Substitutability in the demand for housing over small distances

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Draft

This proto-paper can be shared with other researchers for comment & direction

Abstract

Some pairs of residential locations are better substitutes than others, perhaps even within two hundred meters' distance. As a result, rents and home prices can depart from the predictions of the most common urban models. The imperfect and varying substitutability between locations may arise due to preferences, information, or moving costs. Literatures in economics and complementary disciplines shed surprisingly little light on the spatial substitutability of housing, the housing search process, or the information accessed by housing searchers. Attempts to segment submarkets using reduced-form methods have yielded inconsistent results. What little we know suggests that spatial substitutability varies from place to place, is non-monotonic across space, and is endogenous to market conditions. Housing searchers vary widely, and their diversity can induce significant departures from the market outcomes of a world composed of average searchers. Spatial substitutability has implications for policy debates around gentrification and zoning.

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Table of Contents

Motivation

Standard urban models assume that every residence in a metro area is a good substitute for every other residence. Thus, the impact of a housing supply shock on prices would be equal across the metro. But researchers investigating the effects of new residential construction have found that housing prices in the immediate vicinity fall relative to prices slightly further away (Asquith, Mast, and Reed (2023), Li (2022), Pennington (2021)). This evidence is consistent with a departure from standard models: substitutability may decay across space. Alternatively, the micro evidence may merely reflect negative spatial externalities of new buildings. This paper reviews the available qualitative and quantitative evidence that would help us distinguish between those stories.

The degree of substitutability across space also has implications for political efforts to reform zoning. Advocates and analysts have generally believed that regional prices are closely linked to regional housing supply. But if substitutability is sufficiently low across space, new housing supply would have quite different effects in different places. This in turn would strengthen arguments for some types of reforms and weaken arguments for others.

Why locations might be imperfect substitutes

Models of housing demand in the Alonso-Mills-Muth and Rosen-Roback traditions assume that all locations within a city are perfectly substitutable. Spatial amenities and commute distance are additive (or log-additive) terms that are equally valued by all buyers. Buyers have full information. There are no costs to relocation.

We understand that the world departs from these assumptions in potentially important ways. It may even do so at a hyperlocal scale.

- Imperfect information can lead to departures from bid-rent arbitrage such that the few with information about lower prices in a specific neighborhood can take advantage of it by consuming more housing and raising their utility above the city standard. In other words, they can display downward sloping local demand.
- Relocation costs can have the same effect, although they are eroded over time.
- Unequal amenity valuations can have complex effects (see Couture et al (2023)), including generating downward sloping demand for neighborhoods that have scarcer amenities (Henderson (1991)).
- Pure location preferences - what we might call local ties or neighborhood loyalty - are a special case of amenity. These are demonstrated at the metro level by Zabek (2018). One can easily conceive of preferences for proximity to a family member, ethnic enclave, school, club, church, or place of personal meaning that are held by only a small share of potential residents.

The possible sources of downward-sloping hyperlocal demand may be impossible to distinguish if we only observe market outcomes. For example, a person who pays increasing rent to live in a specific neighborhood despite no change in amenities and no change in the rent of surrounding areas may do so because he is unaware that his rent has diverged from market rent, because relocating would be costlier,

because he values his location's distinct mix of amenities at a higher level than others, or because he has local ties.

In the case of a locational preference with "hard boundaries", like a school catchment area, there could be a discrete drop in substitutability at the boundary. In most other cases, we expect substitutability to decline with distance (or to exhibit a spotty pattern, for instance if the scarce amenity in question is something with multiple nodes, like access to a specific metro line or proximity to a laundromat).

In a clarifying exercise, Lee, Irwin, Irwin, and Miller (2021) test the "Chicago" and "Los Angeles" schools of urban thought, showing how statistical summaries of urban form correspond to differing theories of the city's social and economic patterns. To operationalize this, they test whether "distance-based amenities", such as access to downtown, or a residual "local amenity" are stronger predictors of changes in home prices in Columbus, Ohio from 2000 to 2015. They find that the latter dominate. The paper may claim too much: there is always risk in labeling a residual, and the regressions contain obvious, unremarked collinearity among the various "distance-based amenities." Still, it is undeniable that home prices in Columbus evolved in patterns that cannot readily be explained by an Alonso-Muth-Mills framework. The discipline's inability to say whether these departures are likely explained by 'simple' amenities or imperfect spatial substitutability is a measure of the open question this paper seeks to state.

Note: at some point, the following sketch needs to be replaced with a formal model in a new section.

As Henderson (1991) notes, the difference between substitutability and amenity effects is blurry. Consider a city in which dwellings are distinguished only by their access to amenity *A*. If new dwellings are constructed with high access to *A*, they would compete equally with all other dwellings in the city, all of which would face proportional declines in willingness to pay.

But if the city also has a second amenity, *B*, which only half the population values, dwellings will no longer be perfectly substitutable. The *B*-loving half of the population will tend to live in dwellings with high access to *B*. If new housing is added with high access to *B*, *B*-loving residents will be willing to pay more for it than *B*-indifferent residents. All else equal, demand for other dwellings with high access to *B* will decline more than demand for dwellings with low access to *B*.

If *B* is a spatially-accessed or -distributed amenity - such as a place of employment, a park, a view, air quality, school quality, or walkability - then demand will exhibit spatially decaying substitutability.

With brief reflection, one can convince oneself that virtually every amenity and dwelling feature is disproportionately valued by some segment of the population and most are spatially accessed or distributed.

As noted above, diverse valuation of amenities is just one way that imperfect spatial substitutability can arise; others include moving costs and incomplete information.

Mense (2023) adds an important interpretive wrinkle, arguing that "market integration" does not require substitutability (p. 6). He finds this effect in regional supply shocks caused by weather that delays completion of (mostly) single-family houses in Germany. He finds strong propagation of supply shocks throughout the entire housing market, crossing the line from owned to rental housing stock. He interprets this finding as a propagation via vacancy chains, noting that a large share of moves in Germany

(14.8%) are transitions from rental to ownership. He also shows that supply shocks are associated with potentially large changes in the number of new listings, suggesting long vacancy chains. (Point estimates cluster around four new vacancies per housing unit completed and standard errors allow anything from zero to eight). An alternative way of expressing Mense's finding is that we need to distinguish observable substitutability as an emergent, market-level phenomenon from substitutability in individual choice sets.

Spatially decaying substitutability clearly exists. But understanding its magnitude, its similarities across cities and segments of the housing market, and the relative importance of different potential reasons for imperfect substitutability are all open questions.

Open questions

The goal of this paper is to identify the scope of the unanswered questions about local housing demand facing urban economists and to tentatively suggest research avenues for narrowing our ignorance. Aside from interest for its own sake, the potential for hyperlocal housing demand and imperfect spatial substitutability have implications for several open questions.

