house *i*, its observed value is the sum of the model prediction ($a + bX_i$) plus an error term that is unique for each house (e_i). The error term is also known as a **residual**. The residual is the observed value minus the model prediction.



Model Predictions and Residuals

If we add up all the residuals and square them to solve the problem of those positive and negative cancellations, we obtain something called the *error sum of squares*. If we take the square root of this value, we have the average error for all of the predictions; this is called the *root mean square error* (MSE), and for this dataset it's 224,228. The average error in a house-price prediction from this model is $224,228. The sum of all the residuals can also be adjusted to take into consideration the value of the b coefficient and the range of the X values; this yields a *standard error* for the b coefficient -- which is used in the t test for the significance of the slope.

Here's a few lines of code that allow us to do a regression of these house price data.

```
proc reg data=hedonic.sales2004;
where (br ne 0) and (bth ne 0) and (kit ne 0) and (sqft ne 0);
        model sold_price= sqft;
        title "Vancouver Simple Illustration";
        run;
```

You'll notice there's a "where" clause. I excluded many observations before running the model: the dataset has many sales where data are missing for the number of bedrooms (br) and bathrooms (bth), and some records are even missing information on size (sqft). But for those sales with sufficient information, the model works reasonably well:

```
                 Vancouver Simple Illustration              07:02 Monday, November 7, 2011  17
                                               The REG Procedure
```

Model: MODEL1
Dependent Variable: SOLD_PRICE

Number of Observations Read	3732	1
Number of Observations Used	3732	

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	1.859881E14	1.859881E14	3699.19	<.0001
Error	3730	1.875372E14	50278059742		
Corrected Total	3731	3.735253E14			

Root MSE	224228	R-Square	0.4979
Dependent Mean	612627	Adj R-Sq	0.4978
Coeff Var	36.60101		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	53177	9903.58908	5.37	<.0001
SQFT	1	225.28664	3.70410	60.82	<.0001

SAS Output: Results for the Simple Regression.

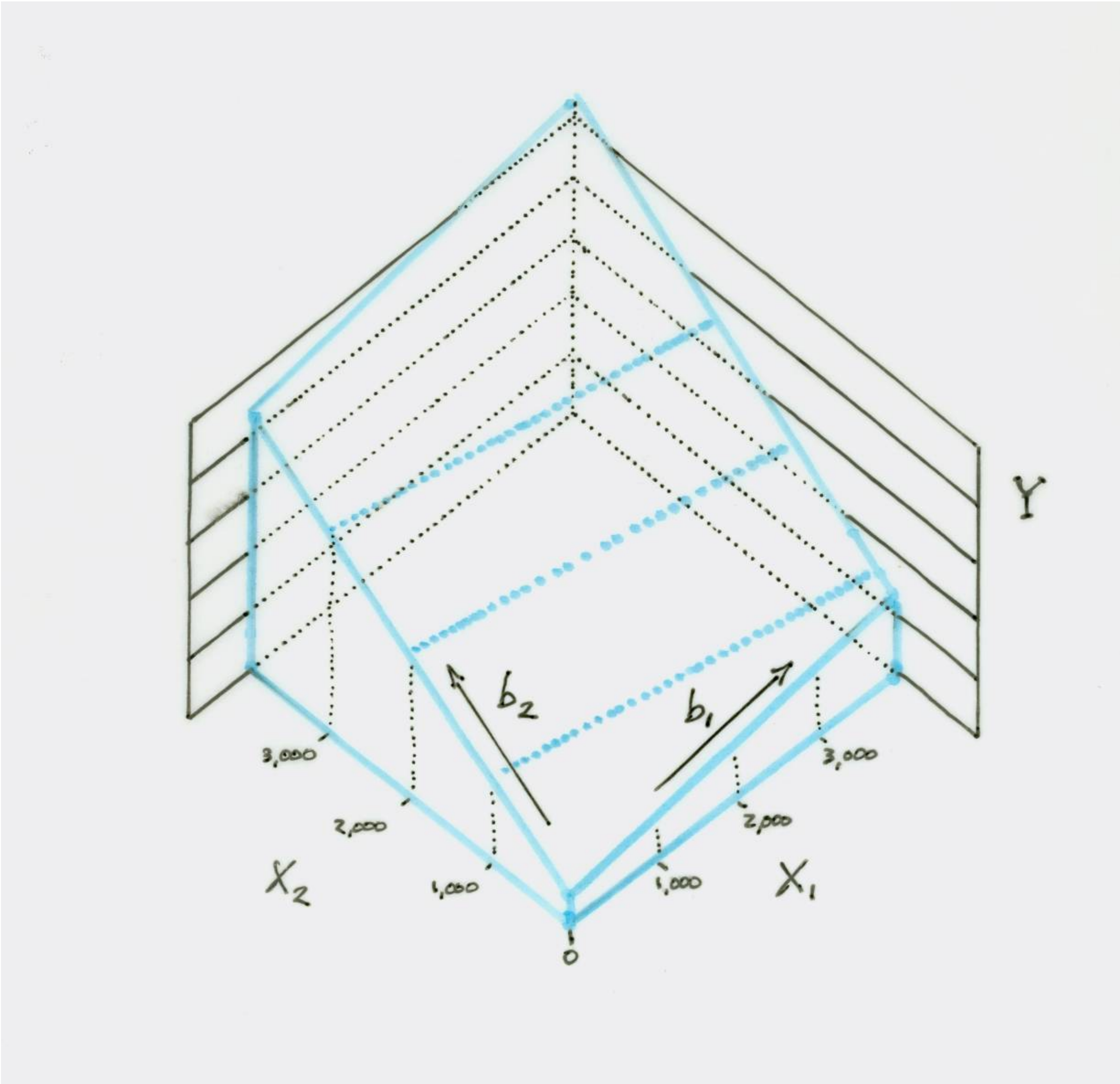
There's a lot of information here, but focus on the things that matter. The number of observations is 3,732. The R-squared value is 0.4979, which is the proportion of variance in sales price that can be attributed to variations in house size. The dependent mean -- the average sales price -- is $612,627. The intercept (a) is $53,177, and the slope coefficient (b) is $225.29. The average prediction error is $224,228, and the t value for the SQFT slope coefficient is very large. The Pr > |t| column is a test for the chance that we could observe a slope coefficient this strong purely by chance -- even if there were really no relationship between size and price. The probability value in this case is tiny -- less than 0.0001 -- indicating that the b value is very reliable. A t value of 2.0 yields a probability of about 0.05; any t value larger than 2 - and any probability value less than 0.05 -- is usually regarded as **statistically significant**.

A Multivariate Hedonic Model

This might be a bit boring by now: more space, higher price ... *duh!* Hedonic models are really only useful and interesting for complex commodities with lots of different attributes. So we should extend the simple regression model to include other variables. Let's add just one more:

$$Y = a + b_1X_1 + b_2X_2$$

Before, we just had one independent variable (X), but now we have two (X_1 and X_2). With univariate regression, we fit a least-squares line to the two-dimensional scatter of points. With multivariate regression with two predictors, we fit a two-dimensional plane into a three-dimensional cloud of points. If we try to visualize a two-dimensional plane fit into three dimensions, it might look something like this:



Vizualizing Multiple Regression with Two Predictors.

Note that the slope with respect to one variable -- b_1, which measures the relationship between Y and X_1 -- can be different from the slope in another direction. There's a separate slope coefficient, b_2, which measures the effect of X_2 on Y. In this drawing, both beta coefficients are positive -- you walk "uphill" with increases in X_1 and with increases in X_2. But it's entirely possible to find cases where one slope coefficient is positive (uphill) while another is downhill (negative). What matters here is that when we regress one dependent on more than one independent variable, each of the beta coefficients tells us the effect of one predictor **while holding the other predictor constant**: in the drawing above, b_1 measures the effect of X_1 on Y, while holding constant the effect of X_2. This is also called measuring the effect of one variable while **controlling for** another.

