The Impact of High-speed Broadband Availability on Real Estate Values: Evidence from United States Property Markets[1]

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Abstract

This working paper presents a study to show the possible impact of fiber-based broadband service availability on real estate values. The research goal is to find out whether people are willing to pay more for real estate located in areas where fiber is available than for a property that does not offer this amenity. Using information from the National Broadband Map and county assessors' data for residential single-family houses from three Metropolitan Statistical Areas in the State of New York, we apply a hedonic pricing model to test the hypothesis. Early results suggest that fiber availability may indeed have a positive impact on real constant-quality house prices. Initial findings also urge additional research efforts to test the impact more thoroughly and to address issues due to potential endogeneity.

Key words: broadband, Internet, real estate, welfare

JEL Classification: R21, L96, L98

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1. INTRODUCTION

An extensive literature on broadband adoption is available. However, empirical studies related to the economic impact of fiber technology are fewer in number. This paper explores whether people are willing to pay more for real estate located in areas where fiber broadband access is available than for a property that does not offer this amenity.

Numerous factors influence the value of residential real estate, including the energy efficiency of buildings, the proximity of good schools, or the amount of crime in neighborhoods. For some people, an important consideration when buying a home might be the availability of fiber-based broadband services to the property. To test this, we aim to evaluate empirically whether access to fiber broadband is associated with any measurable effect on property values. Using a hedonic price framework and data from the National Broadband Map (NBM) the research goal is to investigate how constant-quality real estate prices vary, where constant-quality real estate is defined as a property where structural, land, and community attributes are all held constant. The focus of this investigation is the hypothesized impact of variations in fiber service availability on residential single-family house prices. The paper adds to the existing literature by conducting an empirical analysis of the assumed neighborhood effect of fiber availability.

The existing literature has examined the economic impact of broadband penetration, but not that of fiber-based Internet access. Using 2011 June data from the NBM, the recent Broadband Brief by the Department of Commerce's National Telecommunications & Information Administration and the Economics and Statistics Administration confirmed that "broadband is less available in rural areas than in urban areas" (NTIA-ESA, 2013, p. 11). The NTIA-ESA analysis also showed that proximity to central cities within a Metropolitan

Statistical Area (MSA) is likely to be "more strongly associated with the availability of the highest speed levels of broadband service than population density" (p. 10). The broadband brief, however, leaves the question open whether the location within a MSA is simply associated with increased broadband availability or whether it is a contributing factor to increased broadband availability.

Real estate economists often quantify the impact of variables that are specific to neighborhoods by applying the hedonic method outlined in the seminal paper of Rosen (1974).[1] These hedonic valuation models assume that the main considerations of property values, such as structural characteristics, neighborhood characteristics, and relative location of the property, are known.

The first models focused on the structural characteristics of the property, including the size of the building, the number of bedrooms and bathrooms, and other lot characteristics. Later, other area amenities, such as air pollution (Rosen, 1979), local climate (Haurin, 1980), and crowding (Roback, 1980) were added. Roback (1982) also considered labor markets in her approach. The empirical studies of Beeson and Eberts (1989), Peek and Wilcox (1991), Blomquist and Berger (1992), and Potepan (1994) found that crime, recreational opportunities, and population demographics should also be considered for real estate valuation models.

Despite recent advances in real estate economics, spatial econometrics, and the increasing number of studies that support the existence of neighborhood effects, the impact of fiber-based broadband on property prices is still not a well-researched area. Academic research regarding this topic has been limited by a lack of good quality data on fiber

[1] Hedonic valuation models are regressions of real estate value against property characteristics that determine this value.

broadband access availability. Although a recent research by RVA LLC found that "a fiber connection adds between $5,300 and $6,450 to the value of a home" (RVA, 2013, p. 31), their study was based on surveying homebuyers and developers (*stated preferences*), and it was not an empirical analysis of transactional data (*revealed preferences*).