1) Does market-rate housing supply decrease surrounding rents in gentrifying neighborhoods via supply/demand channels or by creating a local disamenity?
2) Do small jurisdictions have enough monopoly power over their own land use to increase affordability through supply channels? (This is the Hamilton (1978) hypothesis played backwards).
3) How should researchers addressing a host of local-housing-market questions ground their assumptions about the housing demand curve facing a neighborhood or municipality?
4) As parcel-level microdata become increasingly available, can researchers identify microfoundations behind the choices they make in modeling spatial housing demand?

One must also note that the question of hyperlocal elasticity is a subset of a broader empirical question which is hugely important in the debate about delivering housing affordability via supply: *How big are rent elasticities of housing demand?* Does a 10% increase in citywide housing stock decrease rents by 5%? 15%? Political careers are already being staked on this question.

I insist on "*elasticities*", not "*elasticity*" in the previous paragraph. An Econ 101 quiz might expect students to intuit that a longer timeframe and smaller geography would both increase the demand elasticity. The ideal answer to the broader question would actually be to estimate a surface of elasticities varying with time and space, and then allow policymakers to identify the relevant point for their own application. Although no paper is likely to even approach that ideal, having it in our minds can help motivate researchers. (Specifically, it can motivate them to carefully define the time and space over which they estimate an elasticity).

Two literatures - one very new and one venerable - motivated this paper by measuring some of the potential implications of spatially decaying substitutability. The next two sections review these literatures.

Local supply shocks

A commonly held view among residents of high-demand cities is that new multifamily construction in poor neighborhoods tends to accelerate gentrification. A series of papers has tested the effect of new construction on a few dimensions of gentrification and largely found the opposite. In particular, several papers have found a negative effect of new multifamily construction on rents only within a few blocks of the construction. Those papers' authors interpret their result to mean that demand is downward sloping at a hyperlocal level. For this to be true, the substitutability of apartments must decline noticeably across distances as small as a city block.

An alternative explanation would impose fewer restrictions on the demand system: new construction may simply introduce local disamenities that researchers are unable to observe. One researcher, Lin (2022), explicitly frames his research in this way, assuming (contrary to the rest) that demand is perfectly substitutable within each neighborhood in his sample. The remainder of this subsection reviews the literature on hyperlocal housing supply effects, not exclusively in gentrifying contexts.

There are two common identification strategies in this literature. Asquith, Mast, and Reed (2023) use both, making it a useful place to begin. They frame their investigation as a tug of war between "standard supply" effects and "counterintuitive" demand effects (p. 359). I would counter that the supply effect in question is itself non-standard, in the sense of departing from the assumption of perfect spatial substitutability that undergirds common urban economics models.

With their first identification strategy, which they call the "near-far specification", Asquith et al identify a differential rent effect of new construction at a distance of 0 to 250 meters versus 250 to 600 meters. Their identification relies on the assumption that trends in the inner circle and outer circle would be equal in the absence of construction. The effect size is -4.9% of rent.

For the second identification strategy, or "near-near specification", they use the 250-meter radius circle around buildings completed in 2019 as a control group for buildings completed in 2015 or 2016. This approach finds a statistically indistinguishable -6.2% of rent effect.

To confront the question of whether their negative hyperlocal rent effect arises via supply or disamenity, Asquith et al use a simple numerical example of spatially narrow search. They show that if all searchers limit themselves to a 550-meter radius circle, the substitutability between nearby properties can drop quickly across space. This model accounts well for the results of their near-far specification. However, it is in tension with their near-near specification. If properly identified, the near-near estimate should capture the most comprehensive supply plus (dis)amenity effect of new construction at its strongest point. If Asquith et al's argument is correct, the near-near result ought to be larger than the near-far result, which subtracts the supply plus (dis)amenity effect of the new building on apartments in the second-ring.

However, the point estimate of the near-near specification is statistically indistinguishable from the point estimate of the near-far specification. The standard errors are wide enough to allow that the hyperlocal effect is between 28 and 280 percent of the more comprehensive effect, with the point estimates

suggesting 80 percent. With such wide standard errors, we cannot reject the narrow search hypothesis that Asquith et al offer; but neither do we see a strong pattern of evidence in its favor.

Pennington (2021) uses 158 serious fires and San Francisco's glacial permitting process to identify exogenously-timed construction on parcels that have been vacant for years. Helpfully for current purposes, she distinguishes impacts at a variety of distances from the redeveloped parcel. Her estimates show that rents fall significantly at all distances up to about 1,000 meters (Figures 15a and 16a). The estimates for each distance bin are noisy enough that no spatial pattern would be detectable within that range. Likewise, new construction leads to fewer moves to poorer Zip codes - a proxy for displacement - up to 900 to 1500 meters (Figures 15b and 16b). In addition, she finds more moves both to and from richer Zip codes that decay with distance but remain above zero as far as 2,000 meters away (Figure 23).

Point estimates show no evidence of a strong "inner ring" rent reduction effect such as Asquith et al found. In the smallest ring she considers, 100 meters, Pennington finds several large, significant, but very imprecise estimates: eviction notices are fewer while business turnover and new construction are higher.

Table 1: Strategies to estimate the effects of hyperlocal supply shocks

Paper	Sample	Identification strategy	Distance	Time horizon	Implied demand elasticity range
Anenberg and Kung 2014	For sale listings in 4 metros	Timing of new listings	Up to 3,500m	Weeks	
Asquith et al 2023	Apts in low-income nbrhds of 11 central cities	Outer ring control group ("near-far")	250m treatment, 600m control	Up to 3 years	[-0.18,-.07]
		Timing of construction ("near-near")	250m	Up to 3 years	[-0.25, -0.06]
		Timing and distance ("triple difference")	250m treatment, 600m control	Up to 3 years	[-0.26, -0.09]
Blanco 2022	Chicago home prices	Synthetic control	~ 1,600m	Up to 10 years	
Damiano and Frenier 2020	Minneapolis rents	Outer ring control group	300m treatment, 800m control	Up to 5 years	
Li 2022	NYC rental	Timing of	152m	Up to 10	[-0.14, -0.05]

	income	construction		years	
Pennington 2021	SF Craigslist rental listings	Timing of construction	Up to 2,000m	Up to 3 years	

These detailed results and strong identification strategy do not put the paper's identification strategy beyond question. The clustering of fires in areas with older building stock implies that 'distance from fire' is to some extent correlated with income.[1] Another threat appears in Pennington's event study, which shows the principal rent decline arriving a year prior to the completion of construction and extending at least a kilometer from the site (Figure 13). Pennington argues that this is "consistent…with the nuisance effects of construction," an explanation that is unconvincing beyond the blocks nearest the site. After the anticipatory decline, rent remains constant for two years before dropping again.