There's nothing that keeps us to this limited number of dimensions. We can extend the model beyond three dimensions, even if we can't draw them. But in your mind's eye, try to imagine four, five, or more dimensions -- all those many characteristics of houses that different buyers are searching for in a complex, competitive market:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 \ldots$$

... and so on.

There are a few technical complications with multiple regression. For our purposes here, the most important problem is that the model can be biased if the independent predictors are too closely related to one another; this is called **multicollinearity**. A "tolerance" statistic helps us see if this is a problem; values above 0.20 mean that the model is fairly reliable.

Consider house prices as a function of the size of living space, along with several other desirable characteristics: the number of bedrooms (BR), bathrooms (BTH), kitchens (KIT), and the size of the lot (LOT_SZ_SF). We also have a set of dichotomous variables -- indicators that can take a value of 0 for no (the characteristic is not present), and 1 for yes (the characteristic is present). One of the dichotomous measures we have is whether the house has what the realtor describes as an attractive view of the city, Stanley Park, or the North Shore mountains. Another set of dichotomous variables indicate the age of the house: these age variables omit one category -- which in this case refers to housing units built in the last five years. The omitted category is also known as the "reference" category. This is the category that all the others are compared with.

Vancouver Full Hedonic Model 10:20 Wednesday, July 7, 2010 3
The REG Procedure
Model: MODEL1
Dependent Variable: SOLD_PRICE

Number of Observations Read 3732
Number of Observations Used 3732

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	2.297098E14	2.088271E13	540.16	<.0001
Error	3720	1.438155E14	38660076314		
Corrected Total	3731	3.735253E14			

Root MSE	196622	R-Square	0.6150
Dependent Mean	612627	Adj R-Sq	0.6138
Coeff Var	32.09484		

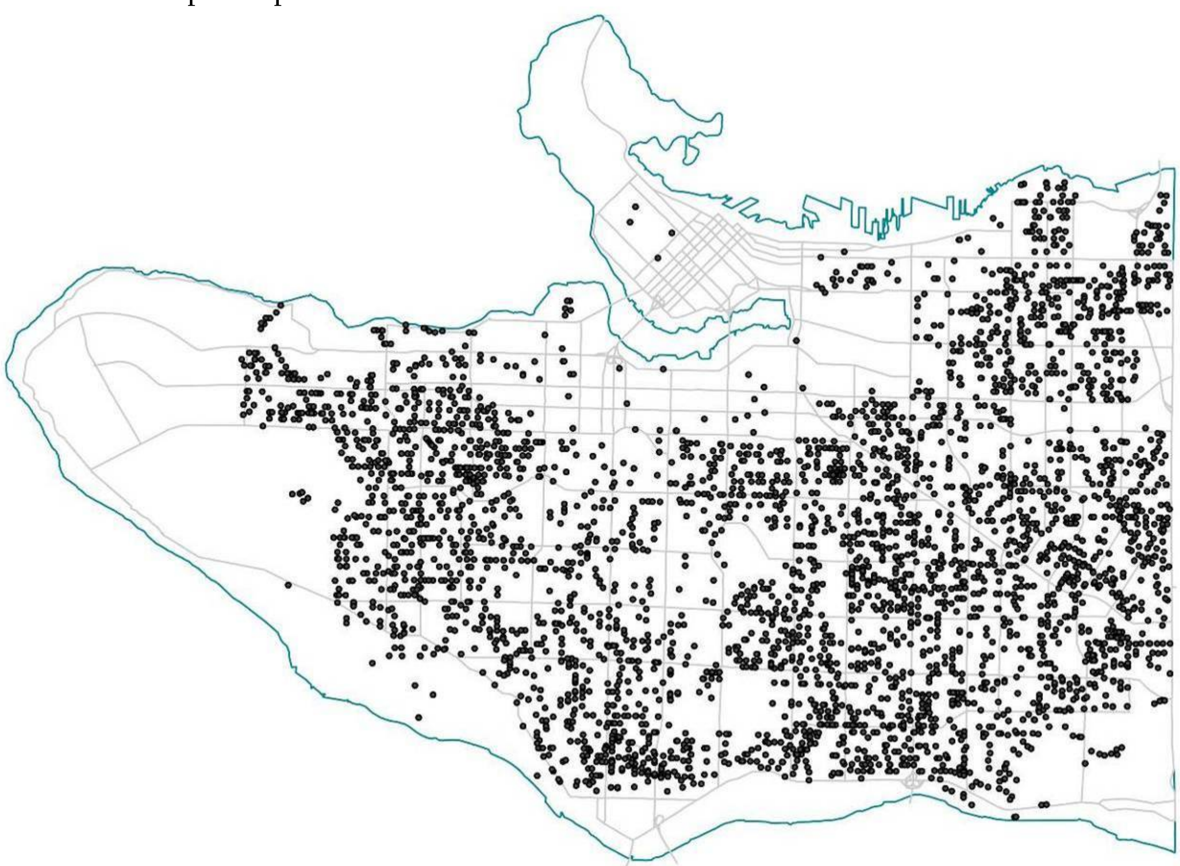
Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Tolerance
Intercept	Intercept	1	236357	21518	10.98	<.0001	.
BTH		1	93857	4964.77298	18.90	<.0001	0.29561
BR		1	-39573	3072.92986	-12.88	<.0001	0.60631
KIT		1	-74075	6075.48904	-12.19	<.0001	0.81672
SQFT		1	183.90763	4.44725	41.35	<.0001	0.53342
LOT_SZ_SF_		1	0.92851	0.23486	3.95	<.0001	0.97855
n_view		1	16610	8142.93454	2.04	0.0414	0.98780
n_agex	age unknown	1	4352.89979	9046.95819	0.48	0.6304	0.61279
n_age1	50 or more years old	1	-37628	15687	-2.40	0.0165	0.16858
n_age2	20 - 49 years old	1	-124855	15213	-8.21	<.0001	0.27762
n_age3	10 - 19 years old	1	-152003	14616	-10.40	<.0001	0.47278
n_age4	5 - 9 years old	1	-80023	16061	-4.98	<.0001	0.58441

SAS Output: Results for the Full Hedonic Model.