The NBM has data to allow for investigation of this research question (NBM, 2011). The NBM shows where broadband is available, the technology used to provide the service, the maximum speeds, and the name of the service providers. Created from collaboration between the National Telecommunications and Information Administration, the Federal Communications Commission (FCC), and all states of the US and territories and the District of Columbia, the NBM is an online tool that provides semi-annual information on the availability, technology, speed, and location of broadband Internet access at the census block level. Matching fiber broadband availability information from the NBM with factual information on real estate sales transactions and property characteristics will not only make it possible to investigate the economic impact of superior broadband, but it also provides another approach to measure the value of fiber broadband in monetary terms.

This study and the model used in this paper were following Haurin and Brasington (1996). Using two variants of a random coefficients model and testing transactional data from six MSAs in Ohio, Haurin and Brasington studied the impact of school quality on real estate prices. They found that public school quality positively influences real constant-quality house prices. For simplicity, we decided to follow their hedonic model for this paper.

Using information from the NBM and county assessors' data for residential single family houses, we tested 2011 transactions from nine counties of three MSAs in the State of New York. We found that the presence of fiber-based broadband is associated with a positive effect on property values. Results suggest that the availability of fiber broadband might be as important in explaining spatial variations in real constant-quality house prices as the presence of cooling capability/air conditioning, fireplaces, or a pool.

The next section overviews the real estate valuation techniques. The empirical model is described in Section three and Section four details the data. The preliminary results are presented in Section five. Section six concludes and describes future work.

2. REAL ESTATE VALUATION TECHNIQUES

Malpezzi (2002) divides real estate valuation model into three main groups: hedonic valuation techniques, repeat sales methodologies, and hybrid models. Hedonic valuation models are essentially regressions of real estate value against property characteristics that determine this value. Hedonic valuation models assume that the main considerations of property values, such as structural characteristics, neighborhood characteristics, and relative location of the property are known. Hedonic price models are derived from Lancaster's (1966) consumer theory, Rosen's (1974) trading model, and Maclennan's (1977) theoretical works. Lancaster suggests that consumer utility is generated not by goods but instead by the characteristics of the goods. Rosen modeled how suppliers and consumers interact assuming a framework of bids and offers for product characteristics. Maclennan's model recognized that observed real estate transaction prices cannot be equilibrium prices and laid down the theoretical foundation for the hedonic models.

Repeat sales methods are based on data that directly measure property price appreciation over different periods. Prices from these known time periods are combined to create matched pairs, providing observations of actual transactions on the same property.

Repeat sales models have the advantage of controlling for unobserved characteristics of a given property (no omitted variable bias). Bailey, Muth, and Nourse (1963) were the first to propose repeat sales regressions, simply using ordinary least squares (OLS). Case and Shiller (1989) pointed out the disadvantages of using OLS and suggested using another regression technique, generalized least squares (GLS).[2]

There are two disadvantages of the repeat sales methods. First, frequently traded properties are not necessarily a random sample of all real estate available. Second, the methods often do not consider improvements to properties; the property sold at t_1 may not be identical to the property sold at t_0.

Hybrid valuation models combine hedonic and repeat sales models. They estimate the two models as imposing a constraint that price changes over time are equal in both models. According to Malpezzi (2002), the basis for the hybrid valuation theory is contained in the influential works of Case and Quigley (1991), Quigley (1995), Hill, Knight and Sirmans (1997), and Knight, Dombrow and Sirmans (1995). The primary disadvantage of the hybrid method is that it requires careful matching of time-series and cross-section observations.

Due to the importance of location and neighborhood characteristics in explaining house price variations, more recent developments in house price models are leveraging advances in spatial econometrics. Dubin (1988), Laakso (1997), Karakozova (2005), Kiel and Zabel (2007) all found empirically that characteristics of the vicinity significantly affect real estate prices. According to LeSage and Pace (2009), there is sound justification to use spatial econometric models in all of the valuation methods described above, as the omitted location and neighborhood variables are considered to be autocorrelated.

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[2] GLS is a statistical technique for estimating the unknown parameters in a regression model. This is typically applied in the case of heteroskedasticity or when there is a certain degree of correlation between the observations.