Li (2022) exploits completion timing of high-rise New York City buildings - mostly condos - to conclude that supply effects overwhelm (positive) amenity effects and lower nearby rents. She tests results in a 152 meter (500 foot) circle, finding insignificant effects in a wider 152 to 304 meter outer ring.[2]

She estimates that a new high rise lowers rent by 1% and adds 0.1 restaurant within the smaller ring. Condos and rental buildings have indistinguishable effects on rents (p. 1345), which is consistent with congestion disamenity effects but only squares with a market-segmentation logic if newly-purchased condos are typically offered on the rental market.

Li also looks at different price tiers of buildings (using post-hoc rents) and finds that new construction has the strongest negative effect on the highest-rent buildings and no effect on low-rent buildings (p. 1349).

Damiano and Frenier (2020) also distinguish between price tiers (using pre-event rents) and find sharper results than Li, identifying increases in low-end rent and decreases in high-end rent. They use a specification most similar to Asquith et al's near-far approach, comparing rents in an inner "treatment" circle to those in an outer "control" ring. To choose the cutoff, they separately test effects in the 0 to 200 meter circle, 200 to 300 meter ring, and 300 to 400 meter ring against a 400 to 800 meter control ring. The effects are significant but declining in the first two bands and are precisely estimated near zero in the third ring. The authors thus proceed by pooling the 0 to 300 meter circle as a treatment group and the 300 to 800 meter ring as a control group.

They find no effect of new construction on rents in the middle half of the distribution. They find that treated bottom-quartile rents rise about 6 percent relative to the treatment group, while top-quartile rents fall about 3 percent. Both effects are estimated with some noise, as in other studies, and appear to reach their full magnitude after about 3 years.

The authors note that the high-end effect is consistent with a local supply effect: "For existing buildings in the same market tier as new construction, the new buildings serve as plausible substitutes for renters and inject more price competition into the neighborhood" (p. 28). The effect on the lower end of the

[1] By my count, Figure 4b shows that 30 of the 47 fires which resulted in new construction were in bottom-tercile income tracts.
[2] A Manhattan street block is typically 80x274 meters.

market is less obvious, especially in the absence of data on any amenities. New buildings could attract amenities or "signal to landlords that demand for their units may be increasing" (p. 29).

Although Damiano and Frenier's split-effect result is typically interpreted as a point in favor of gentrification worries, it does not comport well with the "endogenous demand" model of gentrification whereby each new building generates more demand than it satisfies. If that occurred, one would expect a positive price effect in the most substitutable buildings. Instead, Damiano and Frenier find a phenomenon more simply explained by landlord learning or endogenous amenities.[3]

Blanco (2023) studies demolitions of public housing in Chicago, which constituted extremely large supply shocks, had widely anticipated amenity effects, and displaced thousands. Blanco's ability to follow displaced residents adds a valuable layer of insight.

Blanco uses a synthetic control identification strategy. Relative to the ring-based approach, it has the virtue of keeping the control group further away from the treatment. The cost, of course, is that it relies on the assumption that parallel trends would have continued through the treatment period. An obvious risk to the identification strategy in this particular case is that the treated tracts are largely in centrally-located areas while the control tracts are all in the city's outer neighborhoods (Figure III).

Blanco finds effects not just in Census Tracts where public housing units were demolished, but also in neighboring tracts and second-ring tracts, relative to synthetic control groups made up of tracts from elsewhere in the city. Home prices rose 34%, 18%, and 10%, respectively, in the three treated rings.

Using tracts as units of distance is imprecise, but usually corresponds to larger distances than in the papers discussed above. Many Chicago tracts are rectangles one half or one quarter mile (805 or 402 meters) on a side, corresponding to distances between major roads in the city's grid. The distance from a public housing project to the far side of a second-ring tract is thus usually above 800 meters, often 1,600 meters, and sometimes more.

In tracts with public housing demolitions, the supply shock constituted a loss of 35% of all units (although the demolished units had high rates of vacancy and deterioration). Blanco models the displacement and amenity shocks together. Depending on the parameterization and assumptions, supply effects can amount to between 18% and more than 100% of the home price effect in nearby tracts. Greater spatial substitutability implies, in general, that amenities were more important and supply effects less important in raising prices. Other parameters, however, also play a large role.

Anenberg and Kung (2014) take advantage of the thinness of the home sale market at any given moment to identify the impact of a single new listing on nearby properties already listed for sale. Unlike the preceding papers, they identify an impact only on those homes in the process of transaction.

Although they focus on foreclosed properties, they ultimately find that the listing of a new house for sale - foreclosed or otherwise - induces marketers of nearby properties to lower their asking prices. They

[3] Specifically, high- and low-rent buildings could experience a large, positive amenity effect from nearby new construction while only high-rent buildings experience a countervailing substitution effect.

achieve identification via detailed temporal information: the shock occurs precisely in the week of a new listing.

However, “nearby” is surprisingly wide. For non-foreclosed listings, the effects of which are estimated more precisely (Appendix Figure 3), they find new listings result in price decreases as far as 3,500 meters away. For both types of listings, the effect is greatest in the immediate vicinity and fades noticeably within the first 800 meters.

Lin (2022) stands in noted contrast to these papers despite studying the same phenomenon as Asquith et al, Li, Pennington, and Damiano and Frenier. Lin assumes that new multifamily buildings are perfect substitutes within the small District of Columbia neighborhoods he studies. But they are disamenities to the immediate neighbors - buildings that face them across streets or alleys. Although Lin is unable (as of the most recent draft) to assign observed rental listings to specific building locations (high or low floors, for instance), he finds stronger disamenity effects when new buildings appear across narrower streets. The effect fades when buildings are more than 35 meters apart. This shows evidence that, unsurprisingly, the loss of privacy, viewshed, and sunlight associated with looking directly out at another apartment building is a disamenity. But it also raises questions about the identification of supply effects in other papers, most of which lump together adjacent buildings with those within a somewhat greater radius.

Tests of monopoly zoning power

At a significantly larger geographic scale, a literature dating to White (1975) hypothesizes that municipalities - especially large ones - might be able to exercise a degree of monopoly power by restricting housing supply.[4] Despite the much larger distance involved, this literature is informative in that imperfect substitutability between municipalities is an upper bound on the degree of substitutability between neighborhoods.

Hamilton (1978) and Fischel (1980) comprise the first debate about the hypothesis, but - especially in the former’s case - with standards of evidence that would not be publishable today. Their debate focused on jurisdictional size as the likeliest source of zoning power. Curiously, that dimension vanished in the literature that follows, yielding to non-spatial distinctions.