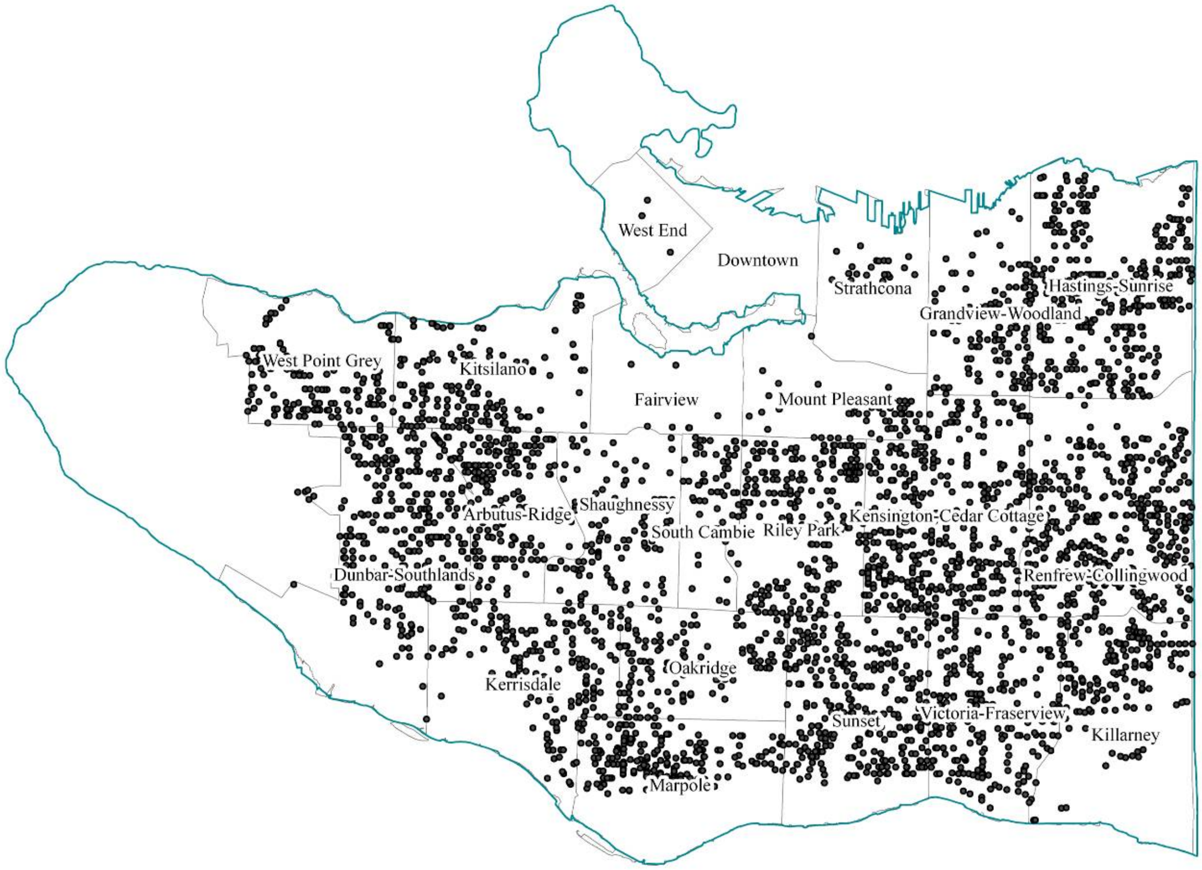
This model yields interesting results. With just seven characteristics of homes -- number of bathrooms, bedrooms, and kitchens, the area of the dwelling and its lot, whether the home has a view, and the age of the structure -- we can account for more than three-fifths of the variation in home sales prices: note the R-squared value of 0.61. (The adjusted R-squared value penalizes the result based on the number of independent variables added to the model.) All of the variables contribute significantly to the model: the only indicator with an insignificant parameter estimate (where the probability of a larger t value occurring by chance is higher than 5 percent) is that for buildings where we do not have reliable information on the age of the structure. All other variables are significant: sales prices increase for larger homes on larger lots with more bathrooms and where realtors identify an attractive view; after adjusting for the size of the unit and the number of bathrooms, more bedrooms actually reduce the sales price. Newer units are favored by the market: compared to units built in the previous four years, homes that are between 10 and 19 years old sell for a discount of more than 152 thousand dollars. The age discount moderates for older units, tapering off to less than 38 thousand dollars for houses older than half a century.

So far, so good. These equations and tables of output are how legions of housing economists and realtors analyze housing markets. But we're geographers, so we need to keep in mind that each of these home sales is occurring on the context of space and place. So we remind ourselves of this fact with a simple map of all the sales:



Single-Family Home Sales in the City of Vancouver. Source: Real Estate Board of Greater Vancouver (2005). *Multiple Listing Service Data*. Vancouver: Vancouver Real Estate Board and Foundation.

Here's an alternative view, with the neighbourhood boundaries as recognized by the City of Vancouver:



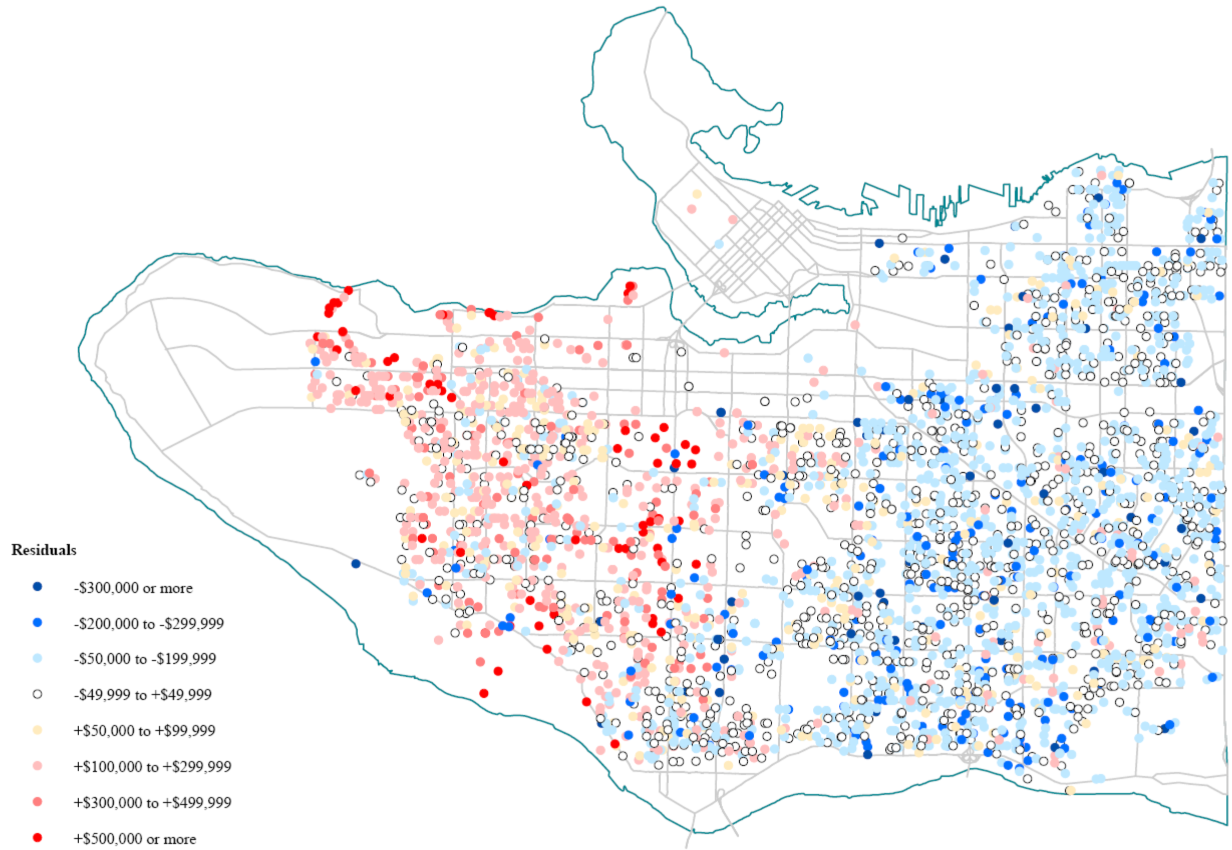
Single-Family Home Sales in the City of Vancouver, with Neighbourhood Names. Source: Real Estate Board of Greater Vancouver (2005). *Multiple Listing Service Data.* Vancouver: Vancouver Real Estate Board and Foundation.

But a map is even more useful if we use it to analyze the residuals from our model. Recall that the residual is the observed sales price, minus the model-predicted price. Residuals measure the accuracy of our model. Mapping the residuals helps us understand whether space and place matter in the model. As a general rule, if there is anything that "makes sense" in the patterns of your map of residuals, then there is some spatial process going on that the model is not accounting for.

In this case, the pattern of residuals does make a lot of sense. There are lots of underpredictions on the West Side, and lots of over-predictions on the East Side.

The largest residual is a 2,800 square foot home, with 7 bedrooms, 3 bathrooms on Point Grey Road in Kitsilano that sold for $2.82 million; the listing provided no information on the age of the home. The model predicted a sales price of only 521 thousand, yielding an under-prediction of more than 2.3 million. Eleven other properties had residuals of more than $1 million: one in Kitsilano, four in Point Grey, two in Kerrisdale, two in South Granville, one in Shaughnessy, and one in Quilchena. At the other extreme, the model over-predicted the sales prices for seven properties by at least 500 thousand dollars: one in Collingwood, one in Kerrisdale, one in

Knight, one in Shaughnessy, one in Grandview, one in Oakridge, and one in the valley section of Renfrew.