3. EMPIRICAL MODEL

Following Haurin and Brasington (1996), this paper tests a simple hedonic price equation.

$$\ln V_{ij} = X_{ij}\beta + J_j\delta_j^{'} + \varepsilon_{ij} \qquad (1)$$

where i is a transacted house, j is the geographic area, and ε is the random error. X_{ij} is a set of structural and land characteristics, and J_j is a set of dummy variables indicating the jurisdiction (census block group) of an observation. In this equation, the coefficient $\delta_j^{'}$ represents percentage deviation of an average house price in district j from the price of a constant-quality property.

The capitalization test for the community and MSA variables is as follows:

$$\delta_j^{'} = Z_j\gamma^{'} + \mu_j^{'} \qquad (2)$$

In equation (2), $\delta_j^{'}$ is related to the community and MSA level variables Z_j. Equations (1) and (2) test for an impact through changes in the lot price. Depending on the land size, the impact varies amongst properties within a given census block group.

Combining equation (2) with (1), the hedonic price equation can be written as:

$$\ln V_{ij} = X_{ij}\beta + Z_j\gamma^{'} + \mu_j^{'} + \varepsilon_{ij} \qquad (3)$$

Equation (3) relates the natural log of the real transaction prices for houses ($\ln V_{ij}$) to a set of structural and land characteristics X_{ij}. Using GLS is appropriate because we test for CBG-specific mean zero random errors in house prices (Garman & Richards, 1990; Haurin & Brasington, 1996).

The parameter of interest in equation (3) is $\partial \ln V_{ij}/\partial FIBER\_D = \gamma_f^{'}$. The coefficient $\gamma_f^{'}$ indicates the percentage deviation of an average house price in CBG j, where fiber broadband is available, from the price of a constant-quality property. Failure to reject the null hypothesis $\gamma_f^{'} = 0$ provides evidence that the presence of fiber in the census block group may have an impact on real estate value.

4. DATA AND VARIABLES

The primary source of the property information is a dataset containing real estate transactional data and property characteristics for single-family detached houses in three MSAs in the State of New York.[3] The data set was obtained from DataQuick (2013), a property information service provider. The master dataset included property characteristics and assessor data for a total of 24,784 sale transactions for single-family detached houses in 2011. Fiber broadband availability data were obtained using the June 2011 version of the NBM. *Other explanatory variables* in (3) are drawn from various sources, including data from US Census (2011), ACS (2011), and Geolytics (2012).

4.1 Variables

As described in the third section, our test relates the natural log of the real estate transaction prices to a set of structural and neighborhood characteristics and several jurisdictional amenities. Detailed definitions of all variables are listed in Table 2.

Measures of the *house and lot characteristics* included the age of the house (AGE10, measured in ten years), lot size (LOTSIZE10k, measured in 10,000 square feet), house size (HOUSESIZE1k, measured in 1,000 square feet), garage size (GARAGESIZE1k, measured in 1,000 square feet), and number of bathrooms (NBRBATH). We used dummy variables to

[3] The three MSAs are: Buffalo-Cheektowaga-Tonawanda, Poughkeepsie-Newburgh-Middletown, and Rochester. Table 1 shows key characteristics of the nine counties in these three MSAs.

indicate the presence of a patio and/or a porch (PATIOPORCH_D), a pool (POOL_D), air conditioning or some cooling solution (COOLCODE_D), and a fireplace (FIREPLACE_D).

Measures of *neighborhood characteristics* included average income per capita (INCOME1k_CBG), expected county population growth (POPGR_CNTY), tax rate (TAX_CNTY, measured in percentage), and the number of serious crimes per capita in the MSA (CRIME_MSA). INCOME1k_CNTY is defined as the 2011 per-capita income in the county, measured in thousands dollars. We measured expected county population growth by the ratio of 2010 to 2000. TAX_CNTY is a public sector variable, and it is the nominal tax rate used in the county. The MSA-level measure of crime is the number of serious crimes per capita.