TK: LARGELY OUTSIDE of academia, advocates of regional government offered the reverse hypothesis: that larger jurisdictions will zone more permissively, for the same reason that Hamilton believed they would zone strictly…

Henderson (1991) returned to the question, helpfully noting that “monopoly power” can mean either that a town faces a downward-sloping demand curve or merely that it has “special amenity” value for some people, generating willingness to pay above opportunity cost. In a simple framework, he identifies optimal regulation and spending levels for a monopolistic suburb.

[4] Those discussing monopoly zoning power circa 1980 proposed that larger jurisdictions would zone more strictly to take advantage of their monopoly power by raising prices. But those who discuss zoning spillovers in the 2020s typically believe that small jurisdictions will be hesitant to loosen zoning because they are too small to generate affordability gains from expanded supply. The mechanism is the same, but the presumed political goals have changed.

Greater Boston, with its fixed partition into fiscally and regulatorily independent towns, has been a favored laboratory for testing the monopoly zoning hypothesis. Case and Mayer (1996) investigate Boston area cross-sectional price changes and find that "towns are not perfect substitutes for each other…town amenities and public services are not easily replicated or quickly adaptable to shifts in demand." Glaeser and Ward (2009) use Hub home sales from 2000-2005. They find that minimum lot size regulation modestly increases prices within a town, but that effect disappears if one controls for demographics or historical forest and density. Their findings are consistent with minimal, if any, monopoly power on the part of each town.

Zabel and Dalton (2011) use 750,000 transactions in 178 Eastern Massachusetts towns from 1987-2006, along with 27 inferred changes in minimum lot size, to estimate "Community Zoning Power" (CZP) for each town. CZP "determines the extent to which land use regulations are capitalized into the price of housing in a town" (p. 575). Under the hypothesis that zoning power arises from different valuations of common amenities, the authors define CZP as the distance between a town's amenity bundle and that of its closest substitute. They estimate CZP both from data on two amenities (job access and school test scores) and as a fixed effect residual from a hedonic regression. Using the latter estimate, the authors' model shows that a town with a high CZP could increase its home prices by over 15% using the same (drastic) minimum lot size increase that would increase prices by less than 5% in a low-CZP town (Figure 4).

The trio of Beantown papers is surprisingly non-spatial. In Zabel and Dalton's framework, for instance, it would have been straightforward to incorporate physical or travel distance between towns as well as distance within amenity space.

Ihlanfeldt (2007) uses data on properties in 100 Florida cities to show that the price-increasing effects of regulation do exist at the city level and are attenuated by the number of cities in the county. However, the key regression appears to be misspecified, such that the interaction term intended to identify the latter effect could be acting also as a fixed effect for urbanized counties.

Lin and Wachter (2020) look for evidence of spillover price effects from regulation. They use California home sales data provided by Zillow (ZTRAX) and a 1992 survey of land use regulations (CALURI) to construct a panel with plausibly exogenous variation in initial restrictiveness. They find that the price effect of the inverse distance weighted regulatory intensity of the 30 nearest Census Tracts is one-fifth as large as the direct effect of own-tract regulation. This finding is consistent with a high rate of spatial decay, although it may be magnified by amenity effects of regulation. With the availability of GIS zoning data, such as via the National Zoning Atlas, this type of analysis might achieve more precise results.

The monopoly zoning literature takes as its units of analysis areas far too large to help quantify the spatial decay of housing demand substitutability across small distances. Consistently showing that monopoly zoning power is weak would implicitly put a low ceiling on the spatial decay of substitutability. But with so many methods and such an emphasis on proving the existence of monopoly zoning power rather than quantifying it in a generalizable way, I struggle to draw an empirical consensus from the literature.

Not all tests find a hyperlocal price effect. Büchler and Lutz (2024) use the timing of upzonings in Zurich, Switzerland, to estimate a null effect on rent in early-treated versus late-treated raster cells, although the

early-treated cells saw a nine percent increase in housing supply. They interpret their rent finding as evidence of a unified housing market in the relatively small Zurich metropolis.

Micro-level evidence

Although the literatures which motivated this question are largely agnostic about the possible reasons that local demand curves might slope downward, a richer understanding of the topic requires some qualitative and quantitative knowledge of the several channels through which imperfect substitutability might arise. This section reviews several types of evidence in extant research, usually found in papers focused ultimately on broader questions.

Housing search: Evidence from interviews

Lurking beneath the modeling assumptions in many technical economics papers are the loose intuitions informed by common experience. Qualitative research can augment and improve our intuitions.

A large geography and sociology literature predating widespread internet use documented the practices of small samples of searchers. Regrettably, the sampling procedures were often non-random and it is difficult to compare outcomes across studies.

- Donaldson (1973) interviewed 174 recent movers in Christchurch, New Zealand. They were more likely to move to neighborhoods with which they have familiarity, including ones that have a high profile from regional amenities or elite status.
- Barrett (1976) interviewed 380 recent Toronto area homebuyers and was disturbed to find that “the behavior of the majority is to buy a house after a very short search which covers only a few houses in a small area” (p. 196). Seventeen searchers bought the first house they looked at. Ninety-two percent had mean search radii from a search-area centroid of less than 3 miles; 62% of less than 1 mile. Ethnic minorities from Southern Europe had intensely clustered search.
- Palm (1976) tested the “Realtor effect” with a survey of 250 Minneapolis realtors, as well as a random sample of listings. They confirmed that realtors show a bias in recommending towns near their own offices and listings. A result, Palm argues, is the undervaluation of the northern part of the city, and overvaluation of western and southwestern suburbs, where more realtor offices are located.
- Huff (1986) interviewed 35 prospective buyers in Los Angeles’ San Fernando Valley. He evaluated three competing models of search (constraint-based, area-based, anchor-based). With such a small sample, it is no surprise that he could reject none of the models.
- Aitken (1987) interviewed 53 renters in London, Ontario, and found that location was a weaker-than-anticipated factor in relocation decisions.
- Newburger (1995) interviewed 157 homebuyers in Boston’s Mattapan and Hyde Park neighborhoods. He found that Black homebuyers, relative to White ones, inspected fewer homes, had longer searches, used fewer agents, used fewer info sources, and visited fewer open houses.

- Rossini (1998) surveyed 606 recent buyers in Greater Adelaide, Australia. The typical searcher "inspected" about 50 properties before buying, but with large dispersion. Search usually covered a few adjoining suburbs: "over 70% of purchasers looked only in the suburb they purchased or in the adjoining suburbs" (p. 8). But only about 15% looked in a single suburb.

