Anticipatory Effects of Rail Upgrades: Auckland's Western Line

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Abstract

We examine effects of urban passenger rail upgrades to Auckland's Western Line. The upgrades, and associated urban renewal projects, were announced in mid-2005. International experience indicates that the anticipated benefits of the upgrades should be factored into people's location and pricing decisions on announcement. We utilise unit record house sale price data, using a new repeat-sales methodology, to measure house price appreciation, testing the hypothesis that price appreciation is affected by proximity to Western Line stations. We find statistically significant rises in values of houses located near stations upon announcement.

JEL codes

H43, H54, R41, R42

Keywords

Rail infrastructure investment; urban regeneration

Contents

1. Introduction

We analyse the economic effects of urban passenger rail upgrades to Auckland's Western Line. These upgrades include double tracking through to Swanson on the outskirts of Auckland's urban area (enabling a more frequent train service), station redevelopment, and related urban renewal projects. The results are used to assess anticipated net benefits of the developments. The rail-related upgrades were announced in mid-2005 and are expected to be completed in late 2010, but were well publicised upon announcement. International experience indicates that the anticipated benefits of the upgrades should have been factored into people's location and pricing decisions on announcement.

We test whether Auckland residents, who do not have a strong history of rail usage, react positively to the prospect of an improved rail service. Our analysis compares developments near Western Line stations situated within Waitakere City (that, in turn, forms part of the greater Auckland urban area[1]) with developments elsewhere in Waitakere City. This approach enables us to control for wider regional and macroeconomic impacts. Having controlled for these wider factors, we estimate the changing impact over time of station proximity on property values. Changes in property values are used to identify benefits attributable to the upgrades since prospective property buyers bid up the price of a property to include the present discounted value of all net benefits; otherwise they would be outbid by another prospective buyer (Roback, 1982; Haughwout, 2002; Grimes and Liang, 2010). "Net benefits" include gross benefits less direct additional property-tax costs due to the project, but do not include costs borne elsewhere, for instance by central government (although these can be accounted for separately).

We utilise actual property sale prices using a repeat-sales methodology to measure price appreciation. Specifically, we examine whether house price appreciation is affected by proximity to Western Line stations, allowing for different effects at each station. Application of a repeat-sales methodology is novel for New Zealand. We utilise a new repeat-sales approach, developed in Grimes and Young (2010), which utilises an unbalanced panel regression with time and house fixed effects to estimate price growth.

We add the effects of distance from Western Line stations to estimate whether proximity to a station has become more highly valued in recent years as the line has been upgraded. We group stations along the line to investigate whether the effect differs depending on the geographic location of a station in relation to the Auckland CBD. While a limited number of

[1] Waitakere City will be amalgamated with the six other local authorities comprising the Auckland urban area in November 2010. This reorganisation does not affect any of our analysis.

international studies have used similar approaches, this is the first time such issues have been analysed using a fixed effects repeat-sales methodology. This paper is also the first to measure the impacts of an urban rail development in New Zealand using a repeat-sales methodology.

We find a statistically significant rise in the values of houses located near a station upon announcement and find that this effect differs by station locality. Our estimates suggest that houses located adjacent to a Waitakere City station rose in value upon announcement of the rail upgrades relative to houses eight kilometres from the station, with the effect diminishing as distance from the station increases.

The next two sections of the paper examine prior studies of transport-related impacts on property prices and provide background information on developments affecting the Western Line. Section 4 outlines our specification of the data and data cleaning process. Section 5 outlines how we add a distance dimension to a fixed effects repeat-sales index and estimates the impact that the Western Line upgrade announcements had on local house prices. In section 6, we translate the house price increases into the implied increase in aggregate land values that are due to the rail announcements and compare this increase to the expenditures associated with the upgrades. Our conclusions and suggestions for extensions of the work are outlined in section 7.

2. Prior Studies

Cities exist as a result of increasing returns to the locational bunching of certain activities, including firm production and the supply and use of amenities. These agglomeration benefits imply that there is a cost to distance; accordingly, firms and households are prepared to pay higher rents to locate in proximity to activities that are important to them. The private trade-off between agglomeration economies and diseconomies (including congestion) does not, in general, create an outcome that is socially efficient (Venables, 2008). For instance, the decision of a migrant to live and work in a city, or of a firm making its location choice, is based on private returns and fails to take into account external effects (positive or negative). The presence of material external effects means that issues of transport planning and land use in cities are important public policy questions. Successful planning can reduce the effective distance between complementary activities so increasing net agglomeration benefits.

Passenger rail is a form of transport that has high fixed costs and low marginal costs of carrying additional passengers. Advocates of rail transit investment argue that rail transit promotes environmental sustainability and helps strengthen the economic viability of a city (Kahn, 2007). However, a fundamental problem with rail transit often is its failure to attract enough patronage to reduce its high average costs (Winston and Maheshri, 2007). Demand for rail is sensitive to network configuration; travellers are more likely to use rail if its coverage is comprehensive and stations are located conveniently. Given these considerations, the role of rail transport within a city falls naturally within the scope of the transport planning and land use policy issues identified by Venables.

A small number of studies have analysed effects of new rail transit services and the benefits they bring to an area. The most common benefit associated with new or upgraded rail systems is the reduction of congestion on roads. Winston and Maheshri highlight that increased patronage on trains can lead to fewer people using cars and other forms of private transport. This reduces traffic congestion, especially during peak times, which leads to time and cost savings for commuters. Along with reduced traffic congestion, fewer vehicles reduce emissions, while urban travel becomes safer as a smaller number of vehicles leads to fewer vehicle-related accidents.

New rail systems are not limited to positive effects, they also present negative effects. Trains consume high amounts of energy which can, in the case of fuel powered trains, directly increase pollution levels, and, in the case of electric trains, indirectly increase emissions through the electricity generation process. In order to achieve low fuel usage per passenger, high patronage levels are required given the fixed fuel cost component in running a train. For those close to tracks or stations, trains increase noise pollution which creates an undesirable externality.

An effective rail system affects property values surrounding the tracks and stations, potentially positively (through the valuation of transport benefits) and negatively (through noise and other negative externalities associated with location near a track). Typically, the price of land is highest within city centres with prices decreasing as distance from the city centre increases (for an Auckland-specific study, see Grimes and Liang, 2009). Transportation improvements effectively help pull some areas closer to the city thus increasing property values, especially in peripheral areas (Baldwin, 2001; Baldwin et al., 2003).

Gibbons and Machin (2005) measure benefits of rail access in London using housing prices and find that house prices rose around 9.3% following improvements to rail.[2] To estimate their model, they apply a modified hedonic method that includes fixed effects for varying areas together with time effects. They also allow for distance effects. Gibbons and Machin time-difference their model into two periods (pre-transport innovation and post-transport innovation)

[2] For a consulting study that values agglomeration benefits due to London's Crossrail project, see Colin Buchanan (2007).

to assess the effects of the transport innovation. Bae et al. (2003) conduct a similar study using the Seoul subway in Korea and find comparable results to Gibbons and Machin.

The increase in accessibility that a rail system offers can influence property values before the change in accessibility occurs, and even before any construction has taken place through a forward-looking announcement effect. Tsutsumi and Seya (2008) use, as a case study, the Tsukuba Express line in Japan to analyse the dynamic change in property prices. The conventional approach used to evaluate the benefits of an infrastructure project on property values is an application of the hedonic approach developed by Rosen (1974). Tsutsumi and Seya adopt a geostatistical approach to estimate their model and offer a comparison of the benefit estimates using both the geostatistical approach and a spatial econometric approach. They find net benefits regardless of which approach is used.

McMillen and McDonald (2004) investigate the effects of the Midway Rapid Transit Line in Chicago, opened in October 1993, on the market for single-family homes. Like Tsutsumi and Seya, the authors adopt a hedonic approach, but in addition they use a repeat-sales estimator to track temporal variations in transit station price gradients. Using the repeat-sales method they are able to obtain estimates of the aggregate benefit of the new train line.

McMillen and McDonald find that the anticipated benefits of the new transit line are capitalized into house prices six years before the construction of the line is completed. House prices start rising after the announcement of the project, with a rise in the absolute value of the house price gradient, with respect to distance from the nearest train station. However, this gradient declines in the period four to six years following the opening of the line. McMillen and McDonald use a standard hedonic price function as their base equation for estimation, which includes three spatial variables – distance to the nearest train station, a dummy variable to indicate that a house is within 1/8 mile of the train line and distance from the city centre. In addition to using the hedonic method, McMillen and McDonald employ a repeat-sales method to estimate the train station gradient indexes. The authors claim that the estimates from the repeat-sales method are subject to less bias due to functional form misspecification than the hedonic estimates. However, there is a trade-off between the two methods as the reduction in misspecification bias from the repeat-sales method comes at the cost of a decrease in sample size and possible selection bias.[3]

The authors find clear negative gradients which imply that as distance to the station decreases, house prices rise. This relationship is found using both the hedonic method and

[3] McMillen and McDonald also extended the standard repeat-sales method, adopting a Fourier approach, to produce smoother distance gradients across time.

repeat-sales method. The sharpest rise in house prices occurs for those houses located close to the station, in line with expectations that the majority of benefits would accrue to these dwellings. There was, however, a significant 'negative externality' discount for being within one block of the train line during the initial period.

Similar to McMillen and McDonald, Jud and Winkler (2006) study the announcement effect of an airport expansion on the prices of houses located around an airport. They measure the change in property values pre- and post-announcement of the airport expansion to see whether a significant change occurred. With the use of a hedonic price model, Jud and Winkler model the house price pre- and post-announcement and test whether there is a significant difference between the two period's coefficients. Consistent with an airport expansion increasing noise pollution and other negative externalities, Jud and Winkler find significant reductions in house prices for properties that surround the expansion. They find that as distance from the expansion increases, the significance of the reductions decrease, suggesting that the effects are strongly localised.