For *neighborhood amenities*, we adopted recreational and arts opportunities (ARTREC_CNTY), accessibility (ACCESS_CNTY), and the distance of the real estate to the central business district (DISTANCE_CBD, measured in miles). ARTREC_CNTY is a variable we used to proxy the recreational and arts opportunities. We defined ARTREC_CNTY as the percentage of employees in the county who work in the arts, entertainment, and recreation sector. We measured accessibility by the average time in minutes to get to the workplace by those who commute to work. The distance to the central business district was defined as the geographic distance between the geocoded location of the property and the latitude and longitude coordinates for the central business district of the principal city in each MSA.[4]

The focus of this paper is the impact of *fiber availability* on real constant-quality house prices. We used information from the NBM (2011) to identify census block groups where fiber technology was present. FIBER_D is the dummy variable indicating the presence

[4] The location of each MSA's CBD was obtained from the research of Holian and Kahn (2012)

of fiber in a census block group.[5] Since our analysis is at the census block group level, we considered fiber available in a census block group if the technology was reported in at least one of the census blocks.[6]

Other *jurisdictional variables* in the estimation are the percentage of non-white households (NONWHITE) and the percentage of people who lived in the same county twelve month ago (TURNOVER_CNTY). The former is used to capture variations in house price resulting from discrimination, and the latter is a measure to proxy community stability.

4.2 Summary statistics

Table 3 presents summary statistics for all the variables used in our empirical analysis. Because some of the properties in our dataset have missing or incomplete data, our final dataset is comprised of 20,521 real estate transactions in the three MSAs of our study.

The average house price is $155,036. The average lot size is 16,322 square feet, and average building size is 1,630 square feet. The average garage size is 343 square feet. On average, 74% of the properties have a patio or porch, 44% have fireplace, 39% have a cooling solution installed, and 8% have a pool. A typical house has two bathrooms and is 50.6 years old.

5. RESULTS

[5] Census block groups are small statistical subdivisions of census tracts. Census tracts typically coincide with the limits of cities, towns or other administrative areas. They contain 1,500 to 8,000 people; on average, they made up approximately four census block groups. There are 217,740 block groups nationwide, as of the 2010 census.

[6] Previous market structure studies have used census tract, county, local telephone exchange and zip-code boundaries to define the geographical market for broadband Internet (Gillett and Lehr, 1999; Prieger, 2003; Wallsten and Mallahan, 2010; Xiao and Orazem, 2011; Nardotto et. al., 2012). Because ISP decisions to roll out and promote new services are usually made for smaller geographical footprints, we define the market for fiber broadband to be a census block group, which generally contains between 600 and 3,000 people.

Table 4 reports the results based on the 20,521 observations located across 2,180 census block groups in the nine counties of the three selected MSAs in New York State.

5.1 Ordinary Least Square Regression

The house and lot characteristics have the expected signs, and most of them are significant. Increasing age (AGE10) reduces house value. The positive coefficient for AGE10_SQ suggests that housing depreciates at an increasing rate, but the result is not significant. The OLS regression shows that increased square footage of the house (HOUSESIZE10k) and square footage of the lot (LOTSIZE10k) both increase the price of the property at a decreasing rate. The presence of a fireplace (FIREPLACE_D), cooling solution (COOLING_D), pool (POOL_D), patio and/or porch (PATIOPORCH_D), and bathrooms (NBRBATH) all increase the value of the house.

The coefficients of the *jurisdictional variables* generally also have the expected sign. Increasing non-white population (NWHITE_CBG), county tax rates (TAX_CNTY), and crime (CRIME_MSA) were associated with decreasing property prices. Increasing per-capita income (INCOME_CBG) and population stability (TURNOV_CNTY) were both associated with greater house value. Positive population growth (POPGR_CNTY) were associated with increased real estate value. Geographic distance from the central business district (Distance_CBD) and better accessibility (ACCESS_CNTY), as expected, were negatively correlated with price. The positive coefficient of *FIBER_D* (γ_1 = 0.026) implies that the presence of fiber increases the property value in the neighborhood. With a mean house price of $155k, this is a change in value of $4.061. The coefficient is significant at the one percent level.