Oddly, this line of inquiry largely faded with the advent of web-based search. A few recent papers shed some light on search in the internet age:

- Chen and Lin (2012) surveyed 82 recent homebuyers, almost all of whom were New York City residents and college graduates. Their mean searcher visited 2.85 zip codes over the course of 7.2 months and moved 7.9 miles from their previous home.
- MacLennan and O'Sullivan (2012) surveyed 1,683 recent homebuyers in Strathclyde, Scotland. About half of respondents bought the only house they visited; even more among younger, lower-income buyers. Only 1 in 8 of the highest-income group did so. High income buyers were also very broad in their search, visiting on average 12 local government areas out of a possible 19.
- Lin (2020) studied the Manhattan rental market, which is uniquely dependent on brokers, many of whom are part-time. On average, brokers have listings of 8.3 rentals in 4.2 buildings in 2.4 Manhattan neighborhoods (out of 28) and 2.0 community districts (out of 12).

The most rigorous and insightful recent evidence comes from a large, collaborative investigation of the residential decisions of low-income urbanites. DeLuca and Jang-Trettien (2020) review and summarize this literature, which relies on 1,200 interviews with hundreds of systematically sampled low-income families over 5 cities and 17 years.

Their key findings are that most moves are "reactive" and characterized by sequential (not joint) decision making about residence and schools. They find that "low-income families often narrowed their search to just a few crucial priorities, most of which involved the attributes of the dwelling itself, rather than an assessment of different neighborhoods." To the extent that they did consider location, they "relied on block by block micro-knowledge they had acquired for neighborhoods they were familiar with, while also feeling pessimistic about searching beyond the boundaries of what they knew." By contrast, the same researchers found that affluent families considered a broader set and explicitly balanced trade-offs.

In a small but complementary study, Boschmann (2011) surveyed 30 low-income households in Columbus, Ohio. He draws three principal conclusions: "(1) these individuals live transitory lives, frequently switching jobs and residences; (2) residential choice is highly influenced by proximity to bus lines; (3) individuals primarily choose places of employment relative to their commuting mobility".

These findings correspond to important informational and transportation limitations facing low-income renters, with the potential consequence of spatially decaying substitutability. Similarly rich and multifaceted evidence on other types of housing market participants would be welcome, to flesh out a more complete qualitative view of the labor market.

Housing search: Evidence from real estate websites

The internet era has massively expanded the information available to - and about - home searchers. Several authors have been able to take advantage of proprietary data to describe the aspects of housing search that leave digital fingerprints. These are almost a perfect complement to interview-based studies, with huge samples and perfect recall, but lacking an interpretive framework.

Piazzesi, Schneider, and Stroebel (2020) show how rich microdata and search modeling can be combined to yield important insights in to housing market dynamics; I will revisit the modeling aspects of their paper in a later section.

Piazzesi et al's key empirical contribution comes from email alerts generated by user-defined parameters on trulia.com. They study the San Francisco Bay region from 2006 to 2012, a unique period of almost monotonic home price decline. For each Zip code, they define three potential submarkets based on price. They find that many searchers are "narrow", setting alerts for a single municipality or Zip code. But other searchers are "broad", looking across a large region and often focusing on the low end of the market.

Rae and Sener (Rae and Sener 2016) offer a similar empirical investigation of prospective buyer search in an expensive city. They use London data from Rightmove, the "leading online housing market portal" (p. 141). These data have the benefit of Rightmove's "Draw-a-Search" feature, which allows users to create their own polygons on a map rather than following administrative divisions. Like Piazzesi et al, they find a wide dispersion of search areas. Half of users define search areas of 5 square kilometers or less; a quarter search less than 1 square kilometer. But at the other extreme are 15 percent of searchers defining a search area of more than 30 square kilometers.

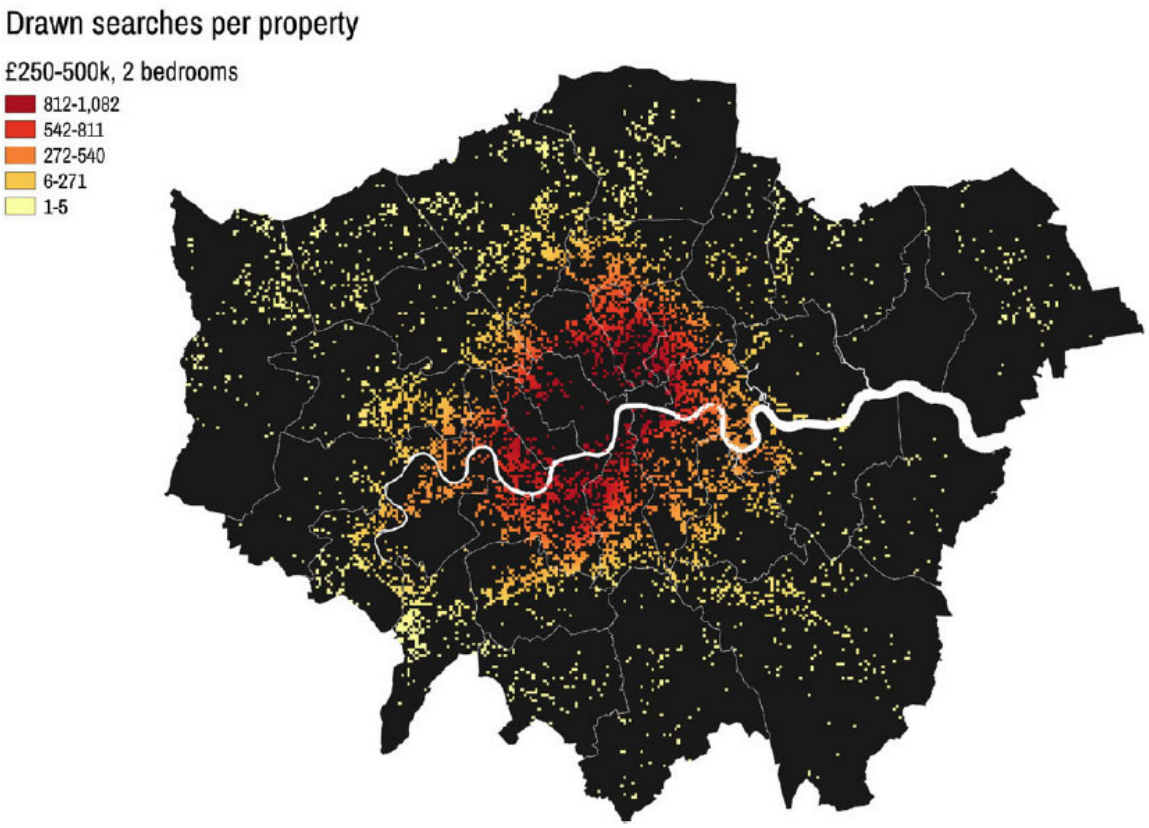

Fig. 6. Search density for 2 bedroom properties from £250,000–500,000.

The London data reveal what can only, in charity, be described as optimistic search behavior: people search for low-cost homes in high-value locations. As a result, the search-per-property ratio for reasonably priced, centrally located properties was hundreds of times higher than for similar properties in suburban locations. (See their Figure 6, above).