Residuals from Vancouver Home Sales Model. Residuals, calculated as the observed value minus the model-predicted value, measure the accuracy of a regression. While the Vancouver model is reasonably accurate for the city overall, its fit varies dramatically once we consider the distribution of residuals across space. Positive residuals occur when the model under-predicts the sales prices: notice that for several dozen homes shown in bright red, the observed sales prices are more than half a million dollars above what we would expect on the basis of all the characteristics included in the model. On the other hand, several dozen homes shown in deep blue have *negative* residuals of more than $300,000: these homes sold for much less than what we would expect on the basis of their characteristics. Homes where the model does a reasonably good job -- residuals of no more than $50,000 positive or negative, shown as white dots -- are scattered across the entire city. But the positive residuals are heavily concentrated on the West Side, while the negative residuals are clustered primarily on the East Side.

There are several ways to explore this geographical variation. Let's consider four.

First, we can define variables for different parts of the city, and add these as dichotomous variables to the hedonic model. This approach tests whether particular areas have higher or lower sales prices, after considering all of the housing characteristics already included in the model. In this case, our data provide information on thirty-two separate parts of the city identified by real estate professionals. To keep things simple for a preliminary test, we'll just define variables for a few neighborhoods, testing whether each of these areas shows significant price variations compared to the rest of the city.

Vancouver Model with Neighborhood Tests 2
10:20 Wednesday, July 7, 2010

The REG Procedure
Model: MODEL1
Dependent Variable: SOLD_PRICE

Number of Observations Read	3732
Number of Observations Used	3732

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	16	2.535639E14	1.584774E13	490.78	<.0001
Error	3715	1.199614E14	32291091298		
Corrected Total	3731	3.735253E14			

Root MSE	179697	R-Square	0.6788
Dependent Mean	612627	Adj R-Sq	0.6775
Coeff Var	29.33224		

Parameter Estimates

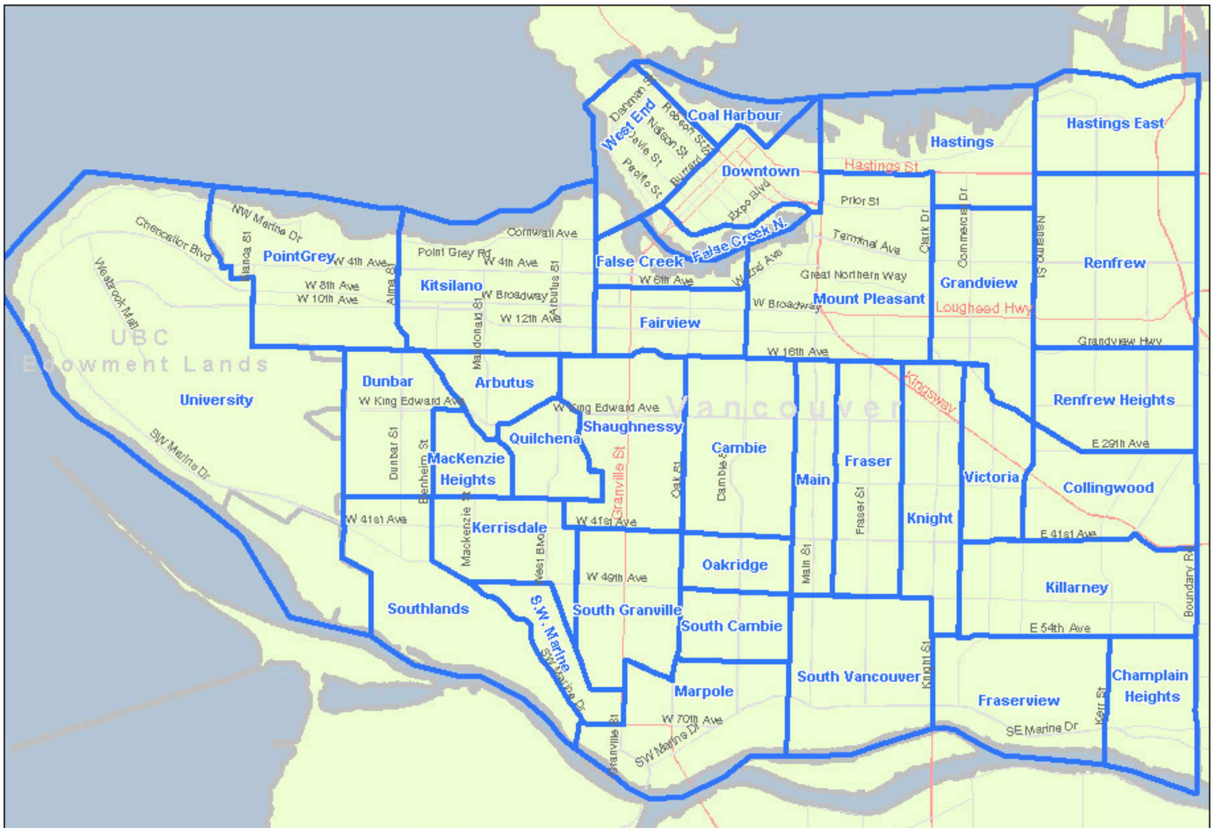
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Tolerance
Intercept	Intercept	1	268597	19821	13.55	<.0001	.
BTH		1	83430	4556.06254	18.31	<.0001	0.29320
BR		1	-35070	2815.52850	-12.46	<.0001	0.60326
KIT		1	-63587	5601.00221	-11.35	<.0001	0.80265
SQFT		1	166.52057	4.18457	39.79	<.0001	0.50323
LOT_SZ_SF_		1	0.92081	0.21477	4.29	<.0001	0.97746
n_view		1	13187	7558.55087	1.74	0.0811	0.95758
n_agex	age unknown	1	-1717.90190	8293.05201	-0.21	0.8359	0.60912
n_age1	50 or more years old	1	-66855	14414	-4.64	<.0001	0.16679
n_age2	20 - 49 years old	1	-130843	13917	-9.40	<.0001	0.27710
n_age3	10 - 19 years old	1	-143009	13365	-10.70	<.0001	0.47231
n_age4	5 - 9 years old	1	-70972	14683	-4.83	<.0001	0.58407
n_shaughn	Shaughnessy	1	308844	20880	14.79	<.0001	0.87166
n_hasting	Hastings	1	-84249	17517	-4.81	<.0001	0.96873
n_pntgrey	Point Grey	1	301064	16064	18.74	<.0001	0.96171
n_mtpleas	Mount Pleasant	1	-72210	21336	-3.38	0.0007	0.97795
n_ktslano	Kitsilano	1	213193	16126	13.22	<.0001	0.96812

SAS Output: Neighborhood Tests.

This approach reveals significant variations. Hastings and Mount Pleasant, zones of the city traditionally associated with moderate- or lower-income homeowners or industrial land uses, have sales prices much lower than the citywide level for the same kinds of homes. All else constant, a home in Hastings sold for about 84 thousand dollars less than the same home elsewhere in the city; in Mount Pleasant, the corresponding discount was about 72 thousand dollars. On the other hand, the well-established bastions of elite wealth -- Shaughnessy and Point Grey -- retain their historic premiums. Homes in Point Grey sold for more than 301 thousand dollars more than the same kinds of structures elsewhere in the city, while the locational premium in Shaughnessy approached 309 thousand dollars.

The second way to explore these geographical variations is to estimate the regression model separately for different neighborhoods. This approach is best when you suspect not just that there might be geographical variation in prices, but that the relationship between prices and the characteristics might be systematically different across various parts of the city. Estimating the full hedonic model above for each of 27 separate neighborhoods across the city yields the table on the following page.

Note that the neighborhood names used by the Realtors are not precisely the same as those used in the official designations by the City of Vancouver. This is a common problem in urban-geographical research: different public and private organizations often have different ways of organizing urban space to collect information about the things that matter for their operations. An additional reference map of neighborhoods used in local real estate marketing is included below.