Kahn (2007) studied the consequences of local public goods improvements for communities near new train stations and examined how community outcomes, such as house prices, change in *treated* areas (close to the rail line) compared to those in *control* areas (distant from the line). He describes three types of treatment for areas which receive new rail access; no increase in access[4] to rail transport, a "Walk and Ride" station built close to a community, and a "Park and Ride" station which is generally located in a community where there is ample land for a carpark. Kahn finds that in the long run, homes that are located near a "Walk and Ride" facility experience a rise in house price, while homes located near a "Park and Ride" facility experience a fall in house price.

This dichotomy may reflect a differential gentrification pattern. New "Walk and Ride" stations may increase foot traffic in the local community, as people walk to the station. This lifestyle could attract upper income households which, in turn, could attract more upper income households to these areas.[5] This gentrification effect is not predicted to be as prominent in communities that are close to "Park and Ride" facilities. Kahn finds that "Walk and Ride" stations have a positive and statistically significant effect on house prices in around half the cities sampled, while "Park and Ride" station treatment has a negative and statistically significant effect in two cities. Kahn also finds that "Park and Ride" treatments reduce the proportion of college

[4] Access here is defined as a community being within a mile of the closest station.
[5] Bayer and McMillan (2010) find that reductions in commuter costs can lead to increased social stratification as households find it easier to locate in neighbourhoods with similar households.

graduates living within the community, adding weight to the conclusion that this type of treatment results in less gentrification.

A new rail line increases the set of possible commuting choices available to communities. However, this does not guarantee positive outcomes. Glaeser et al. (2008) find that public transit stations can act as poverty magnets. The urban poor are less likely to own their own vehicles and thus place greater value on public transport. Increased access means that a town's urban poor have greater access to the broader community, which could lead to an increase in anti-social behaviour elsewhere. Consistent with this analysis, Bowes and Ihlanfeldt (2001) discover that the presence of a car parking lot ("Park and Ride" facility) increases crime in areas close to a station. However, areas that are further away from the station (between a quarter and one mile) experience less crime if that station has a parking lot. Bowes and Ihlanfeldt suggest that a parking lot alters the distribution of crime around the station, increasing crime close to the parking lot and decreasing crime further away. Accordingly, price impacts of a rail upgrade may have non-linear spatial effects with houses located near a station increasing less in price than houses located a little further distant from the station.

3. Background

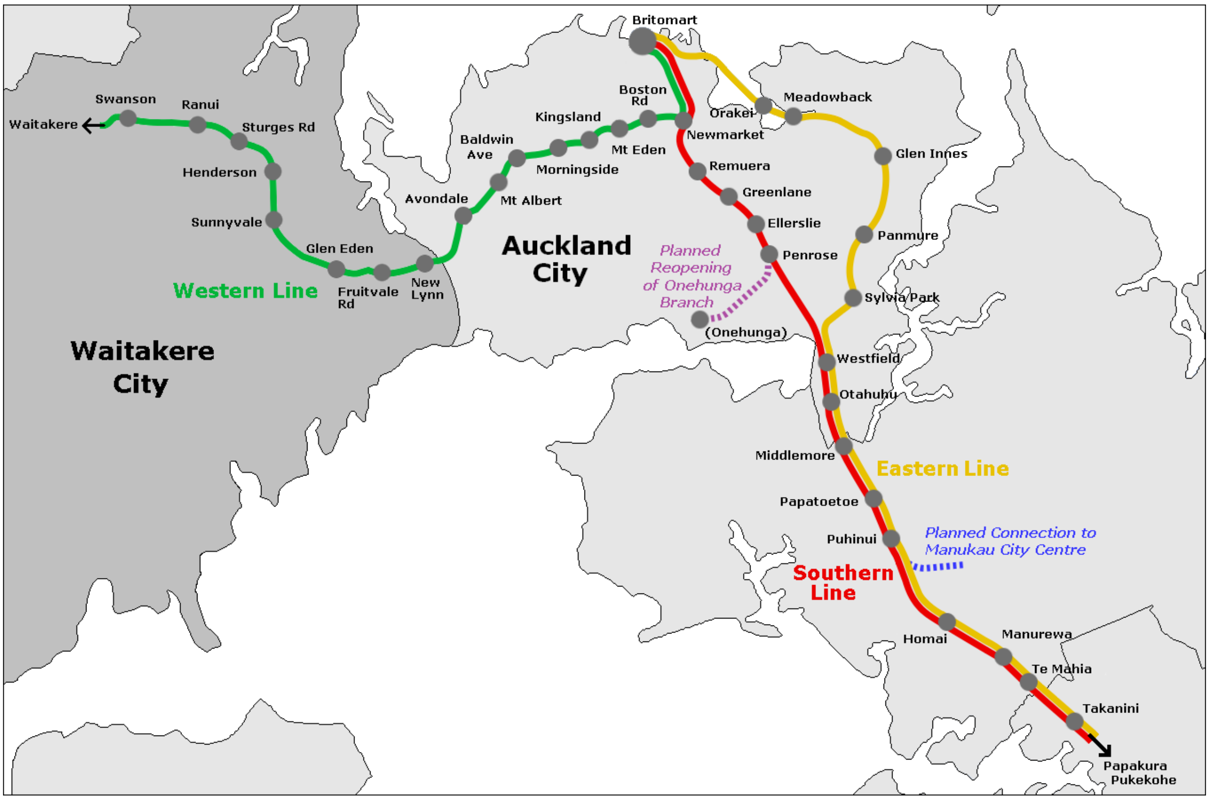
Auckland is New Zealand's primate city. Statistics New Zealand estimates the urban area population at 1.33 million in 2009, 31% of the country's population. It is the economic capital of New Zealand, with major national and international corporations holding offices within the city. Crucial to Auckland maintaining or increasing its dominant role is an effective transport system. One component of such a system is a rail network that is able to move commuters reliably around and through the city. Auckland's roads are already congested[6], with an anticipated increase of 25% in usage over the next decade (Project DART, 2010a). An integrated passenger transport network could improve the congestion issues facing Auckland commuters during peak hours. In 2008/09 Auckland managed 7.65 million rail passenger journeys per year, whereas some other similar sized cities internationally manage 30 -50 million (Project DART, 2010a).

In 2003, the Britomart Transport Centre, a major new rail and public transport hub, opened in the Auckland CBD creating prospects for further rail development in Auckland. The New Zealand Government agreed in 2005 to upgrade the Auckland rail network to improve its reliability, safety, and service. Project DART (Developing Auckland's Rail Transport) was

[6] One study found that Auckland's afternoon peak road travel delays were higher than in either Brisbane or Perth, and equal to those in Adelaide (similar sized cities in Australia), albeit lower than in Sydney or Melbourne (Ministry of Economic Development et al, 2007).

implemented to begin the improvements to Auckland's rail network to allow more frequent and reliable passenger services. Project DART involves a number of upgrades, the most significant being the redevelopment of the Newmarket Station and junction, the duplication of the Western Line to Swanson and improvements of stations along it, and the construction of the New Lynn Station and trenching the rail line through the New Lynn Township (Project DART, 2010b). The initial upgrades will increase capacity making it possible for a larger number of trains to operate per hour. The project is the most significant redevelopment of the rail network in New Zealand since the 1980s. In addition to these developments, in 2007 ONTRACK (the rail provider) committed to reopening the Onehunga line for passenger services. These costs were absorbed into the overall contingencies for Project DART. A $50 million passenger link to Manukau City is also being constructed. Work began on the Manukau link in July 2009, with trains due to start operating at the end of 2010 (Project DART, 2010c). Already, 21 of the region's rail stations have been upgraded and all 41 stations in the region will be upgraded by 2012 (ARTA, 2010). Figure 1 depicts the Auckland railway system.

Figure 1: Map of the Auckland Railway System



A number of agencies are involved in the upgrades to the Auckland rail network. ONTRACK (a division of the New Zealand Railways Corporation, a state owned enterprise) is responsible for the 'below rail' components of the rail infrastructure in Auckland, and is responsible for the implementation of Project DART. Auckland Regional Transport Agency (ARTA), on behalf of Auckland Regional Council (ARC), is responsible for the 'above rail' infrastructure and for planning, funding and developing the transport system in the Auckland region (Project DART, 2010d). Other agencies involved are Waitakere City Council (WCC) and New Zealand Transport Agency (NZTA), previously known as Land Transport New Zealand (LTNZ).

In the 2006 Budget, the Government included funding of up to $600 million for Project DART. ARC, as at June 2009, had invested $190 million into the upgrades as part of Project DART and has programmed a further $190 million.

Newmarket is the second busiest railway station, after Britomart, on the Auckland rail network. It is the station which links the northern, western and southern lines. Its redevelopment, which began in 2007, was critical to the upgrades, as the original layout caused a bottleneck and service delays (Project DART, 2010e). Since its recent completion, trains are expected to run smoothly and more frequently - every 10 minutes at peak times along the Western Line (ARTA, 2010). In addition, the revised track layout allows a range of new service options, such as a direct link between Britomart and the west, and possibly a link between the west and south (Project DART, 2010e).

The most significant component of Project DART is the duplication (double tracking) of the Western Rail Line between Avondale and Swanson.[7] Once complete, this line will offer a reliable and efficient link between the Auckland CBD and West Auckland, reaching out beyond Swanson to Waitakere village. Work on this part of the project began in late 2005 with the double-tracking between Titirangi Road and Henderson. This piece of tracking was completed in June 2007 and, subsequently, the section between Henderson and Swanson was completed. In late 2007, work began on the sections between Whau Creek and Titirangi Road including the major work being done at the New Lynn station. This section was completed June 2010. The section between Avondale and Whau Creek began double-track construction in late 2008 and was also completed June 2010 (Project DART, 2010f).

The rail project complemented major urban redevelopments within Waitakere City. The city council's new offices – the Waitakere Central Civic Centre – were opened in Henderson in July 2006. Shortly afterwards (November 2006), the rejuvenated Henderson rail station was opened with a glass footbridge connecting it to the new Civic Centre and to Henderson Mall.