Unrealistic optimism in costless search allows us a glimpse of the usually invisible part of a demand curve, sloping down to impossibly large quantities at implausibly low prices. These unrequited desires, however, do little to guide our understanding of how marginal demand interacts across space. Someone searching with equal intensity a block they can afford and one they cannot contributes nothing to spatial demand substitution; they effectively demand housing in only one location.

Gargano, Giacoletti, and Jarnecic (2020) use the 2017-2019 web search data of 9,000 unique users of realestate.com.au, the largest Australian real estate website. Like Piazzesi et al and Rae and Sener, they observe huge variation in search breadth and intensity across users. The interquartile range in Gargano et al's data is from 2.4 to 10.3 unique postcodes viewed in a month.[5] They find that searchers from postcodes with higher recent price growth searched more broadly, consistent with slacker collateral constraints.

[5] A typical Australian postcode contains 9,000 people, making it almost the same size as a U.S. Zip code.

They also find that postcodes which receive less search attention are cheaper than other postcodes and have larger positive price effects from increased attention. Although this finding is identified using an instrument of questionable validity,[6] it provides correlational evidence consistent with search-and-matching models.

Aside from their unique settings in time and place, the great limitation of this literature is that it captures only one artifact of searchers' processes. The diversity of website use certainly suggests comparable diversity in the more advanced aspects of the search process, but the differences in activity may be attenuated or magnified in subsequent steps. Diversity of use may also reflect diversity of searcher characteristics. For example, to this reader, Piazzesi et al's "broad searchers" seem suspiciously like investors intending to flip houses or use them as short-term rentals: bargain hunters indifferent to Zip code but focused on locations with retail and entertainment amenities, they end up purchasing in locations inhabited by young, impecunious parents.[7]

Evidence from moving data

Several researchers have used address-change data from Infutor or the Census Bureau to track moves, which provide indispensable evidence on the resolution of housing searches. However, with each researcher asking questions specific to their own application, the published record contains far less relevant information than the data obviously contain. Describing such data with an eye toward understanding substitutability is a clear step for future research.[8]

Blanco (2023), reviewed above, identified tenants displaced by public housing demolitions. Among displaced residents, 40% remained at most two census tracts distant from their previous home. An equal number moved elsewhere in Chicago, and 20% left the city.

In Pennington's (2021) data, by contrast, nearly half of all movers left the Bay Area entirely (Table 2), unsurprisingly a vastly higher rate of departure from the region than among Chicagoans displaced by demolition.[9]

Taken as an experiment in spatial substitutability, these patterns are concentrated enough to suggest that many people are searching rather narrowly - but dispersed enough to suggest that an equal or greater number are searching quite broadly.

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[6] The authors instrument for price growth with unavailable land, an instrument which Davidoff (2016) argues is invalid. They acknowledge the critique, but do not show that it is inapplicable to their context. Worse, the unavailability of land in one's own postcode might especially be a motive for searching in other postcodes, which would violate the exclusion restriction.

[7] Piazzesi et al's model assumes that buyers become occupants, but that's a modeling choice. They make no strong claims, noting instead that searcher characteristics are "a promising area for future work" (p. 749).

[8] One possible research design would be to identify consistent Tract to Tract flows, and identify which ones are disrupted when new housing supply hits the market. I.e., if Tract 1 regularly sends movers to Tracts 2, 3, and 4, does a newly-opened subdivision in Tract 4 decrease flows from 1 to 2 and 3? If flows are too sparse at a detailed level, however, this might not be feasible.

[9] It is not clear from Pennington's Table 2 what timeframe is covered.

Mast (2024) uses Census Bureau data on annual residences to segment large U.S. metropolitan areas into "districts" or "neighborhoods" comprised of several Census Tracts each, based on the high frequency of moves among those tracts. His approach is grounded in revealed preference under reasonable assumptions. However, his approach is not designed to test the size of such neighborhoods; rather, he chooses an exogenous scaling parameter to target district size.

Information use

Relatively little research has been conducted to learn how different groups of housing searchers access information.

Kroft and Pope (2014) show that Craigslist significantly disrupted the inefficient and costly rental information market, leading to a 10 percent decrease in rental vacancies. Boeing and Waddell (2017) characterize a snapshot of Craigslist rental listing data in mid-2014. These data are rich on many dimensions; although they cannot be readily linked to transactions or buyers, future researchers may find other ways to employ them to understand spatial aspects of housing supply.

Krysan (2008) reports the results of the Detroit Area Study undertaken in 2004. The internet was used by 28% of housing searchers, a newspaper by 36%. However, among prospective buyers neither method was as popular as looking for yard signs or working with a real estate agent (Table 1).

Several research approaches have noted that search processes and information sources differ by race and income groups. Newburger (1995) found that Black Boston homebuyers were more likely to look for listings in the *Boston Herald* than their White neighbors, who favored the *Boston Globe*. In addition, Black searchers used fewer information sources overall. Farley (1996) found that Black searchers in Detroit, rationally distrusting brokers, relied more on personal networks, newspaper ads, and driving around. Revisiting Detroit a decade later, Krysan (2008) found fewer distinctions between races, especially among homebuyers. Still, Black renters were more likely than White ones to use personal networks, and Black searchers encountered more difficulties. Boeing, Besbris, Schachter and Kuk (2021) show that Craigslist is more prevalent and Craigslist listings contain more detailed information in higher-income, whiter neighborhoods.

As noted above, DeLuca and Jang-Trettien (2020) found that poor movers were likely to rely on their own or their networks' knowledge of specific geographic areas. DeLuca, Wood, and Rosenblatt (2019) describe how low-income African-American families in Mobile and Baltimore found new housing units:

> Respondents were most likely to receive information about housing from their relatives who lived nearby and were also likely themselves to be living in poor neighborhoods. Most often, these network members shared the addresses of "For Rent" signs they had seen in nearby windows, or the contact information of a "friend of a friend" who was leasing an available unit. (p. 570)

For voucher holders, lists of available units provided by the local agency were a valuable resource. However, given the scarcity of available units that both accepted housing vouchers and could pass an inspection, voucher holders typically accepted the first offer.

Harvey, Fong, Eden, and DeLuca (2020) tested the reach of this logic by interviewing a random sample of families across the income spectrum. They found that households of all incomes shared the aspirational goal of a carefully-selected "forever home." Rental dwellings, by contrast, were viewed as "temporary

stops." Not surprisingly, few low-income families were in a position to realize that aspirational goal. As in DeLuca et al (2019), low-income family moves were usually reactive and informationally sparse.