Neighborhood Definitions Used in Vancouver Real Estate. *Source:* Pointelligence, Inc. (2012). *Vancouver Neighbourhoods and Community Areas Used in the MLS System.* Vancouver: available at http://www.blocktalk.ca, reproduced here pursuant to Sections 29 ("Fair dealing for the purpose of research, private study, education, parody, or satire") and 30.04 ("work available through Internet") provisions of Canada Bill C-11.

Vancouver Home Sales Model, Estimated by Neighborhood.

Neighborhood	Arbutus		Cambie		Collingwood		Dunbar		Fraser VE		Fraserview		Grandview	
Number of sales	109		137		198		171		206		136		156	
Model fit (R-squared)	0.81		0.69		0.82		0.79		0.69		0.84		0.53	
Average sales price	$875,007		$ 692,784		$405,103		$860,377		$429,793		$516,490		$425,655	
Variable	Parameter	Pr > |t|	Parameter	Pr > |t|	Parameter	Pr > |t|	Parameter	Pr > |t|	Parameter	Pr > |t|	Parameter	Pr > |t|	Parameter	Pr > |t|
Intercept	572,182	<0.01	455,152	<0.01	312,058	<0.01	434,108	<0.01	243,740	<0.01	297,809	<0.01	329,871	<0.01
Bathrooms (number)	- 4,429	0.83	32,680	0.01	9,478	0.08	33,826	0.04	30,023	<0.01	15,259	0.13	20,958	0.05
Bedrooms (number)	- 26,074	0.03	- 5,521	0.43	- 3,531	0.28	- 11,828	0.27	- 9,191	0.02	3,190	0.52	- 2,100	0.70
Kitchens (number)	22,178	0.43	- 7,519	0.60	242	0.97	66,439	0.00	3,938	0.61	- 29,831	0.01	- 4,945	0.64
Floor area (square feet)	224.90	<0.01	92.15	0.00	60.62	<0.01	130.61	<0.01	60.78	<0.01	83.97	<0.01	64.02	<0.01
Lot size (square feet)	- 6.10	0.48	- 2.52	0.59	20.36	<0.01	38.54	<0.01	23.77	<0.01	16.14	<0.01	10.79	0.16
View (dummy)	109,475	<0.01	50,759	0.01	5,872	0.44	83,483	0.00	7,611	0.45	19,700	0.05	45,386	0.01
Age of building not specified	- 23,464	0.55	7,533	0.68	- 23,051	0.01	3,706	0.89	- 26,323	0.01	1,878	0.92	- 37,447	0.01
Age of building 50 years or more	- 285,630	<0.01	- 79,684	0.04	- 142,806	<0.01	- 345,020	<0.01	- 78,813	<0.01	- 125,019	<0.01	- 103,100	0.00
Age of building 20-49 years	- 355,080	<0.01	- 23,321	0.58	- 141,295	<0.01	- 400,550	<0.01	- 84,464	<0.01	- 133,372	<0.01	- 129,994	0.00
Age of building 10-19 years	- 346,665	<0.01	- 76,637	0.03	- 74,163	<0.01	- 313,421	<0.01	- 70,004	0.00	- 101,615	<0.01	- 70,744	0.17
Age of building 5-9 years	- 208,811	<0.01	- 22,959	0.51	- 31,063	0.10	- 197,415	<0.01	- 73,274	0.00	- 36,890	0.13	- 92,365	0.08

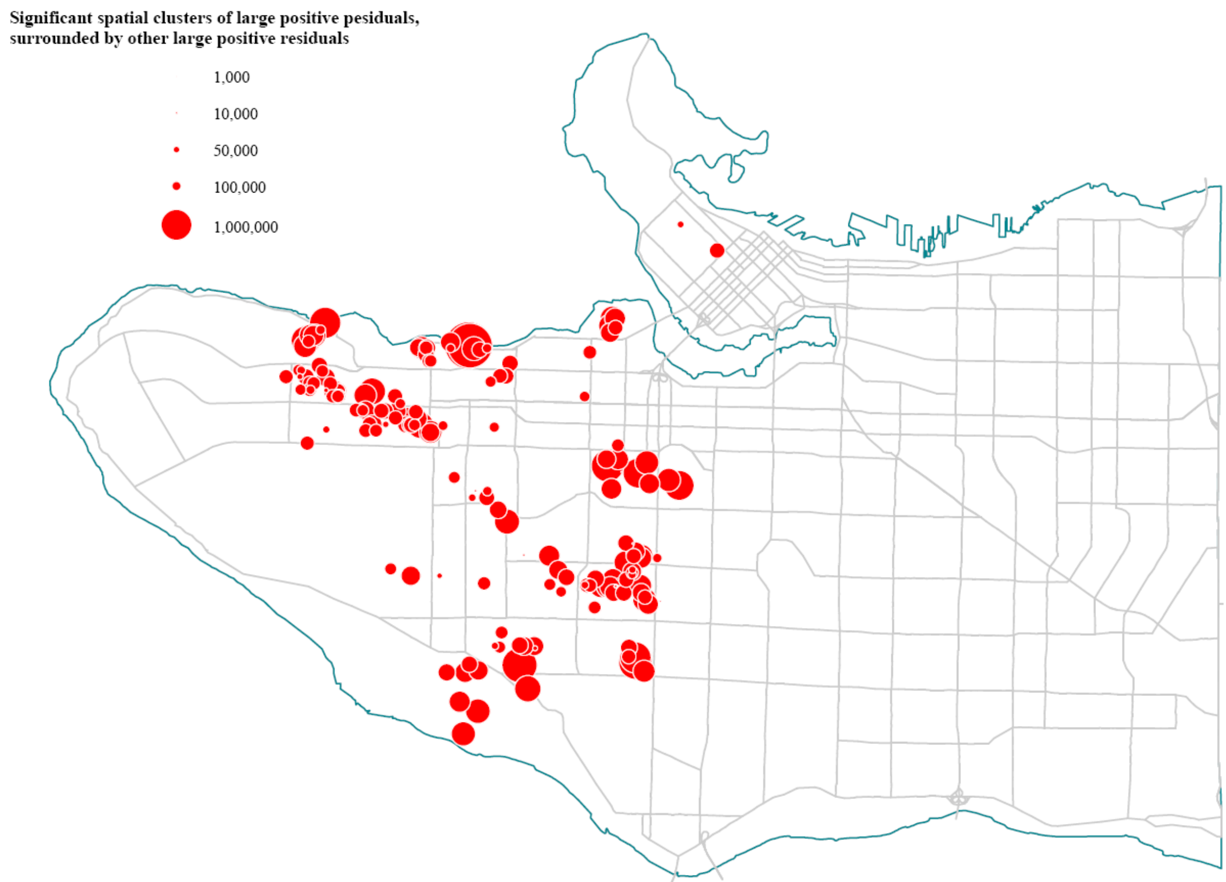
Neighborhood	Hastings		Kerrisdale		Killarney		Kitsilano		Knight		MacKenzie		Main	
Number of sales	112		105		228		133		197		67		112	
Model fit (R-squared)	0.8		0.74		0.87		0.38		0.8		0.82		0.45	
Average sales price	$422,457		$ 895,552		$487,331		$785,037		$422,054		$895,991		$464,497	
Variable	Parameter	Pr > |t|	Parameter	Pr > |t|	Parameter	Pr > |t|	Parameter	Pr > |t|	Parameter	Pr > |t|	Parameter	Pr > |t|	Parameter	Pr > |t|
Intercept	222,181	<0.01	375,154	0.01	257,688	<0.01	280,135	0.08	310,382	<0.01	484,576	<0.01	226,898	0.04
Bathrooms (number)	32,628	<0.01	41,736	0.15	20,628	<0.01	23,120	0.51	17,412	0.01	42,906	0.06	40,614	0.01
Bedrooms (number)	- 17,133	0.00	- 46,551	0.04	- 4,664	0.13	16,368	0.45	6,496	0.06	- 6,718	0.69	- 7,260	0.40
Kitchens (number)	- 6,264	0.50	56,412	0.30	4,291	0.39	42,027	0.32	- 11,224	0.04	- 49,865	0.21	- 1,149	0.95
Floor area (square feet)	70.96	<0.01	143.04	<0.01	65.32	<0.01	104.90	0.02	34.26	0.00	63.96	0.09	64.47	0.00
Lot size (square feet)	32.65	<0.01	55.74	<0.01	31.31	<0.01	39.14	0.06	19.24	<0.01	63.98	<0.01	10.66	0.29
View (dummy)	51,303	<0.01	397	1.00	- 4,571	0.76	278,049	0.00	13,623	0.07	97,764	0.01	50,510	0.09
Age of building not specified	- 26,032	0.03	17,749	0.78	- 20,109	0.05	39,470	0.44	- 16,253	0.06	37,186	0.37	- 16,564	0.37
Age of building 50 years or more	- 98,170	0.00	- 335,707	0.00	- 143,714	<0.01	- 184,194	0.18	- 114,655	<0.01	- 308,680	<0.01	7,244	0.94
Age of building 20-49 years	- 105,382	0.00	- 345,657	0.00	- 135,202	<0.01	395,943	0.02	- 115,845	<0.01	- 278,899	0.00	- 34,092	0.72
Age of building 10-19 years	- 72,542	0.01	- 210,905	0.02	- 77,327	<0.01	- 147,173	0.35	- 57,527	0.00	- 171,352	0.00	- 1,198	0.99
Age of building 5-9 years	- 64,527	0.03	- 153,217	0.13	- 38,246	0.00	- 278,287	0.11	- 18,938	0.23	- 106,891	0.12	77,088	0.44