5.2 Random-effects GLS Regression

Generally, results of the random effects model are very similar to those of the OLS model. The house and lot characteristics have the expected signs, and are most of them are significant. Increasing age (AGE10) was associated with reduced house value, and the positive coefficients for AGE10_SQ suggest that housing depreciates at an increasing rate. We were able to confirm that the increased square footage of the house (HOUSESIZE10k) and the square footage of the lot (LOTSIZE10k) were both associated with an increase in the price of the property at a decreasing rate. The presence of a fireplace (FIREPLACE_D), cooling solution (COOLING_D), pool (POOL_D), and bathrooms (NBRBATH) were all associated with increased value of the house. The coefficient to show the impact of the presence of a patio and/or a porch was also positively correlated, but it was not significant in the GLS model.

The coefficients of *jurisdictional variables* generally also have the anticipated sign. An increasing non-white population (NWHITE_CBG), county tax rates (TAX_CNTY), and crime (CRIME_MSA) were associated with decreasing property prices. Increasing per-capita income (INCOME_CBG) and population stability (TURNOV_CNTY) were both associated with greater house value. Better accessibility (ACCESS_CNTY) and positive population growth (POPGR_CNTY) were both found to be associated with increased real estate value. Distance from the central business district, as expected, was found to be negatively correlated with the price, but the result was not significant. The positive coefficients of *FIBER_D* ($\gamma'_1 = 0.051$) implies that the presence of fiber in the neighborhood increases property value. With a mean house price of $155k, this is a change in value of $7.905. The coefficient is significant at the five percent level.

6. SUMMARY AND CONCLUSIONS

This paper presented an empirical study of the impact of access to fiber-delivered Internet on real estate values. The research goal was to determine if people are willing to pay more money for real estate located in areas where fiber broadband access is available than for a property that does not offer this amenity. Using information from the NBM and county assessors' data for residential single-family houses from three MSAs in New York State, we applied a hedonic pricing model used in real estate economics. The random-effects GLS model signified that the presence of fiber-based broadband was associated with a positive effect on property values in the neighborhood.

However, caution is warranted in drawing conclusions at this point for two reasons. First, correlation does not necessarily equal causation. Fiber availability may drive real estate prices upwards. An unobserved variable may jointly determine both real estate prices and fiber presence. Alternatively, both might be correct. Residential properties in markets with high-speed broadband access would be expected to have greater value. However, good quality broadband infrastructure is also expected to be rolled out first in high-income areas with high-valued real estate. Estimating the value of high-speed internet availability through property markets creates challenges in addressing this potential endogeneity. Second, this proof-of-concept study was using data from three MSAs only. The selection of the MSAs was arbitrary, and the real estate dataset is unrepresentative. In addition, our exposure time was rather short; the analysis focused on 2011 data alone.

Regardless of these limitations, we believe that these early results are strong enough to justify further research. Based on a larger data set, the objective of our future work is to measure the value of broadband Internet throughout real estate markets across the United States. The semi-annually updated NBM data on fiber broadband availability makes it feasible to test our hypothesis on a larger set of real estate transactional data and use a wider array of geographies. To address endogeneity, future work will control for the unobserved consumer demand effects that are jointly positively correlated with residential real estate prices and high speed Internet roll out and use the advances of spatial econometrics to acquire results that are more robust. A future version of this research will also test the impact of ultra high-speed broadband (i.e., 100Mbps or greater) on property prices and run a technology agnostic study.

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TABLE 1
COUNTY POPULATION, AREA SIZE, AND HOUSING UNITS

MSA/COUNTY	Total Population	Area Size	Pop. Density	Housing Units
Buffalo-Cheektowaga-Tonawanda, NY				
Niagara County	216,469	1139.7	414.4	99,120
Erie County	919,040	1226.9	881.4	419,974
Poughkeepsie-Newburgh-Middletown, NY				
Orange County	372,813	838.6	459.3	137,025
Dutchess County	297,488	825.3	373.9	118,638
Rochester, NY				
Livingston County	65,393	640.3	103.5	27,123
Monroe County	744,344	1366.7	1132.6	320,593
Ontario County	107,931	662.5	167.6	48,193
Orleans County	42,883	817.4	109.6	18,431
Wayne County	93,772	1383.1	155.3	41,057
9 County Average	317,792	988.94	421.9	136,684
US Average (3143 counties)	98,232	1208.0	259.3	41,904

Source. US Census (2013).