Somewhat in tension with the work of DeLuca and colleagues, Bergman, Chan, and Kapor (2020) used a randomized control trial to show that - when presented with a measure of school quality on the popular website GoSection8 - voucher holders were much more likely to choose highly-rated schools. The two approaches can be reconciled without great difficulty: whether for rational or "behavioral" reasons,[10] lightly-informed choices can be significantly altered by the availability of more information.

A potentially fruitful area of future research would be to contrast rental and purchase moves among middle class families: Do financially secure renters exhibit the same informational and search patterns as low-income renters? Or are rental and purchase searches conducted similarly by middle-income families?

Operational frameworks

Although research has yielded surprisingly little usable information about the spatial substitutability of housing demand, economics does offer several modeling frameworks through which such information could be used to better understand the importance of substitutability.

Spatial search and matching

The theoretical framework of search and matching models is obviously well-suited to housing markets. In search theory, incomplete information and timing frictions cause departures from the classic model where each household optimizes across all locations. If search is geographically clustered, spatially varying housing demand can arise endogenously from searchers' being unequally attentive to supply in different places.

Piazzesi et al (2020), discussed above, is a promising treatment that integrates diverse search types. In the model, they allow broad searchers to endogenously crowd into busier market segments, matching the regularity they observe in search data. This behavioral response yields the unintuitive result that an increase in listings in a specific Zip code can result in slower, not faster, housing searches there, since the new listings endogenously attracts broad searchers.

At the most general level, their work reveals that the geographic parameters of search are "shallow" phenomena, emerging from the balance between different types of searchers in overlapping submarkets that clearly vary in spatial extent. Any search for "deep" parameters of spatial substitutability is likely to be frustrated. And researchers should be conservative about extrapolating even the best-identified findings to other times and places.

A potential avenue of further research within the search and matching framework is to model how endogenous search choices change with economic conditions, both across time and in the cross section

[10] That is, households may act on convenient information because it is cheap and/or because it is salient.

of cities. So far, no branch of inquiry has offered useful heuristics on how one might expect spatiality of search or substitutability to differ in tighter or looser housing markets.

Quantitative spatial economics

Another promising framework which could embed a rich fabric of spatial substitutability is the recent growth of large, complex, but computable city models, which has been called "quantitative spatial economics."

Ahlfeldt, Redding, Sturm, and Wolf (2015) advanced the study of cities by deriving a computable model of a complex city. Unlike the classic monocentric city, theirs allows for scattered employment and distinctions among blocks. Block housing demand is influenced by commuting market access - a weighted average of the commuting time to jobs - and local amenities, some of which are endogenous. Within blocks, all housing units are perfectly substitutable and residential floor space is supplied elastically.

In the model, households draw an idiosyncratic, pairwise utility shock that randomizes the value of all possible block-job combinations to generate realistic scattering of people and commutes across blocks. Thus, people do not usually commute to the nearest job.

The idiosyncratic draws are not spatially correlated; a household's best block-job combinations might be located anywhere in the city. As a consequence, the spatial decay in housing substitutability is a two-level step function: homes within a given block are perfectly substitutable, but those elsewhere in the city are equally substitutable.

In application, Ahlfeldt el al's extremely granular data allow them to study Berlin blocks of about 5 hectares each, with a population of 274 per inhabited block. They calibrate the substitutability parameters of the model to account for geographic wage dispersion at this level.

Couture, Gaubert, Handbury, and Hurst (2023) use a similar model to look at downtown gentrification, a situation in which unequal demand for certain amenities plays a key role. The authors specify a "demand system similar to a nested logit" (p. 7), with high substitution elasticity among neighborhoods of the same type and less substitutability between neighborhoods of different types.

Couture et al borrow Ahlfeldt et al's block-level calibration for within-type substitutability. They call it an "amplification parameter", noting that a household's neighborhood match quality increases with city size: the more neighborhoods, the more match quality draws, the better chance of generating an excellent match. (This mechanical feature could of course be scaled away, but it may also be a reasonable reflection of real world dynamics).

Couture et al apply the borrowed block-level parameter to data for U.S. Census Tracts, which are scaled to have populations around 4,000. Furthermore, they show in Table 3 that the magnitude of their results is quite sensitive to this parameter.

Assuming that Ahlfeldt et al's substitutability parameter is correct for urban blocks, would the correct parameter for Census Tracts be smaller or larger? One can construct a story in favor of either direction.

Baum-Snow and Han (2023) go some distance toward answering that question, but can only confirm that either is possible. They use a model very similar to that of Couture et al in order to estimate U.S. Census Tract-level price elasticities of housing supply. As part of their structural estimation, they must pin down the parameters of a housing demand system based on a nested Frechet distribution. Depending on their model, they estimate a tract-level, within-municipality elasticity of substitution either lower (3.9) or higher (8.5) than the block-level, metro-wide substitutability parameter estimated by Ahlfeldt et al (6.83).

As a framework, quantitative spatial economics holds some promise for implementing richer models of spatial substitutability. However, the work undertaken so far has received little guidance from other literatures in how to model spatial substitutability and what magnitudes appear to be reasonable. As Couture et al show, the implicative stakes are high.

Neighborhood choice and sorting

An older literature that has directly incorporated and gauged the importance of substitutability - usually at an abstract level - is the study of neighborhood choice. This literature can be thought of as a simplification of quantitative spatial economics, as it typically makes the employment side of the city exogenous.

Quigley (1985) argues that earlier research on housing choice were empirically flawed because they assumed Independence of Irrelevant Alternatives (IIA). IIA is unlikely in the case of houses, because some - especially those located close together - are more substitutable than others. He hypothesizes that searchers pick a town, then a neighborhood, then a dwelling. Testing IIA with data on 584 renters who moved to metro Pittsburgh and responded to a 1967 survey, he finds large departures at both the neighborhood and town level, which imply that substitutability between dwellings and neighborhoods varies. Without accounting for the variation in spatial substitutability, his exercise would have underreported the degree to which renters were responsive to car commute time and neighborhood racial composition.

Bayer, McMillan, Murphy, and Timmins (2016) introduce intertemporal dynamic considerations into a model of neighborhood choice. They use mortgage applications and housing transactions in the San Francisco Bay Area from 1994 to 2004 to show that the dynamic model outperforms a static counterpart. They model the Bay Area's geography as three large regions composed of neighborhoods with different characteristics. Each household has a high preference for one of the regions, but no idiosyncratic neighborhood attachment. The model performs quite well, which is consistent with high substitutability between neighborhoods within large regions.

They incorporate significant moving costs, which are a potential source of departure from the classic Rosen-Roback framework of additive, compensated amenities. In their model, only current movers have re-optimized around each period's evolution of expected amenity flows. However, those current movers cannot capture the gains to the barrier of entry: incumbent owners increase prices to fully price in the value of expected amenities, returning us to a world where amenities are, from the perspective of housing demand, purely additive and fully compensated.