[7] All stations beyond Avondale are in Waitakere City, the focus of our empirical analysis.

In March 2005, Waitakere City Council (WCC) initiated plans to redevelop New Lynn to improve transport efficiency and promote economic growth in the area. Major construction was needed to develop the New Lynn station and surrounding area at a total cost of $300 million (WCC, 2009). A rail trench, costing $160 million (The New Zealand Herald, 2009), had to be dug to allow the tracks to run under the roads to allow for a higher frequency of service. The area surrounding the station is planned to be developed for business. Of the $600 million funding approved for Project DART, $140 million of this was devoted to the trench upgrades at New Lynn. Other funding contributors to the upgrades at New Lynn were ARTA (through ARC) contributing $13.6 million to the new station, WCC investing $69 million for the trench and road upgrades, as well as $22 million for the new station. NZTA, along with Watercare (the local authority water and waste water entity), were to provide the balance (WCC, 2009).

In addition to these developments, the Auckland rail system is being electrified. In the 2007 Budget, Government announced its support by contributing $500 million as its share of the $1 billion project (ONTRACK, 2010), with ARC providing the other $500 million (ARC, 2009). ONTRACK was given permission to begin work on electrifying the Auckland rail network in 2008, with a deadline of 2013 for completion (ONTRACK, 2010). Electrification of the lines will extend from the CBD to Papakura in the south and to Swanson in the west, and include the Onehunga Branch Line and Manukau Rail Link (ONTRACK, 2010). Government signalled that funding of $500 million will be provided for the purchase of new electric trains, which will run on the upgraded and electrified rail network (Beehive, 2009; MoT, 2009).

In total, central Government has contributed a total of $1.6 billion to the upgrades of the Auckland rail network; $600 million on Project DART, $500 million on the electrification and $500 million on the purchase of new electric trains (MoT, 2009). The Regional Council (ARC and ARTA) has contributed a total of $900 million, and other parties have contributed around $150 million. Thus the total cost associated with the Auckland upgrades is in the vicinity of $2.65 billion, but only a proportion of this is specific to the Western Line.[8] (These estimates make no allowance for time discounting of expenditures.)

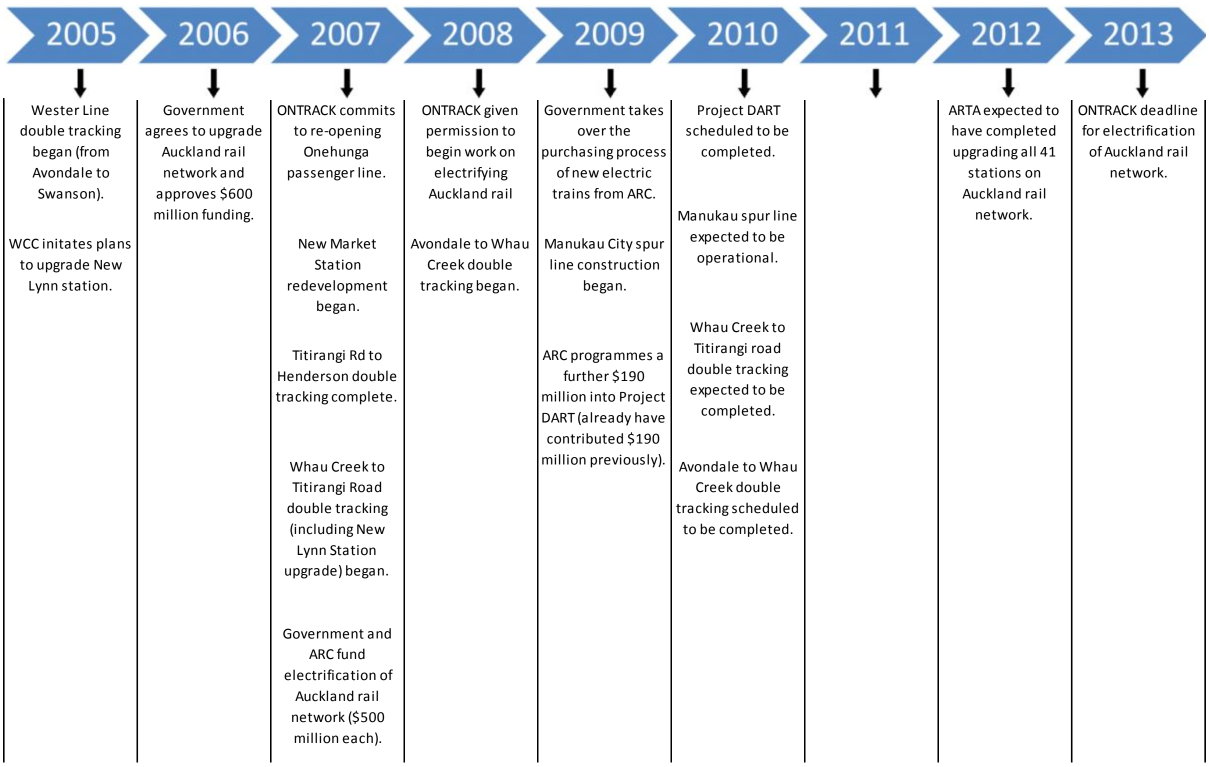
There are a number of potential benefits associated with the Auckland rail upgrades. ARC (2009) divides these benefits into four broad categories. The first is benefits to road users (travel time savings and congestion reduction, especially during peak hours). The second is benefits to passenger transport users (improved quality and reliability of passenger services and travel time savings). The third category relates to agglomeration benefits arising from

[8] Approximately 70% of the Government funding (approximately $420 million) was allocated to the Western Line duplication; see http://www.kiwirail.co.nz/index.php?page=auckland-projects.

intensification of economic activity in and around the Auckland CBD and around New Lynn and other stations. The final category comprises indirect transport benefits (including reductions in greenhouse gas emissions, fewer motor vehicle accidents, less noise pollution, reduced urban sprawl, improved air quality, and a reduction in the 'hidden' costs of motoring such as land used for roads and parking).

Auckland rail patronage trebled in the nine years to 2008/09 and doubled between 2004/05 and 2008/09.[9] Similarly, Western Line patronage doubled between 2004/05 and 2008/09 (from 1.35 million to 2.71 million journeys per annum). Our estimates use 2004/05 as a base year for calculating benefits. However, as discussed in the Conclusions, the significant growth in rail patronage since that date may result in an under-estimation of the benefits accruing from the upgrades. Indeed, one possible contributor to the patronage growth since 2004/05 (besides higher fuel costs) is the greater prominence given to the rail network as a result of the announced upgrades described above. Figure 2 sums up the major events in a timeline.

Figure 2: Timeline of Major Events



[9] Auckland rail patronage figures (sourced from ARTA Annual Reports) were: 2.29 million journeys (1999/2000), 3.80 million (2004/05) and 7.65 million (2008/09).

4. Data Description

4.1. House Price Data

The house sales price data used in this study is obtained from Quotable Value New Zealand (QVNZ). A request was sent to QVNZ for data on 500 randomly chosen detached houses (residential dwellings, RD) sold in each of the 12 quarters March 2007 to December 2009, thus providing a potential dataset with observations on 6,000 houses.[10] Two conditions needed to be met for houses to be eligible; first, the sale of a house had to be that house's most recently recorded sale, and second, each house had to have been recorded as sold at least one additional time since the early 1990s. Once these houses were compiled, data on each prior recorded sale of each house needed to be included in the dataset. For each sale, we required each house to have a unique property identifier (to link sales of the same house), the address of the house, the house's meshblock (MB),[11] the sale date (to deduce the sale quarter), the rateable value (RV) (Government valuation) and the date of the RV.

Another data series obtained from Quotable Value provided the QVNZ quarterly house price index for residential dwellings within Waitakere City. This series spanned a period from December 1989 through to September 2009. The QVNZ index uses the Sale Price Appraisal Ratio (SPAR) method to calculate its index.[12]

4.2. Data Cleaning

We received a dataset from QVNZ that contained observations on 5,715 houses over the 12 quarters (4 of the 12 quarters had fewer than 500 eligible sales, ranging from 390 to 487 sales); the dataset included 5,284 unique houses over this period.[13] A separate QVNZ file supplied the pre-2007 sales data for each house. This file included 1,428 houses that had been sold, but not post 2007; 467 had sold only once and so were removed from the sample. This resulted in our raw dataset having 6,245 unique houses with repeat-sales data and 19,898 sales observations in total (i.e. each house sold, on average, a little over three times during the period). A number of houses had more than one sale recorded within a quarter. In these cases we kept the most recent observation and discarded the prior observations in that quarter, considering that the last sale

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[10] If in any quarter there were less than 500 sales that met the conditions specified, the full list of house sales in that quarter that met the conditions would be included.

[11] A meshblock is Statistics New Zealand's smallest sampling unit, approximately equivalent to a city block in urban areas.

[12] For more details on the SPAR method see Bourassa et al. (2006); de Vries et al. (2009).

[13] Some houses were included in more than one quarter, possibly due to those periods that had less than 500 sales having the full list of sales included.

was most likely to be closest to actual market value.[14] After removing these observations, we were left with 6,234 unique houses and 19,651 total sales observations.

The next step was to remove any outlying or spurious observations. To do so, we employed an "adjusted valuation" method. This method involved taking the ratio of the sales price to the adjusted valuation of the property. The adjusted valuation of a house is its rateable value updated to its equivalent value in the sale period. Because properties are only valued on average every three years, a house's rateable value needed to be updated to match the relevant sale period. We used QVNZ's house price index (SPAR) and the following formula to calculate the adjusted valuations.

$$adjvaluation_t = valuation_{t-N} \times \frac{SPAR_t}{SPAR_{t-N}} \quad (1)$$

where *adjvaluation* is the updated rateable value in quarter t; t is the quarter of the current sale; *valuation* is the rateable value of the house in quarter t–N (i.e. the last time the house was rated was N quarters ago); and *SPAR* is the QVNZ house price index in quarters t and t–N.