TABLE 2

VARIABLE DESCRIPTIONS

Variable	Description and data source
logHOUSEPRICE	Log of transaction amount for residential single family house (deflated). Source: DataQuick (2013)
AGE10	Age of house in ten years. Source: DataQuick (2013)
LOT SIZE10k	Lot size in ten thousand square feet. Source: DataQuick (2013)
HOUSESIZE1k	House size in thousand square feet. Source: DataQuick (2013)
GARAGESIZE1k	Garage size in thousand square feet. Source: DataQuick (2013)
NBRBATH	Number of bathrooms. Source: DataQuick (2013)
PATIOPORCH_D	Patio & porch dummy. Source: DataQuick (2013)
FIREPLACE_D	Fireplace dummy. Source: DataQuick (2013)
COOLING_D	Cooling solution dummy. Source: DataQuick (2013)
POOL_D	Pool dummy. Source: DataQuick (2013)
NBRBATH	Number of bathrooms. Source: DataQuick (2013)
Q1SALE	Dummy variable to indicate Quarter 1 sales. Source: DataQuick (2013)
Q2SALE	Dummy variable to indicate Quarter 2 sales. Source: DataQuick (2013)
Q3SALE	Dummy variable to indicate Quarter 3 sales. Source: DataQuick (2013)
FIBER_D	Availability of fiber-based Internet access technology in the CBG in 2011. Source: NBM (2011)
TAX_CNTY	Nominal property tax rate. Source: The Tax Foundation (2013)
INCOME1k_CBG	Per capita income in the CBG (in thousands). Source: ACS (2011)
NWHITE_CBG	The percentage of nonwhite households in the CBG. Source: ACS (2011)
DISTANCE_CBD	Calculated distance from the property to the MSA's center (in miles). Source of MSA center geocodes: Holian and Kahn (2012)
TURNOVER_CNTY	Percentage of households who lived in the same house or in the same county 12 month ago. ACS (2011)
ACCESS_CNTY	Weighted average of the average commuting time to work. Source: ACS (2011)
ARTREC_CNTY	Percentage of employees in the art & recreation sector. This is a measure of art & recreation opportunities. Source: CBP (2011)
POPGR_CNTY	2010 county population divided by 2000 county population. Source: Geolytics (2012)
CRIME_MSA	Serious crimes including murder, robbery, etc. This is a MSA-level variable. Source: FBI (2011)

TABLE 3
SUMMARY STATISTICS

Variable	Obs.	Mean	s.d.	Min	Max
HOUSEPRICE	20521	155036.7	128501.7	4200	2250000
lnHOUSEPRICE	20521	11.65183	0.810398	8.336308	14.59855
AGE10	20521	5.062516	3.231351	0	292
LOTSIZE10k	20521	1.632267	1.630365	0.04356	8.712
HOUSESIZE1k	20521	1.63024	0.638391	0.384	9.146
GARAGESIZE1k	20521	0.343415	0.248996	0	12.324
PATIOPORCH_D	20521	0.744359	0.436231	0	1
FIREPLACE_D	20521	0.44145	0.496572	0	1
COOLING_D	20521	0.392232	0.48826	0	1
POOL_D	20521	0.078944	0.269657	0	1
NBRBATH	20521	1.971395	0.862973	0	8
Q1SALE	20521	0.186687	0.389669	0	1
Q2SALE	20521	0.26295	0.440246	0	1
Q3SALE	20521	0.297987	0.457385	0	1
Q4SALE	20521	0.252376	0.434386	0	1
TAX_CNTY	20521	2.676215	0.360779	1.77	3.02
FIBER_D	20521	0.680181	0.466418	0	1
INCOME1k_CBG	20521	63.96973	26.28247	8.466	175.481
NWHITE_CBG	20521	0.148656	0.200824	0	1
DISTANCE_CBD	20521	11.90923	9.044666	0.238185	46.71218
TURNOV_CNTY	20521	0.958216	0.008421	0.921552	0.965054
ACCESS_CNTY	20521	23.70592	4.07874	20.92004	33.88074
ARTREC_CNTY	20521	1.599454	0.353301	1.209812	2.04769
POPGR_CNTY	20521	0.66925	4.000225	-3.28593	9.211786
CRIME_MSA	20521	3.44403	0.816763	2.41	4.392

NOTES. Obs. is number of observations. s.d. is standard deviation..