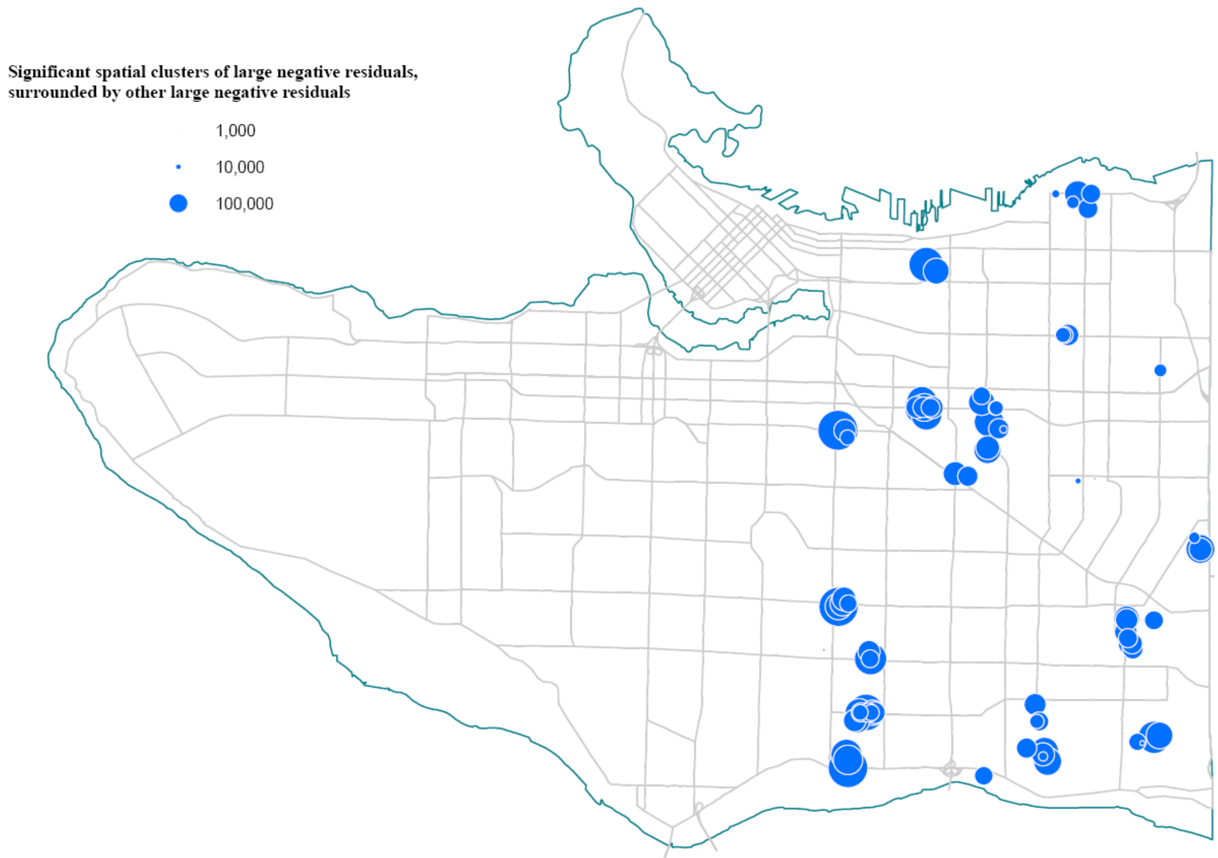
Neighborhood	Marpole		Mount Pleasant		Oakridge		Point Grey		Quilchena		Renfrew H		Renfrew V	
Number of sales	126		74		47		135		52		204		258	
Model fit (R-squared)	0.79		0.59		0.89		0.62		0.8		82		64	
Average sales price	$573,487		$ 428,646		$671,727		$985,236		$996,856		$429,291		$418,201	
Variable	Parameter	Pr > |t|	Parameter	Pr > |t|	Parameter	Pr > |t|	Parameter	Pr > |t|	Parameter	Pr > |t|	Parameter	Pr > |t|	Parameter	Pr > |t|
Intercept	325,469	<0.01	79,816	0.51	436,844	<0.01	560,317	<0.01	797,047	0.00	245,455	<0.01	230,461	<0.01
Bathrooms (number)	29,506	0.00	14,281	0.44	27,037	0.35	25,991	0.36	3,706	0.91	31,487	<0.01	33,072	<0.01
Bedrooms (number)	- 4,266	0.46	- 30,953	0.00	- 37,465	0.00	- 1,638	0.93	- 3,423	0.90	- 4,627	0.12	5,035	0.16
Kitchens (number)	827	0.94	19,612	0.37	- 17,554	0.60	- 20,886	0.65	- 32,982	0.61	- 3,922	0.45	- 1,445	0.84
Floor area (square feet)	74.35	<0.01	168.73	<0.01	158.82	<0.01	189.19	<0.01	146.78	0.01	37.53	0.00	1.65	0.44
Lot size (square feet)	26.46	<0.01	17.52	0.14	0.08	0.40	21.01	0.11	52.24	0.00	32.01	<0.01	36.00	<0.01
View (dummy)	7,859	0.59	32,735	0.34	38,699	0.47	177,300	<0.01	83,295	0.12	9,407	0.09	9,318	0.20
Age of building not specified	- 2,915	0.87	398	0.99	- 7,074	0.86	55,286	0.30	- 28,686	0.76	- 5,991	0.44	1,474	0.87
Age of building 50 years or more	- 149,291	<0.01	- 30,218	0.78	- 140,238	0.09	- 393,569	<0.01	- 668,882	<0.01	- 109,034	<0.01	- 83,257	<0.01
Age of building 20-49 years	- 141,727	<0.01	- 27,640	0.81	- 125,400	0.04	- 437,599	<0.01	- 735,624	<0.01	- 90,675	<0.01	- 81,885	<0.01
Age of building 10-19 years	- 88,096	<0.01	- 6,362	0.95	- 103,415	0.01	- 438,353	<0.01	- 663,111	<0.01	- 60,575	<0.01	- 39,559	0.02
Age of building 5-9 years	- 42,081	0.11	- 84,160	0.54	27,184	0.65	- 166,386	0.06	- 375,441	0.00	- 55,108	0.00	- 16,368	0.33