The SPAR index was available from the December quarter in 1989 (1989q4) to 2009q3. Therefore, any observations or sales we have prior to 1989q4 or after 2009q3 will not have a matching SPAR index. Observations that fell outside our data range were dropped. This resulted in our sample containing 6,219 houses and 17,921 sales observations.

Using the adjusted valuation ratio meant that any sale price that is suspiciously large or small in comparison to its adjusted valuation, will show up as an outlier. Figure 3 shows the distribution of the adjusted valuation measures; Table 1 displays the percentiles of the distribution. As expected, the distribution is centred on one; 98% of the observations lie between 0.72 and 1.49. Using these results, we decide to drop any outlying observations defined as those which are outside the interval (2/3, 3/2). This results in a sample that contains 5,760 unique houses and a total of 17,213 observations.

We next remove sales observations that occur in adjacent quarters. This step was included to remove any sales (akin to within-quarter sales) that occur within a short space of time. The most recent of the adjacent quarter sales is kept. Once these adjacent quarter sales are removed we are left with 5,729 unique houses and a total of 16,848 sales observations.

[14] Closely timed prior sales may have been driven by non-market factors including taxation-related reasons.

Figure 3: Distribution of the Adjusted Valuation Measure

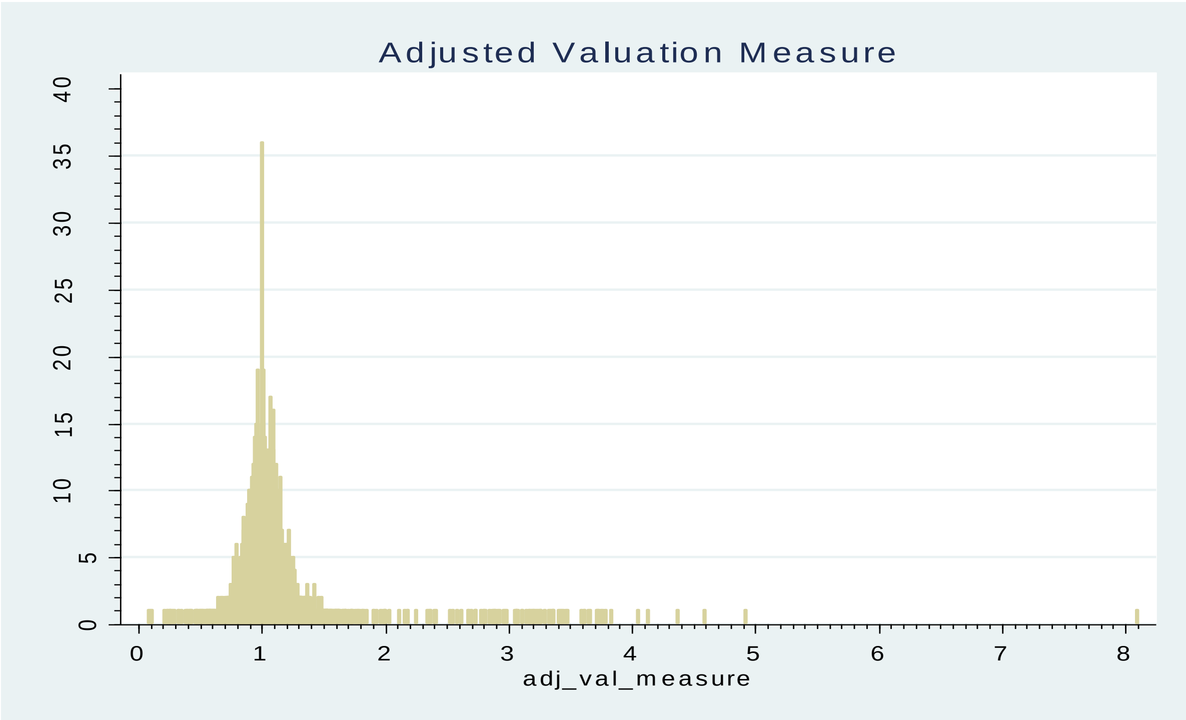


Table 1: Percentiles of the Adjusted Value Measure

Mean	1.0253
Standard Deviation	0.2094
Percentiles	
5%	0.8219
25%	0.9337
50%	1.0084
75%	1.0900
95%	1.2386
Number of Houses	6,219
Observations	17,921

Finally, we require a sufficiently large number of observations for each quarter so that our estimates are precise. In each of the quarters prior to 1993q3 there are fewer than 110 sales per quarter, whereas from 1993q3 to 2009q3 each quarter has at least that many sales. We therefore drop all observations prior to 1993q3. This results in our final data set containing 5,729 unique houses with 16,245 total sales observations, spanning a period from 1993q3 to 2009q3. On average, there are 250 sales per quarter in our sample, compared to an average of 1,098 sales per quarter within Waitakere City for the same period. Our sample therefore contains 22.8% of all sales within Waitakere City for this period.

5. Proximity and Station Effects

A property's distance from its local amenities is hypothesised to influence its value. A railway station, or other public (and private) transport link, is a major local amenity that impacts on residents, and potentially also on firms. Accordingly, ceteris paribus, properties located nearer to a railway station should attract higher sales prices than those located further away. Given the upgrades to Auckland's Western line, the rail service is expected to improve. This improvement will increase the ease of access of residents along the Western line to the Auckland city centre and to other suburbs. The rail upgrades were announced mid-2005. We test the hypothesis that the announcement of the upgrades had a positive impact on the general level of house prices post-announcement and that this impact will be greater for those houses closer to the station than those located further away.

To account for the effect of a property's distance to a local train station, we incorporate a distance variable into our house price index model. This distance variable is incorporated into the model in an analogous way to that in McMillen and McDonald (2004) but using a different repeat-sales methodology. Grimes and Young (2010) propose a new approach to calculating a repeat-sales index which utilises an unbalanced panel (UP) estimation approach including individual fixed effects and time fixed effects. They find that there is a close similarity between the UP repeat-sales method and other commonly used repeat-sales methods such as the Case-Shiller method, but the UP method is simpler to estimate. The baseline equation (prior to inclusion of distance effects) is represented as:

$$\ln HP_{it} = \alpha_i + \mu_t + \varepsilon_{it} \tag{2}$$

where $\ln HP_{it}$ is the log of the sale price of house i in quarter t; a_i represents the individual house fixed effect; μ_t represents the time fixed effect; and ε_{it} represents the error term.

The panel is estimated using OLS with clustered errors. The error term may not be correlated across houses i, but is likely to be correlated within i. Clustering the errors on houses preserves the assumption of zero correlation between errors across houses, but allows the errors to be correlated within houses. Clustering the errors does not affect the bias of estimates but improves inference by correcting for correlated errors (Nichols and Schaffer, 2007).

To incorporate a distance effect into this approach, we interact the distance of each property from its nearest station with the time fixed effects, μ_t, using a quadratic functional form.[15] Houses located eight kilometres distant from their nearest station are assumed to have

[15] Other function forms were considered (linear and logarithmic); however, quadratic distance seemed most appropriate and was consistent with other studies.

zero effect from the upgrades. Accordingly, we define our distance measure as: $PROXIMITY_i = 8 - DISTANCE_i$, where *DISTANCE* is the Euclidean distance (in kilometres) between a house's meshblock centroid and its nearest station. Any house that is more than eight kilometres distant from its nearest station has its *DISTANCE* set at eight to ensure that *PROXIMITY* has a minimum of 0.[16]

Table 2: Distance Descriptives - Total and by Station Group

	All Stations	Group 1	Group 2	Group 3
Distance				
mean	2.793	2.107	2.502	3.922
Std dev.	2.328	1.720	1.982	2.845
5th Percentile	0.462	0.415	0.516	0.451
25th Pecentile	1.136	0.953	1.137	1.489
50th Percentile	1.964	1.602	1.748	3.648
75th Percentile	4.030	2.467	3.636	5.435
95th Percentile	7.228	5.921	6.074	9.298
No. Houses	**5729**	**1945**	**2092**	**1692**
No. Sales	**16245**	**5586**	**5779**	**4880**

Defining our distance measure in this way allows us to analyse how the announcement effects varies as proximity to the nearest station changes. *PROXIMITY* is incorporated into the model is as follows:

$$\ln HP_{it} = \alpha_i + \mu_t + \beta_t PROXIMITY_i + \gamma_t PROXIMITY_i^2 + \varepsilon_{it} \quad (3)$$

There are eight stations within Waitakere City that are affected by the upgrades. Given their geographical locations, they form three relatively distinct groups. The New Lynn, Fruitvale Rd and Glen Eden stations form one group; the Sunnyvale, Henderson and Sturges Rd stations form another group; and Ranui and Swanson stations form the third group. The first group of stations is closest to the city centre and the urban redevelopment at New Lynn, while the second is slightly further out and based around the town centre of Henderson; the third group includes the stations most distant from the Auckland CBD (see the map in Figure 1).

Not only do the stations have different situations relative to the CBD, but the distribution of houses around the stations also differs. Table 2 shows that, of our sample of houses, those located around the New Lynn set of stations are on average a little closer to the stations (2.1 km) than those situated around the Henderson group (2.5 km); the Ranui/Swanson houses are on average situated quite a bit further from the nearest station (3.9 km). In addition,

[16] There are few houses in our sample greater than eight kilometres from a station – the 95th percentile of *DISTANCE* is 7.23km (Table 2).

there is a much greater distribution of houses around the mean for Ranui/Swanson than for the other two groups, and a greater proportion of houses in excess of 6 kilometres from the station than for the stations closer to the city.