A key assumption in generating this result is full information on both sides. Thus, Bayer et al's result would not erase imperfect substitutability microfounded in incomplete information or search.

Anenberg & Kung (2020) use a similar neighborhood choice model to investigate the effects of a *relative* increase in housing supply within one part of a metro. Regrettably, the authors misreport their findings, claiming to offer a test of housing supply as a potential solution to metrowide unaffordability. However, their assumption that population is perfectly elastic to housing supply (p. 8) implicity washes out any price effect via supply increases.

Instead of answering the question they pose in the paper's introduction, Anenberg and Kung offer an answer to the present paper's question, although at an intermediate level of geographic aggregation. By allowing the housing stock of a single Public Use Microdata Area (PUMA) to increase while holding the citywide household/housing ratio equal to one, they effectively isolate the intrametro substitution effect.

In their estimates, substitutability across PUMAs is high. Price differences between PUMAs are mostly the result of "amenities" such as the college-educated population share. They estimate metro-specific PUMA rent elasticities with respect to (relative) new housing supply between -0.04 and -0.1.

Zabek (2018) uses a Rosen-Roback model to show that depressed regions such as Appalachia and the Rust Belt are inhabited by people with stronger local ties, via negative selection into emigration. Strong ties lead to lower real wages in declining places as people who would otherwise migrate instead remain and accept lower wages. Although Zabek does not consider sub-metro area geographies, his regional logic could translate to hyperlocal ties.

Segmentation of housing submarkets

Finally, one cannot ignore a long literature intended to improve the work of tax appraisers. This literature is largely built around the goal of partitioning cities into perfectly substitutable 'submarkets' where home prices comove. However, a series of reviews have found the literature incapable of coming to agreement on methods, scale, or theory.

Watkins (2001) effectively reviews the literature through the late 20th century, summarizing 18 previous papers in Table 1. He concedes that submarkets analysis has not been embraced by wider scholarship, partly because it is internally inconsistent. Papers apply different definitions, statistical tests, geographic granularity, and methods to different data. Testing his own data, Watkins finds that both spatial and structural (that is, relating to the physical structure of buildings) factors should be considered in defining submarkets.

Case, Clapp, Dubin, and Rodriguez (2004) tried to address some of the disagreements by executing a four-way competition on a common data set, which covered 60,000 transactions in Fairfax County, Virginia, from 1967 to 1991. They find that nearest-neighbor data is especially useful for out-of-sample prediction, regardless of the method employed. However, their competition did not yield a clear winner, nor does it seem to have heavily influenced subsequent scholarship.

Islam and Asami (2009) again reviewed the literature, covering 20 papers in Table 1. An additional decade of research did not yield consensus. Most papers from this era (such as Tu, Sun, and Yu (2007)

and Goodman & Thibodeau (2007)) continue to use hedonic models in the general tradition of Goodman (1978).

Pryce (2013) renews a critique made earlier by Bartik (1987) and Epple (1987), showing theoretically that comovement of hedonic factor prices does not guarantee that two houses are in the same submarket (nor do differences in factor prices guarantee that they are in different submarkets). Instead, he aims to recover the idea of submarkets based on substitutability, which goes back to Rapkin et al (1953) and Grigsby (1963).

Pryce sets out four desirable criteria for submarket identification strategy, notably including robustness to "continuity in the substitutability space." To satisfy his own criteria, he proposes cross-price elasticity of price (CPEP $\eta_{ij} = \left(\frac{dp_i}{dp_j}\right)\left(\frac{p_j}{p_i}\right)$) as a measure of substitutability. That is, places where prices comove are substitutable and can, at some degree of substitutability, be treated as parts of the same submarket.

Pryce acknowledges the obvious objection that prices may comove for reasons unrelated to substitutability, such as interest rates or wage fluctuations. For instance, one can imagine two neighborhoods that are both dependent on wages in a particular industry and thus share business cycle fluctuations despite little direct substitution.

To simplify CPEP, Pryce proposes a gradient $\phi = \partial\eta_{ij}/\partial f(D_{ij})$ in distance as the simplest summary statistic for microgeographic variation in substitutability. However, his own empirical application to Glasgow shows that spatial substitutability is far from uniformly decaying - some suburbs have prices that comove most with other, non-contiguous areas.

While a few authors, such as Beenstock, Feldman, and Felsenstein (2020), have applied and advanced Pryce's approach to other data, others have rebuffed the critique. Bhattacharjee, Castro, Maiti, and Marques (2016) argue that similarity in hedonic characteristics and hedonic prices is sufficient for close substitutability.

Keskin & Watkins (2017) question whether hedonic statistical methods can perform as well as the opinions of experts, such as real estate agents. Their work also sheds light on the degree to which the literature has failed to agree even on the scale of the question at hand - they note that "submarkets" have been identified in various papers with average sizes that range from one thousand to three million residents (p. 1452). Their own analysis uses 2,175 transactions in Istanbul. Not surprisingly, so few data points scattered across a city of 15 million souls is too few to outperform local real estate agents in predicting home prices.

The clearest take-away from this large, pragmatic strand of research is its utter inability to coalesce around a method, scale, or conclusion with respect to the segmentation of housing submarkets. This bodes poorly for empirical, reduced-form approaches to the adjacent (if not quite identical) question raised in this essay. Instead of relying on the data to speak, we will need a richer approach founded in qualitative, theoretical, and microdata research.

Next steps

The purpose of this paper is to define an area of ignorance rather than to answer a specific question. With that in mind, I expect that the paper will eventually conclude with “steps for future research” far beyond what one researcher (certainly this researcher) can accomplish.

First, I can build out the current knowledge-review in straightforward ways:

- Add insights from papers and literatures that others suggest. There must be more information on housing search practices, even if it offers relatively little guidance on substitutability.
- Add data description of the American Housing Survey’s housing search module.
- I should add a formal model to define substitutability - but what type of model?

Second, I would like to define some attainable research targets that likely require multiple research projects to achieve, such as:

- Produce a reasonably complete portrait of the range of housing search behaviors across a variety of variables.
- Generate stylized facts about what market conditions, demographics, housing stock characteristics, etc., are likely to increase or decrease spatial substitutability.

Third, I can imagine suggesting specific research questions for future papers. (Or should some of these be eventual components of the current paper?)

- Add spatial decay of substitutability to a quantitative spatial economics model and test the implications.
- Systematically survey realtors about client behaviors, especially with respect to the spatial range of houses viewed / offered.
- Study, somehow, the interplay of web search and physical search.
- Deepen the local supply shock with more evidence, including from non-gentrifying neighborhoods; distinguish adjacent from substitutable buildings.
- Use condo sales and/or rental manager surveys to find out which *within-building* locational amenities are valued, especially with respect to what their windows face.

I am open to suggestions on specifics, structure, or otherwise.

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