Neighborhood	S.W. Marine Dr.		Shaughnessy		South Granville		South Van		Southland		Victoria	
Number of sales	56		87		163		224		71		112	
Model fit (R-squared)	0.85		79		0.79		0.8		0.79		0.87	
Average sales price	$847,286		$1,328,867		$987,418		$426,566		$937,873		$431,288	
Variable	Parameter	Pr > |t|	Parameter	Pr > |t|	Parameter	Pr > |t|	Parameter	Pr > |t|	Parameter	Pr > |t|	Parameter	Pr > |t|
Intercept	- 15,346	0.93	355,524	0.11	424,767	<0.01	364,537	<0.01	777,094	<0.01	291,951	<0.01
Bathrooms (number)	141,628	<0.01	64,254	0.08	39,906	0.06	9,124	0.05	64,641	0.04	22,167	0.00
Bedrooms (number)	- 50,226	0.05	- 24,378	0.37	- 57,197	0.00	933	0.73	- 53,733	0.01	- 2,078	0.59
Kitchens (number)	- 53,322	0.38	- 54,199	0.50	57,665	0.14	- 14,548	0.00	- 26,849	0.58	- 8,980	0.14
Floor area (square feet)	144.53	<0.01	126.99	0.00	183.45	<0.01	46.94	<0.01	92.49	0.00	49.62	<0.01
Lot size (square feet)	24.74	0.01	41.47	<0.01	31.45	0.00	13.80	<0.01	18.94	<0.01	26.12	<0.01
View (dummy)	- 17,991	0.84	403,800	0.01	186,588	0.05	15,463	0.01	- 6,806	0.93	4,062	0.72
Age of building not specified	82,088	0.32	69,708	0.30	7,042	0.87	- 11,290	0.16	2,933	0.96	- 20,404	0.10
Age of building 50 years or more	58,617	0.63	- 259,349	0.12	- 345,651	<0.01	- 136,361	<0.01	- 315,179	0.00	- 136,803	<0.01
Age of building 20-49 years	118,895	0.24	- 200,702	0.28	- 468,879	<0.01	- 125,378	<0.01	- 398,435	<0.01	- 125,516	<0.01
Age of building 10-19 years	- 118,286	0.21	- 96,404	0.56	- 384,823	<0.01	- 61,997	<0.01	- 295,235	0.00	- 72,634	<0.01
Age of building 5-9 years	- 91,454	0.33	124,036	0.47	- 133,470	0.05	- 43,417	0.00	- 287,486	0.01	- 47,996	0.01

Note: several neighborhoods had too few sales to estimate models, and were deleted: Champlain (9), Fairview (10), South Cambie (31), University (2), West End (4).

The third way to explore variations is to treat the residuals themselves as worthy of study. We can use the value and location of positive and negative residuals as data for explicitly spatial-statistical analysis. We can test whether high positive residuals tend to be clustered close to other high positive residuals -- and if strongly negative residuals are clustered close to strongly negative residuals. The best way to think of this approach is to imagine drawing a map with a statistical significance test: the technique screens out the patchwork of mixed high, low, and moderate residuals on the map shown above -- and identifies those statistically significant clusters of high and low residuals.





There's a fourth way to explore the geography of hedonic models. This is a modification of our first approach -- which involved coding a few neighborhoods with dichotomous indicators. In this case, we replace those indicators with ***characteristics of the neighborhoods***. We can get detailed social and economic information down to a reasonably detailed spatial scale -- the census tract level -- from the Census of Canada. Here we include median household income, as a ratio of the metropolitan level, as an indicator of social class. Then we test whether the neighborhood life cycle works -- with equivalent houses in older neighborhoods fetching lower prices than the same homes in newer neighborhoods. Finally, we add measures of the racial and ethnic composition of the neighborhood to test whether the market shows any evidence of systematic racial inequality.

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                                          The REG Procedure
                                            Model: MODEL1
                                    Dependent Variable: SOLD_PRICE

                                Number of Observations Read         3732
                                Number of Observations Used         3732
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Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	21	2.767213E14	1.31772E13	505.01	<.0001
Error	3710	9.680396E13	26092711903		
Corrected Total	3731	3.735253E14			

Root MSE	161532	R-Square	0.7408
Dependent Mean	612627	Adj R-Sq	0.7394
Coeff Var	26.36716		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate	Tolerance
Intercept	Intercept	1	291927	45648	6.40	<.0001	0	.
BTH		1	61467	4160.30923	14.77	<.0001	0.23166	0.28413
BR		1	-20112	2575.69568	-7.81	<.0001	-0.08551	0.58246
KIT		1	-30876	5166.21692	-5.98	<.0001	-0.05721	0.76234
SQFT		1	138.23623	3.83352	36.06	<.0001	0.43298	0.48452
LOT_SZ_SF_		1	0.73352	0.19359	3.79	0.0002	0.03212	0.97213
n_view		1	33141	6848.04063	4.84	<.0001	0.04166	0.94266
n_agex	age unknown	1	-4340.72143	7467.48007	-0.58	0.5611	-0.00624	0.60705
n_age1	50 or more years old	1	-96040	13008	-7.38	<.0001	-0.15170	0.16548
n_age2	20 - 49 years old	1	-144165	12647	-11.40	<.0001	-0.18297	0.27116
n_age3	10 - 19 years old	1	-145345	12033	-12.08	<.0001	-0.14713	0.47077
n_age4	5 - 9 years old	1	-73024	13226	-5.52	<.0001	-0.06051	0.58168
mhhinc	median household income ratio	1	196287	14067	13.95	<.0001	0.19331	0.36395
b46	share units built before 1946	1	48713	44290	1.10	0.2715	0.02507	0.13449
b60	share units built 1946-1960	1	-134573	64267	-2.09	0.0363	-0.02615	0.44803
b70	share units built 1961-1970	1	286941	61141	4.69	<.0001	0.05576	0.49487
b80	share units built 1971-1980	1	-196331	83239	-2.36	0.0184	-0.03131	0.39640
b95	share units built 1991-1995	1	-258092	90391	-2.86	0.0043	-0.04371	0.29803
vm_ch	vismin Chinese	1	-185623	23903	-7.77	<.0001	-0.08478	0.58615
vm_bl	vismin Black	1	-983726	635403	-1.55	0.1217	-0.01538	0.70774
vm_fl	vismin Filipino	1	-457525	91692	-4.99	<.0001	-0.05622	0.55033
vm_se	vismin Southeast Asian	1	-1709815	137730	-12.41	<.0001	-0.15326	0.45834

Mean values for hedonic variables 18:17 Tuesday, July 13, 2010 115

The MEANS Procedure

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
SOLD_PRICE		3732	612627.09	316407.93	175000.00	2950000.00
BTH		3732	2.8657556	1.1925058	1.0000000	8.0000000
BR		3732	4.5120579	1.3452974	1.0000000	11.0000000
KIT		3732	1.5125938	0.5862738	1.0000000	5.0000000
SQFT		3732	2483.28	991.0475869	1.0000000	26002.00
LOT_SZ_SF_		3732	5307.11	13855.19	0	834840.00
n_view		3732	0.1969453	0.3977440	0	1.0000000
n_agex	age unknown	3732	0.2915327	0.4545291	0	1.0000000
n_age1	50 or more years old	3732	0.5171490	0.4997728	0	1.0000000
n_age2	20 - 49 years old	3732	0.2020364	0.4015731	0	1.0000000
n_age3	10 - 19 years old	3732	0.1160236	0.3202961	0	1.0000000
n_age4	5 - 9 years old	3732	0.0742229	0.2621685	0	1.0000000
mhhinc	median household income ratio	3732	1.0498301	0.3116141	0.2165000	2.1649000
b46	share units built before 1946	3732	0.2461795	0.1628154	0	0.6850000
b60	share units built 1946-1960	3732	0.1911372	0.0614765	0.0047000	0.3447000
b70	share units built 1961-1970	3732	0.1233439	0.0614846	0.0185000	0.3926000
b80	share units built 1971-1980	3732	0.1104348	0.0504605	0.0086000	0.4779000
b95	share units built 1991-1995	3732	0.0974360	0.0535910	0.0155000	0.3154000
vm_ch	vismin Chinese	3732	0.3750790	0.1445056	0.0192000	0.6625000
vm_bl	vismin Black	3732	0.0066736	0.0049472	0	0.0412000
vm_fl	vismin Filipino	3732	0.0436556	0.0388780	0	0.2132000
vm_se	vismin Southeast Asian	3732	0.0316387	0.0283611	0	0.1373000

SAS Output: Hedonic Model with Tests for Neighborhood Life Cycle and Racial Inequality.