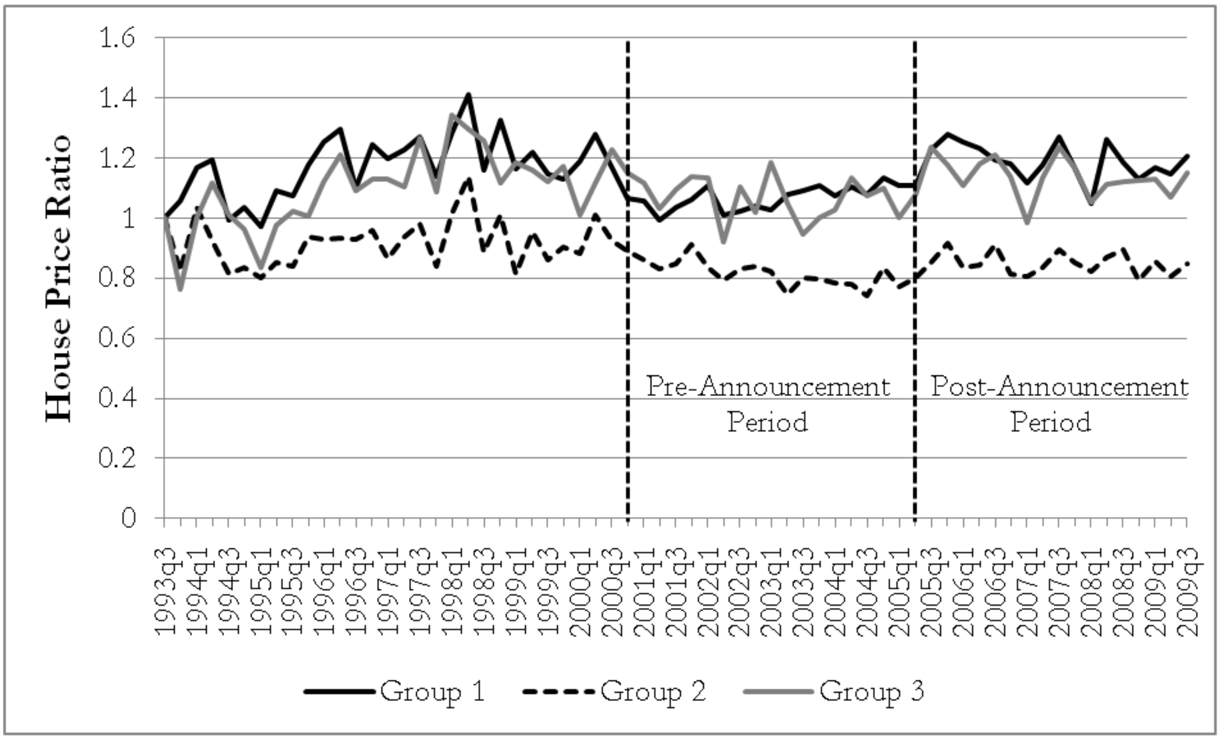
Because of their different spatial characteristics, we examine whether the upgrade benefits differ across the three station groups. To do so, we incorporate station group dummy interactions into the distance effect model to analyse whether there is a different distance effect for each group of stations. The model now becomes:

$$\ln HP_{it} = \alpha_i + \mu_t + \beta_t STN_j * PROXIMITY_i + \gamma_t STN_j * PROXIMITY_i^2 + \varepsilon_{it} \quad (4)$$

where STN_j is a dummy variable representing station group j (j=1,2 or 3) and where STN_j=1 if house i is closest to station group j, and =0 otherwise.

Estimation of this model produces the results shown in Table A1 of the Appendix. To observe the changing effects of station proximity over time for each station group, we plot, for a given house i, the ratio of its value if it were adjacent to the station relative to its value if it were eight kilometres distant. Figure 4 presents these ratios. As in McMillen and McDonald (2004), the distance-related effects are volatile over time. Nevertheless, we observe a slight upward shift in the house price ratios post 2005q2 (relatively to the previous 18 quarter period), coinciding with the announcement of the upgrades to the Western rail line upgrades.

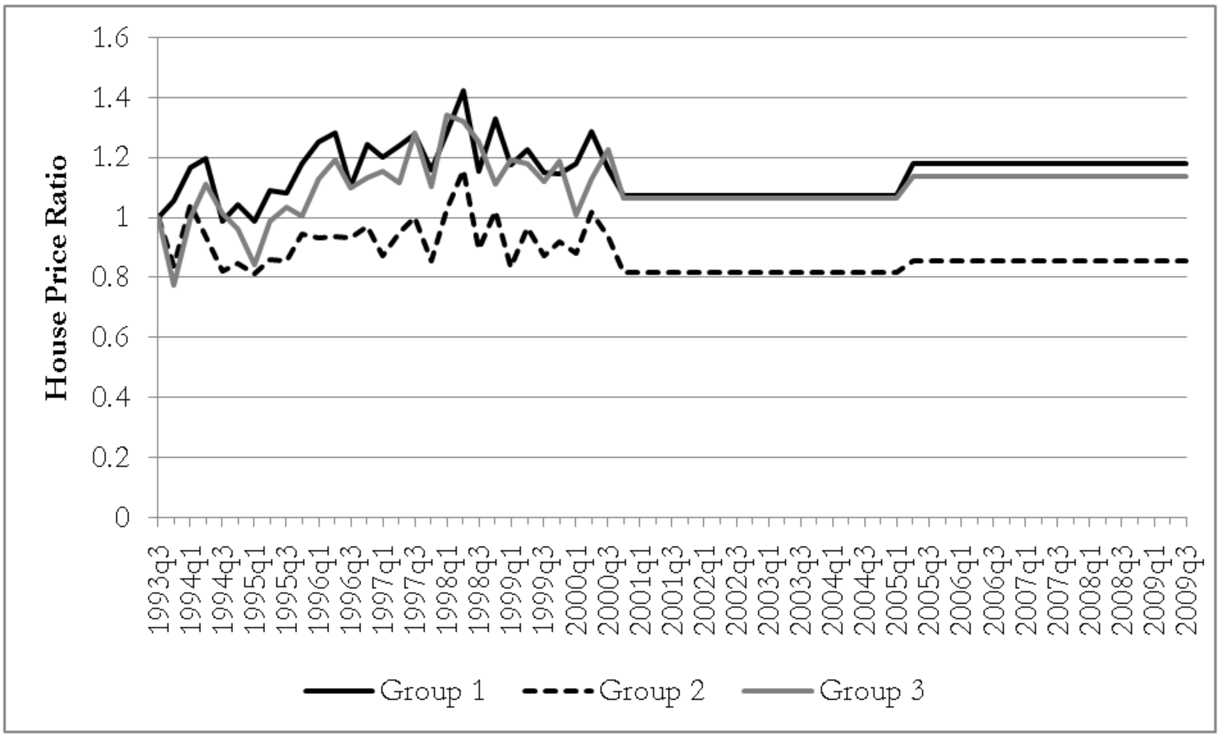
Figure 4: House Price Ratios (Adjacent to station / 8 km distant)



To analyse the announcement effect of the upgrades with greater clarity, we group the 18 quarters after the announcement (2005q2 through to 2009q3) into a single post-announcement period and compare it to the 18 quarter pre-announcement period (2000q4 through to 2005q1). Each of these periods is accorded its own β and γ coefficients, while all quarters prior to 2000q4 retain their own individual β and γ estimates.

Figure 5 plots the house price ratios (adjacent / 8 km distant) with the pre-announcement and post-announcement groupings for each station group; Table A2 in the Appendix provides the estimation results. Figure 5 indicates that each group's ratio increases following the announcement, implying an increase in relative house prices after the upgrade announcement for houses close to a station.

Figure 5: House Price Ratios with Pre-/Post-Announcement Groupings



Having these pre- and post-announcement period groupings allow us to examine whether the increases across the announcement are significant. For each station, we perform a Wald test on the pre- and post-announcement distance coefficients, with the null hypothesis H_0: $\beta_{Pre\text{-}Announcement} = \beta_{Post\text{-}Announcement}$ and $\gamma_{Pre\text{-}Announcement} = \gamma_{Post\text{-}Announcement}$. The test statistics of the Wald test for station groups 1, 2 and 3 are F (2, 5728) = 22.64, F (2, 5728) = 10.56 and F (2, 5728) = 12.67, respectively. Each test statistic has a p-value of 0.0000, rejecting the null hypothesis of no announcement effect from the upgrades, and instead implying that the relative prices for houses near a station rose significantly post-announcement relative to their pre-announcement levels.[17]

Denoting the pre-announcement coefficients on distance as β' and γ' and the post-announcement coefficients as β'' and γ'' and treating all other coefficients as unaffected by the announcements, equation (5) implies, for each station group *j* and a given house, the following (where HP′ and HP″ are pre and post announcement house prices respectively):

$$\ln HP'' - \ln HP' = (\beta'' - \beta') * STN_j * PROXIMITY + (\gamma'' - \gamma') * STN_j * PROXIMITY^2 \quad (5)$$

Equation (5) allows us to perform a difference-in-difference analysis to investigate how the announcement effect (i.e. post/pre announcement price) varies as the proximity to a station changes. Figure 6 shows the percentage increase in house price from pre- to post-announcement, as proximity to (or distance from) the nearest station changes. The figure indicates the percentage increase in house price at the time of the upgrade announcement for houses at different distances from the station. All increases are expressed relative to prices of houses eight or more kilometres from a station, for which the price impact is assumed to be zero. Of houses within one kilometre of a station, those surrounding Group 1 experience the highest increase in house price, rising by 9.94% at the station; Groups 2 and 3 rise 4.83% and 6.78%, respectively. Also evident from Figure 6 is that Groups 2 and 3 behave similarly, while Group 1 follows a different pattern. The redevelopment surrounding the New Lynn station provides a plausible explanation as to why property prices increase as proximity to Group 1 stations improves, in contrast to a slight drop-off with greater proximity for the other two groups. For these latter groups, the potential for negative externalities associated with more frequent train movements and greater patronage leads to a diminution in value uplift close to these stations.