TABLE 4
OLS AND RANDOM EFFECTS GLS REGRESSION

	OLS			GLS		
	Coefficient	Estimate	s.e.	Coefficient	Estimate	s.e.
<u>Structural & lot characteristics</u>						
CONSTANT	β_0	4.970973***	0.739063	β_0	4.403418***	1.505939
AGE10	β_1	-0.05123***	0.004068	β_1	-0.05893***	0.003388
AGE_SQ	β_2	0.000359	0.000311	β_2	0.001254***	0.000222
LOTSIZE10k	β_3	0.054200***	0.007175	β_3	0.055347***	0.007637
LOT10k_SQ	β_4	-0.00673***	0.000958	β_4	-0.00584***	0.000946
HOUSESIZE1k	β_5	0.360486***	0.026554	β_5	0.340801***	0.019275
HOUSE1k_SQ	β_6	-0.02408***	0.005681	β_6	-0.02256***	0.003803
GARAGESIZE1k	β_7	0.206576***	0.022258	β_7	0.212733***	0.01779
GARAGE1k_SQ	β_8	-0.02024***	0.003890	β_8	-0.01982***	0.003316
PATIOPORCH_D	β_9	-0.03091***	0.008492	β_9	0.008238	0.007844
FIREPLACE_D	β_{10}	0.165179***	0.007679	β_{10}	0.111224***	0.007886
COOLING_D	β_{11}	0.100019***	0.007091	β_{11}	0.091769***	0.007713
POOL_D	β_{12}	0.042865***	0.009826	β_{12}	0.059502***	0.011901
NBRBATH	β_{13}	0.116733***	0.006908	β_{13}	0.089419***	0.00584
Q1SALE	β_{14}	-0.02819*	0.011083	β_{14}	-0.01762*	0.009486
Q2SALE	β_{15}	0.035359***	0.009762	β_{15}	0.033495***	0.008614
Q3SALE	β_{16}	0.057077***	0.009094	β_{16}	0.043895***	0.008359
<u>Neighbourhood/MSA characteristics</u>						
FIBER_D	γ_1	0.026222***	0.009206	γ'_1	0.050989**	0.02216
TAX_CNTY	γ_2	-0.44253***	0.033004	γ'_2	-0.49567**	0.067664
INCOME1k_CBG	γ_3	0.004054***	0.000166	γ'_3	0.005615***	0.000387
NWHITE_CBG	γ_4	-0.94814***	0.028945	γ'_4	-1.04032***	0.040944
DISTANCE_CBD	γ_5	-0.00212***	0.000799	γ'_5	-0.00215	0.001543
TURNOV_CNTY	γ_6	9.084472***	0.776347	γ'_6	10.33109***	1.60284
ACCESS_CNTY	γ_7	-0.01922***	0.004656	γ'_7	-0.03023***	0.009796
ARTREC_CNTY	γ_8	-0.29152***	0.034443	γ'_8	-0.31609***	0.068766
POPGR_CNTY	γ_9	0.0186***	0.00341	γ'_9	0.01427**	0.007157
CRIME_MSA	γ_{10}	-0.22429***	0.017977	γ'_{10}	-0.28885***	0.037398
R-squared		0.6209			0.6153	

NOTES. Dependent variable is 2011 Log Real Transaction House Price. Sample size is 20,521 transactions in nine counties. s.e. denotes robust standard errors in parenthesis. ***significant at the 0.01 level; **significant at the 0.05 level; *significant at the 0.1 level.