These models yield interesting results. All else constant, increasing the household income ratio by 100 percent increases the price of a house by $196,287 compared to an otherwise identical house in a lower-income neighborhood. Increasing the share of units built in the 1970s from zero to 100 percent cuts sales prices by $196,331 -- a harsh verdict on the decade of disco and long hair. But notice that neighborhoods built in the early 1990s are even less attractive to the market.

The racial-ethnic composition variables are all statistically significant, with the exception of proportion visible minority Black; since there are relatively few residents of the Vancouver region who identify themselves as Black, their residential distribution is too small to reliably test for inequalities in the real estate market. But for those who identify themselves Chinese, Filipino, and Southeast Asian, the model suggests that the real estate market involves some degree of inequality. Increasing the proportion of a neighborhood's residents who identify themselves as Chinese from zero to 100 percent cuts a house price by $185,623, even when comparing houses of the same size, age, and other observable characteristics. Since the model also includes measures of the age of the housing stock of neighborhoods, the negative effect of Chinese neighborhood composition on prices cannot be blamed on the predictions of the neighborhood life cycle. There's something else going on here, even if our house-sales dataset may not give us enough information to find out exactly what it is. We cannot tell, for instance, the racial or ethnic identity of the *buyer* or *seller*; all we have are the characteristics of the houses, and then the income, age, and racial-ethnic characteristics of the *neighborhoods* surrounding each of the home sales. But the strongly negative effects of the visible-minority neighborhood variables are troubling indeed: real estate transactions seem to reflect underlying racial inequalities in how different parts of the city are valued in a competitive market system.

Let's consider one last refinement. In the model above, note the unexpected effects for the number of bedrooms -- implying that each additional bedroom actually reduces home value by about $20,000. This doesn't seem to make sense at first. But think carefully about neighborhoods and houses you've seen in different cities. Houses with lots of bedrooms are sometimes large, expensive mansions. But houses with lots of bedrooms might also be rooming houses, or homes divided up into several apartments. It's not a sure thing, therefore, that more bedrooms are always more desirable in the marketplace: we might be seeing non-linear effects. This also applies to the number of bathrooms and kitchens. So let's replace our continuous measures for these variables with dichotomous indicators:

Vancouver Model with Nonlinear Effects 00:43 Monday, November 5, 2012 45

The REG Procedure
Model: MODEL1
Dependent Variable: SOLD_PRICE

Number of Observations Read 3732
Number of Observations Used 3732

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	30	2.77376E14	9.245866E12	355.89	<.0001
Error	3701	9.614927E13	25979268769		
Corrected Total	3731	3.735253E14			

Root MSE	161181	R-Square	0.7426
Dependent Mean	612627	Adj R-Sq	0.7405
Coeff Var	26.30978		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate	Tolerance
Intercept	Intercept	1	299929	55490	5.41	<.0001	0	.
xbth_2	2 Bth	1	13132	11168	1.18	0.2397	0.02012	0.23749
xbth_3	3 Bth	1	64407	12788	5.04	<.0001	0.08642	0.23622
xbth_4	4 Bth	1	131525	15344	8.57	<.0001	0.15834	0.20385
xbth_5	5 Bth	1	231321	18385	12.58	<.0001	0.23416	0.20081
xbth_6	6 or more Bth	1	397144	44240	8.98	<.0001	0.08202	0.83320
xbr_2	2 BR	1	20938	36976	0.57	0.5713	0.01525	0.09588
xbr_3	3 BR	1	4028.61463	36119	0.11	0.9112	0.00472	0.03887
xbr_4	4 BR	1	-1552.14582	36167	-0.04	0.9658	-0.00219	0.02671
xbr_5	5 BR	1	-20127	36430	-0.55	0.5807	-0.02829	0.02652
xbr_6	6 or more BR	1	-50828	36720	-1.38	0.1664	-0.06738	0.02935
xkit_2	2 Kit	1	-20294	6369.17402	-3.19	0.0015	-0.03172	0.70187
xkit_3	3 or more Kit	1	-68308	14475	-4.72	<.0001	-0.04348	0.81944
SQFT		1	133.36426	3.91384	34.08	<.0001	0.41772	0.46281
LOT_SZ_SF_		1	0.74445	0.19328	3.85	0.0001	0.03260	0.97092
n_view		1	34999	6852.44487	5.11	<.0001	0.04400	0.93735
n_agex	age unknown	1	-3132.75859	7477.94997	-0.42	0.6753	-0.00450	0.60272
n_age1	50 or more years old	1	-95988	13690	-7.01	<.0001	-0.15161	0.14875
n_age2	20 - 49 years old	1	-137164	13619	-10.07	<.0001	-0.17408	0.23281
n_age3	10 - 19 years old	1	-145812	12299	-11.86	<.0001	-0.14760	0.44867
n_age4	5 - 9 years old	1	-80497	13411	-6.00	<.0001	-0.06670	0.56324
mhhinc	median household income ratio	1	199616	14062	14.20	<.0001	0.19659	0.36264
b46	share units built before 1946	1	48539	44258	1.10	0.2728	0.02498	0.13410
b60	share units built 1946-1960	1	-154691	64334	-2.40	0.0162	-0.03006	0.44514
b70	share units built 1961-1970	1	292926	61032	4.80	<.0001	0.05692	0.49448
b80	share units built 1971-1980	1	-200547	83205	-2.41	0.0160	-0.03198	0.39501
b95	share units built 1991-1995	1	-271145	90308	-3.00	0.0027	-0.04592	0.29728
vm_ch	vismin Chinese	1	-189872	23883	-7.95	<.0001	-0.08672	0.58460
vm_bl	vismin Black	1	-953506	634721	-1.50	0.1331	-0.01491	0.70617
vm_fl	vismin Filipino	1	-467650	91761	-5.10	<.0001	-0.05746	0.54711
vm_se	vismin Southeast Asian	1	-1718271	137584	-12.49	<.0001	-0.15402	0.45732

The nonlinear effects are clear. Compared to one-bedroom houses of the same size and age, two-bedroom houses fetch $20,938 more on the market. This amount increases only by $4,029 for three-bedroom homes, however, and then turns negative. Bathrooms, by contrast, show a consistently positive effect. Consider how a realtor or home improvement contractor would look at these results. Suppose you have a two-bedroom, two-bathroom home that's about "average" for the Vancouver market, and you're thinking of adding another room. A new bedroom would increase your current resale value by only about 0.6 percent (4,028/612,627); a new bathroom, by contrast, would boost your resale value by 10.5 percent (64,407/612,627).

Your Job

This is one of your project options. If you choose this project, there are several interesting possibilities.

First you could do a close investigation of the spatial patterns of residuals across different neighborhoods, using one of the maps above. What can you find about the different neighborhoods that help to explain the locational premium given to some parts of the city? How does this locational premium reflect the distinctive history and identify of that neighborhood? How does the locational premium reinforce community identity? Likewise, what can you find to make sense of the locational "penalties" assigned to other parts of the city?

You can use searches of local newspaper coverage to learn about how these issues are discussed in different neithborhoods.

Another option is to study the results of the models estimated separately across the different neighborhoods. What are the main differences in the coefficient estimates for different parts of the city? Does the evidence support the neighborhood life-cycle model, or does the evidence give us reason to rethink that model? If the neighborhood life-cycle model doesn't help us understand the market, what kind of revised model might be more useful?