A Wald test of equal announcement effects across the three station groups rejects the hypothesis in favour of significantly different effects.[18] A Wald test also rejects an equal effect for Groups 2 and 3.[19] Therefore, each station group experiences different individual effects from the announcement. Figure 6 shows that Group 3 houses experience a greater price effect than Group 2 houses, consistent with greater benefits of the upgrades for houses that are most distant from the CBD so experiencing a larger benefit from the upgrade. However the added urban redevelopment around New Lynn results in a still higher value uplift for Group 1 houses.

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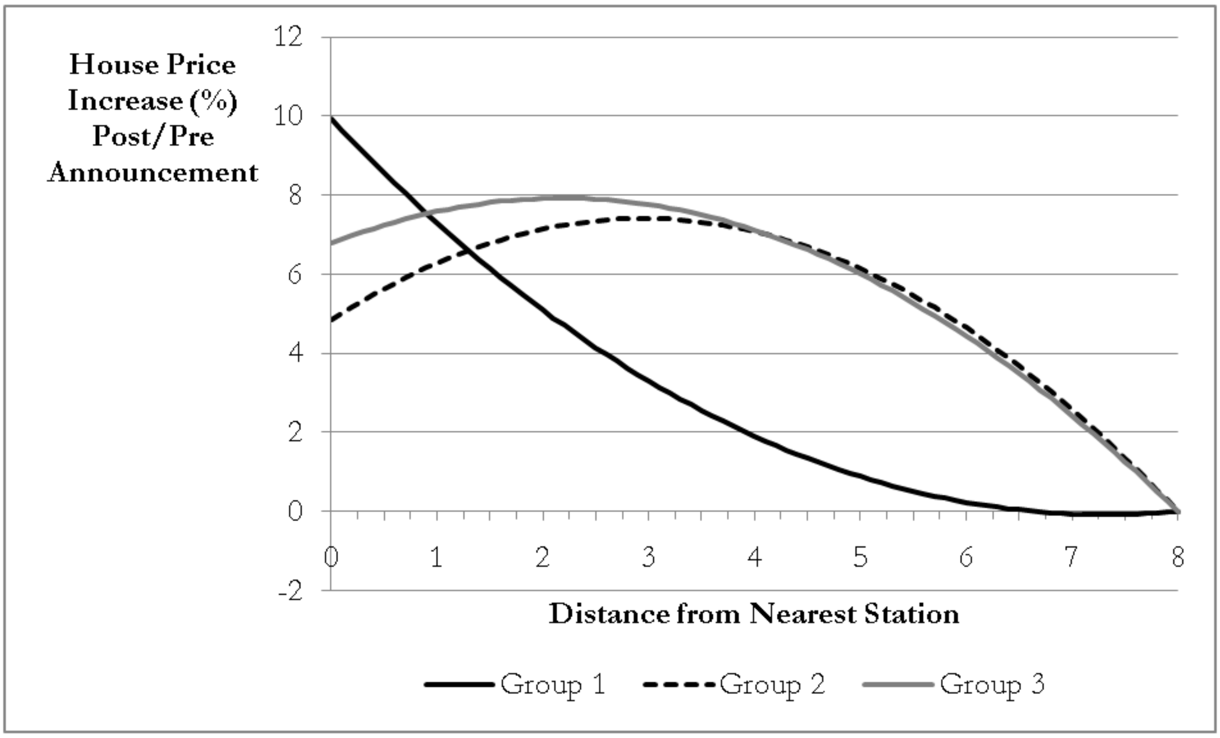
[17] We take the 18 pre-announcement quarters as the relevant comparator since they reflect residents' valuation of rail prior to the upgrade information coming to hand.

[18] The test statistic is $F(6, 5728) = 9.01$ with p-value = 0.0000.

[19] The test statistic is $F(4, 5728) = 6.46$ with p-value = 0.0000.

Figure 6: Proximity Effect



6. Impacts on Land Values

The total increase in residential land values due to the rail announcements reflects the sum of the expected capitalised value accruing to local residents as a result of the anticipated upgrades in rail service and accompanying urban design improvements (Roback, 1982; Haughwout, 2002). We base our calculation of this value on the estimates presented in Table A2.

A house greater than eight kilometres from its nearest station (i.e. *PROXIMITY* = 0) is assumed to experience no change in price as a result of the rail announcement (i.e. it is neither worse off nor better off as a result of the anticipated upgrades); we denote this distance as $PROXIMITY_0$. We take the ratio of equation (5) for a house in a meshblock with proximity *m* ($PROXIMITY_m$) to a station (where $8 \geq PROXIMITY_m > PROXIMITY_0$) relative to that of a house at $PROXIMITY_0$ to give the estimated increase in value of a house in meshblock *m* as

$$\frac{(HP''/HP')_m}{(HP''/HP')_0} = \frac{\exp\{(\beta''-\beta')*STN_j*PROXIMITY_m + (\gamma''-\gamma')*STN_j*PROXIMITY_m^2\}}{\exp\{(\beta''-\beta')*STN_j*PROXIMITY_0 + (\gamma''-\gamma')*STN_j*PROXIMITY_0^2\}} \quad (6)$$

where *HP″, HP′, β″, β′, γ″* and *γ′* are defined as in equation (5).

Our assumption about the independence of house prices at least 8 kilometres from the station to rail upgrades means that $(HP''/HP')_0 = 1$; therefore the ratio of post- to pre-announcement house prices for a house in meshblock *m* simplifies to:

$$(HP''/HP')_m = \exp\{(\beta''-\beta')*STN_j*PROXIMITY_m+(\gamma''-\gamma')*STN_j*PROXIMITY_m^2\} \quad (7)$$

While equation (7) provides the estimated increase in *house* prices due to the rail announcement, we are more interested in *land* value changes since land is the immobile factor that reflects the infrastructure upgrades. If all properties in the affected area comprised just houses, and if values of improvements (essentially buildings) are unaffected by the upgrades (given that replacement cost has not changed due to the rail upgrade), then the absolute change in land value is equal to the absolute change in house values. Defining LP as the land value and IMP as improvements (≡HP-LP), and dropping area subscripts for expositional simplicity, the proportionate increase in land values becomes[20]:

$$LP''/LP' = (HP''-IMP'')/(HP'-IMP') \quad (8)$$

Assuming that the value of improvements does not change due to the announcement (IMP″=IMP′), and denoting the pre-announcement ratio of improvements to house prices as φ (=IMP′/HP′), we can express the land value change as:

$$LP''/LP' = [(HP''/HP')/(1-\varphi)]-[\varphi/(1-\varphi)] \quad (9)$$

If we assume that the rail upgrades produce value only for residents (and not for firms or farms), then we can sum the increase in land values across station groups for all residential land (including land relating to apartments as well as stand-alone and other types of dwelling) in areas within eight kilometres of a station to calculate the total capitalised value uplift anticipated from the upgrades. The first entry in Table 3 provides this value.[21]

Table 3: Estimated Value of Land Uplift

	Land Value Uplift (2004 $s)
Residential Land	$605,000,000
Residential + Commercial + Industrial Land	$667,000,000

[20] QVNZ values every property in Waitakere City for property tax (local authority rates) purposes, splitting assessed capital value into land value and improvements value. The assessed values form the basis for our calculations in this section.

21 In calculating this value we have used meshblock-specific values for φ, as determined by the QVNZ 2004 residential (RD) valuations of IMP and HP for each Waitakere City meshblock.

In addition to producing value uplift for houses, the upgrades may raise the value of land for commercial and industrial purposes. (We assume that there is little or no effect on farm or forestry values.) If we ascribe the same rate of land value uplift (within meshblocks) to commercial/industrial land as for residential land, we arrive at the second entry in Table 3. This latter entry will provide an over-estimate of the value uplift if proportionate benefits of the upgrades to commercial/industrial users are less than for residential users. Conversely, the commercial/industrial land around New Lynn may have risen by more than the rate of residential land rise given that much of the area surrounding the New Lynn project is commercial property. The residential-only figure is likely to provide an under-estimate of the value uplift since some advantage to commercial and industrial users (beyond New Lynn) is likely from the upgrades; for instance, commuters from other suburbs can in future access these workplaces more easily as can the firms' customers. We note that these estimated benefit values relate only to Waitakere City and not to any areas beyond that city's boundaries. In particular, they do not relate to any value uplift for houses near stations within Auckland City that lie on the Western Line closer to the Auckland CBD.

The estimated range of benefits (within Waitakere City) of $605 million to $667 million can be compared with the projected costs of the Western Line developments. The costs have been shared between central government, regional and local government, and other agencies. Because of the varied nature and timing of the projects, it is difficult to derive an aggregate cost for all the developments, let alone assign costs specifically to upgrades related to the Western Line. However, a conservative estimate for the latter is in the vicinity of $620 million.[22] Of the Western Line costs, some relate to Waitakere City and some to Auckland city. If we ascribe half the Western Line rail costs to Waitakere (which has half the Western Line stations) we arrive at a cost of $310 million for the upgrades relating to Waitakere City (excluding New Lynn). The additional New Lynn costs discussed in Section 3 are in the order of $300 million, resulting in a total cost figure of around $610 million (noting that these are nominal undiscounted costs spread over an unspecified number of years). The estimate of benefits for Waitakere City is therefore in the same order as the cost figure. However it is possible, as discussed in the next section, that our measure of benefits does not fully capture all longer-run benefits or all benefits across a wider spatial scale.

[22] This figure represents three-quarters of Project DART's $826 budgeted expenditure (excluding New Lynn), where the ratio of three-quarters is chosen to reflect the dominant role of the Western line upgrades within the Project DART programme. These figures exclude costs of electrification and new train purchases which were announced some years after the 2005 announcements.

7. Conclusions

After decades of decline, Auckland's passenger rail network has recently been subject to material new investment activity. Beginning with the opening of the Britomart Transport Centre in Auckland's CBD in 2003, all stations in the network are being upgraded, all lines are being electrified, two new lines (Onehunga and Manukau) are being opened, the Western Line is being double tracked through to Swanson (on the edge of the Auckland urban area) and major urban redevelopment is occurring along this line. The most notable urban redevelopment is occurring around New Lynn, with an undergrounding of the rail line through the town centre. In addition, council building developments adjacent to the Henderson station have improved the appearance and connection of the rail line to a major employment and retail node.

One difficulty of upgrading a transport network that has fallen into relative disrepair is that prospective passengers may take considerable convincing to switch modes leading to slow take-up of the new service. By contrast, in a city that is used to rail travel, an enhanced service may be met with faster up-take. Residents and firms in a rail-conscious city are likely to value the upgrades in anticipation of opening by choosing to locate where a new or enhanced service has been announced. This anticipation will bid up house prices and commercial/industrial land values upon announcement of the new offering.

A populace that is not used to rail travel may be less likely to demonstrate a positive announcement effect through bidding up house prices in anticipation of upgraded services. This factor is particularly relevant to the upgrades analysed here. The number of Western Line passenger journeys doubled between 2004/05 and 2008/09 (with no increase, as yet, in train frequency). Thus we are applying the benefit analysis to a low base, and the set of residents who value rail may have increased substantially over time, let alone increasing still further once the more frequent services are operating.

Given this background, our study has analysed whether houses near Waitakere City Western Line stations showed any positive announcement effect when the Western Line upgrades and New Lynn redevelopment were announced in mid-2005. In order to estimate whether such an effect occurred, we needed to control for all other factors affecting house prices. We have done so by estimating a repeat-sales index for Waitakere City and then examining whether the addition of distance-related effects has explanatory power over and above the house-specific characteristics and city-wide trends. The distance-related effects refer to the proximity of a house to its nearest rail station and the station's distance from the Auckland CBD.

Our estimates indicate that houses adjacent to a Waitakere City Western Line rail station rose in price on announcement of the upgrades in mid-2005, and that the magnitudes of the rises were sensitive to which station the houses were located nearest. Houses more distant from the rail track also rose, but by decreasing amounts up to a distance of around 8 kilometres from the station where no rise was apparent.

Residents in houses within a kilometre or so of the station may anticipate a benefit directly by walking to a station that will offer an improved service once double tracking is complete in late 2010. However they may also suffer from increased train noise and from negative effects of increased station patronage. Residents beyond this distance may benefit in multiple ways. First, they may drive to the station and then utilise a "park and ride" facility and thence commute by train. Second, they may take other public transport (bus) to a station and then catch the train. Third, they may anticipate reduced congestion on major roads as others switch to the train and so have enhanced transport connectivity even if they never catch a train. The latter group may be amongst those living further from a train station (up to eight kilometres distant) who nevertheless benefit from the rail upgrades.

We apply our estimates of land price rises to all parts of Waitakere City that are within eight kilometres of a rail station, finding a rise in values of $605 million to $667 million upon announcement in 2005 (using 2004 values). These benefits are broadly comparable to the costs ascribed to the Western line upgrades pertaining to Waitakere City (including the New Lynn projects costs). Two points need to be noted here.

First, these benefits relate solely to properties within Waitakere City. They do not reflect any benefits accrued along the Western Line within Auckland City (closer to the city) or in Rodney District (beyond Waitakere City to the north). The latter area may benefit to the extent that rail travel to the area is improved through the double tracking and other upgrades. Furthermore, they do not include any benefits to businesses outside Waitakere City that may arise, for instance, through improved access to those firms from a wider pool of employees (i.e. the labour market matching component of agglomeration externalities).

Second, these benefits reflect announcement effects. If people were perfectly informed, perfectly rational and faced no credit constraints, the announcement effect appropriately values the net benefit of the project to local residents. If, however, one or more of these provisos is not met, the benefits estimated by the announcement effect will likely under-state the final net benefits experienced by residents situated near the line. Given Auckland residents' lack of experience with commuter train travel, it is quite possible that revealed benefits will be higher than existing residents anticipated; however this may only become apparent after the new higher frequency services have begun operating and people have actually tried the new service.

At the analytical level, it will be important to repeat this study some years after the double tracking is complete. One could then examine whether the value placed on the upgrades is affected by experience of the new service as well as by its anticipation. In addition, one could extend the analysis to houses around other stations on the Western line (within Auckland City) and to houses around other parts of the Auckland rail network. Particular interest might be attached to houses near the planned Onehunga and Manukau lines (after those lines have been opened) since these areas have not hitherto had a passenger train service.

For policy-makers, the results of the analysis suggest that the rail upgrades have been valued positively by local residents, and the estimated anticipated benefits are broadly comparable with the budgeted costs. Whether this outcome changes as greater experience of the network ensues, is a topic for future research.

References

Auckland Regional Council (ARC), 2009. *Rail electrification*. Available online at http://www.arc.govt.nz/transport/rail-electrification/rail-electrification_home.cfm. Last accessed 10 February 2010.

Auckland Regional Transport Agency (ARTA), 2010. *Auckland Rail Network upgrade*. Available online at http://www.arta.co.nz/publications-projects/projects/auckland-rail-network-upgrade.html. Last accessed 12 January 2010.

Bae, Change-Hee Christine, Myung-Jin Jun and Hyeon Park. 2003. "The impact of Seoul's subway Line 5 on residential property values," *Transport Policy*, 10, pp. 85-94.

Baldwin, Richard E. 2001. "Core-periphery model with forward-looking expectations," *Regional Science and Urban Economics*, 31:1, pp. 21-49.

Baldwin, Richard E., Rikard Forslid, Philippe Martin, Gianmarco Ottaviano, and Frederic Robert-Nicoud. 2003. *Economic Geography and Public Policy*. Princeton: Princeton University Press.

Bayer, Patrick J. & McMillan, Robert. 2010. "Tiebout Sorting and Neighborhood Stratification", Economic Research Initiatives at Duke (ERID) Working Paper No. 49, Duke University.

Beehive, 2009. *Govt announces $500m for Auckland's electric trains*. Available online at http://beehive.govt.nz/release/govt+announces+500m+auckland039s+electric+trains. Last accessed 20 January 2010.

Bourassa, Steven C., Martin Hoesli, and Jian Sun. 2006. "A simple alternative house price index method," *Journal of Housing Economics*, 15:1, pp. 80-97.

Bowes, David R. and Keith R. Ihlanfeldt. 2001. "Identifying the Impacts of Rail Transit Stations on Residential Property Values," *Journal of Urban Economics*, 50, pp. 1-25.

Colin Buchanan. 2007. "The Economic Benefits of Crossrail." Report prepared in association with Volterra, London: Crossrail Library.

de Vries, Paul, Jan de Haan, Erna van der Wal and Gust Mariën. 2009. "A house price index based on the SPAR method," *Journal of Housing Economics*, 18:3, pp. 214-223.

Gibbons, Stephen and Stephen Machin. 2005. "Valuing rail access using transport innovation," *Journal of Urban Economics*, 57, pp. 148-169.

Glaeser, Edward L., Matthew E. Kahn and Jordan Rappaport. 2008. "Why do the poor live in cities? The role of public transportation," *Journal of Urban Economics*, 63:1, pp. 1-24.

Grimes, Arthur and Yun Liang. 2009. "Spatial Determinants of Land Prices: Does Auckland's Metropolitan Urban Limit Have an Effect?", *Applied Spatial Analysis and Policy*, 2, pp. 23-45

Grimes, Arthur and Yun Liang. 2010. "Bridge to Somewhere: Valuing Auckland's Northern Motorway Extensions", *Journal of Transport Economics and Policy*, 44(3), forthcoming

Grimes, Arthur and Chris Young. 2010. "A Simple Repeat Sales House Price Index: Comparative Properties Under Alternative Data Generation Processes," *Motu Working Paper 10-10*, Motu Economic and Public Policy Research, Wellington.

Haughwout, Andrew. 2002. "Public Infrastructure Investments, Productivity and Welfare in Fixed Geographic Areas", *Journal of Public Economics* 83(3), pp. 405-428

Jud, G. Donald, and Daniel T. Winkler. 2006. "The Announcement Effect of an Airport Expansion on Housing Prices," *The Journal of Real Estate Finance and Economics*, 33:2, pp. 91-103.

Kahn, Matthew E. 2007. "Gentrification Trends in New Transit-Oriented Communities: Evidence from 14 Cities That Expanded and Built Rail Transit Systems," *Real Estate Economics*, 32:2, pp. 155-182.

McMillen, Daniel P. and John McDonald. 2004. "Reaction of House Prices to a New Rapid Transit Line: Chicago's Midway Line, 1983-1999," *Real Estate Economics*, 32:3, pp. 463-486.

Ministry of Economic Development, The Treasury and Statistics New Zealand, 2007. *Economic Development Indicators 2007*. Wellington: New Zealand Government.

Ministry of Transport (MoT), 2009. *Auckland Rail Upgrade*. Available online at http://www.transport.govt.nz/ourwork/rail/AucklandRailUpgrade/. Last accessed 20 January 2010.

Nichols, Austin and Mark E Schaffer. 2007. "Clustered standard errors in Stata," United Kingdom Stata Users' Group Meetings 2007 07, Stata Users Group.

ONTRACK, 2010. *Auckland electrification project*. Available online at http://www.ontrack.govt.nz/ourprojects/Pages/Auckland.aspx. Last accesses 13 January 2010.

Project DART, 2010a. *Project DART BACKGROUND – the case for rail*. Available online at http://www.projectdart.org.nz/default.asp?s1=projectdart&s2=The%20case%20for%20rail. Last accessed 13 January 2010.

Project DART, 2010b. *Project DART: Developing Auckland's Rail Transport*. Available online at http://www.projectdart.org.nz/default.asp?s1=ProjectDart. Last accessed 10 February 2010.

Project DART, 2010c. *MANAKAU RAIL LINK*. Available online at http://www.projectdart.org.nz/default.asp?s1=the%20projects&s2=Manukau%20City%20rail%20link. Last accessed 10 February 2010.

Project DART, 2010d. *AUCKLAND'S RAIL NETWORK: a shared responsibility*. Available online at http://www.projectdart.org.nz/default.asp?s1=projectdart&s2=Auckland's%20rail%20network. Last accessed 13 January 2010.

Project DART, 2010e. *NEWMARKET*. Available online at http://www.projectdart.org.nz/default.asp?s1=the%20projects&s2=Newmarket. Last accessed 10 February 2010.

Project DART, 2010f. WESTERN *LINE DUPLICATION – AVONDALE TO SWANSON*. http://www.projectdart.org.nz/default.asp?s1=the%20projects&s2=Western%20Line%20Duplication. Last accessed 10 February 2010.

Roback, J. 1982. "Wages, Rents and the Quality of Life", *Journal of Political Economy* 90, pp. 1257-1278

Rosen, Sherwin. 1974. "Hedonic prices and implicit market, product differentiation in pure competition," *Journal of Political Economy*, 82:1, pp.34-55.

The New Zealand Herald, 2009. *Rail project speeds ahead on fast track*. Available online at http://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=10584978. Last accessed 20 January 2010.

Tsutsumi, Morito and Hajime Seya. 2008. "Measuring the impact of large-sclae transportation projects on land price using spatial statistical models," *Papers in Regional Science*, 87:3, pp. 385-401.

Venables, Anthony. 2008. "Economic Geography" in: B.R. Weingast and D. Wittman (eds): *The Oxford Handbook of Political Economy*, Oxford: Oxford University Press.

Waitakere City Council (WCC), 2009. *New Lynn redevelopment funding secured and celebrated*. Available online at http://www.waitakere.govt.nz/WhaHap/nm/mr/2009/sep09.asp#newlynnredevelopment. Last accessed 13 January 2010.

Wang, Ferdinand T. and Peter M. Zorn. 1997. "Estimating house price growth with repeat-sales data: What's the aim of the game?" *Journal of Housing Economics*, 6:2, pp. 93-118.

Winston, Clifford and Vikram Maheshri. 2007. "On the social desirability of urban rail transit systems," *Journal of Urban Economics*, 62, pp. 362-382.

Appendix

Table A1: Estimation Results for Full Model

VARIABLES	Time Fixed-Effect Terms	Station Group 1		Station Group 2		Station Group 3	
		Linear Distance Interaction Terms	Quadratic Distance Interaction Terms	Linear Distance Interaction Terms	Quadratic Distance Interaction Terms	Linear Distance Interaction Terms	Quadratic Distance Interaction Terms
1993q4	0.135	-0.0777	0.0106	0.0234	-0.00594	-0.00388	-0.00378
	[0.124]	[0.0584]	[0.00681]	[0.0617]	[0.00704]	[0.0613]	[0.00716]
1994q1	0.0231	0.0228	-0.00042	0.0385	-0.00428	0.032	-0.00397
	[0.129]	[0.0582]	[0.00649]	[0.0644]	[0.00743]	[0.0631]	[0.00725]
1994q2	0.0939	-0.0374	0.00744	0.0463	-0.00698	0.0199	-0.00077
	[0.139]	[0.0711]	[0.00838]	[0.0677]	[0.00773]	[0.0656]	[0.00715]
1994q3	0.285	-0.0361	0.00439	0.028	-0.00672	-0.0539	0.0069
	[0.145]	[0.0668]	[0.00751]	[0.0710]	[0.00797]	[0.0673]	[0.00730]
1994q4	0.375	-0.0995	0.013	-0.0368	0.00181	-0.0909	0.0108
	[0.125]	[0.0595]	[0.00690]	[0.0656]	[0.00765]	[0.0605]	[0.00673]
1995q1	0.413	-0.0629	0.00745	-0.0328	0.000614	-0.06	0.00471
	[0.117]	[0.0545]	[0.00612]	[0.0601]	[0.00707]	[0.0574]	[0.00666]
1995q2	0.31	-0.0508	0.00773	0.0606	-0.0101	-0.00593	0.000382
	[0.148]	[0.0664]	[0.00714]	[0.0699]	[0.00761]	[0.0685]	[0.00738]
1995q3	0.373	-0.0288	0.00472	0.071	-0.0116	-0.0097	0.00154
	[0.116]	[0.0557]	[0.00641]	[0.0592]	[0.00688]	[0.0557]	[0.00631]
1995q4	0.427	-0.0399	0.00755	0.0524	-0.00757	0.0061	-0.00065
	[0.115]	[0.0547]	[0.00628]	[0.0604]	[0.00714]	[0.0547]	[0.00611]
1996q1	0.462	-0.00339	0.00393	0.101	-0.0138	0.0216	-0.00088
	[0.118]	[0.0550]	[0.00619]	[0.0572]	[0.00640]	[0.0553]	[0.00608]
1996q2	0.469	-0.0184	0.00635	0.125	-0.0167	0.0303	-0.00081
	[0.133]	[0.0610]	[0.00684]	[0.0654]	[0.00721]	[0.0650]	[0.00718]
1996q3	0.509	-0.0215	0.0042	0.0949	-0.013	-0.00027	0.0014
	[0.110]	[0.0555]	[0.00680]	[0.0563]	[0.00661]	[0.0523]	[0.00585]
1996q4	0.499	-0.0122	0.00496	0.0779	-0.0104	0.0163	-0.00013
	[0.114]	[0.0546]	[0.00622]	[0.0575]	[0.00648]	[0.0580]	[0.00660]
1997q1	0.613	-0.0732	0.012	0.0753	-0.0117	-0.0132	0.00356
	[0.116]	[0.0530]	[0.00591]	[0.0574]	[0.00661]	[0.0544]	[0.00605]
1997q2	0.58	-0.0428	0.00858	0.0813	-0.0112	0.0222	-0.00124
	[0.114]	[0.0528]	[0.00589]	[0.0566]	[0.00648]	[0.0567]	[0.00652]
1997q3	0.539	-0.0265	0.00704	0.0841	-0.0108	0.00721	0.00278
	[0.115]	[0.0531]	[0.00598]	[0.0575]	[0.00662]	[0.0571]	[0.00651]
1997q4	0.668	-0.0757	0.0115	0.0424	-0.00803	-0.0291	0.00497
	[0.128]	[0.0582]	[0.00639]	[0.0625]	[0.00707]	[0.0583]	[0.00640]
1998q1	0.449	-0.0032	0.00429	0.13	-0.016	0.00651	0.00382
	[0.121]	[0.0548]	[0.00643]	[0.0615]	[0.00709]	[0.0572]	[0.00628]
1998q2	0.39	-0.0116	0.00685	0.0968	-0.0101	0.0325	-1.25E-06
	[0.116]	[0.0549]	[0.00631]	[0.0616]	[0.00739]	[0.0567]	[0.00649]
1998q3	0.443	0.00126	0.00217	0.117	-0.0165	-0.0006	0.00364
	[0.111]	[0.0532]	[0.00617]	[0.0562]	[0.00647]	[0.0548]	[0.00623]
1998q4	0.439	-0.0178	0.00666	0.0876	-0.0108	0.0405	-0.00335
	[0.117]	[0.0550]	[0.00628]	[0.0583]	[0.00657]	[0.0576]	[0.00669]
1999q1	0.555	-0.0495	0.00858	0.0929	-0.0148	-0.0293	0.00633
	[0.115]	[0.0528]	[0.00591]	[0.0573]	[0.00649]	[0.0566]	[0.00644]
1999q2	0.47	0.00582	0.00239	0.0821	-0.011	0.0258	-0.00091
	[0.117]	[0.0546]	[0.00629]	[0.0606]	[0.00711]	[0.0562]	[0.00639]
1999q3	0.535	-0.00742	0.00307	0.0744	-0.0116	-0.00307	0.00217
	[0.111]	[0.0522]	[0.00589]	[0.0558]	[0.00634]	[0.0540]	[0.00611]
1999q4	0.549	-0.0417	0.00714	0.0795	-0.0115	-0.0291	0.00613
	[0.118]	[0.0547]	[0.00607]	[0.0588]	[0.00661]	[0.0560]	[0.00610]
2000q1	0.563	-0.0532	0.00936	0.0271	-0.00537	-0.00177	0.000392
	[0.112]	[0.0539]	[0.00621]	[0.0598]	[0.00715]	[0.0543]	[0.00613]
2000q2	0.499	-0.0701	0.0126	0.0132	-0.0015	0.00998	0.000462
	[0.117]	[0.0649]	[0.00828]	[0.0626]	[0.00776]	[0.0555]	[0.00619]
2000q3	0.44	0.0271	-0.00095	0.098	-0.0135	-0.0258	0.00643
	[0.122]	[0.0575]	[0.00655]	[0.0614]	[0.00694]	[0.0600]	[0.00734]
2000q4	0.526	-0.00119	0.00117	0.051	-0.00819	-0.0349	0.00657
	[0.115]	[0.0546]	[0.00623]	[0.0577]	[0.00670]	[0.0547]	[0.00603]
2001q1	0.558	-0.044	0.0064	0.0368	-0.0069	-0.0395	0.00667
	[0.116]	[0.0544]	[0.00625]	[0.0573]	[0.00645]	[0.0565]	[0.00634]

2001q2	0.59 [0.112]	-0.0709 [0.0543]	0.00873 [0.00628]	0.043 [0.0563]	-0.00825 [0.00645]	-0.0612 [0.0539]	0.00813 [0.00616]
2001q3	0.543 [0.128]	-0.0123 [0.0582]	0.0021 [0.00658]	0.0399 [0.0639]	-0.00754 [0.00728]	-0.0399 [0.0611]	0.00639 [0.00677]
2001q4	0.541 [0.122]	-0.021 [0.0563]	0.00355 [0.00626]	0.023 [0.0598]	-0.00432 [0.00665]	-0.0251 [0.0610]	0.00514 [0.00725]
2002q1	0.606 [0.105]	-0.0442 [0.0497]	0.00712 [0.00568]	0.0796 [0.0538]	-0.0128 [0.00627]	-0.0599 [0.0543]	0.00947 [0.00631]
2002q2	0.706 [0.128]	-0.0751 [0.0592]	0.00955 [0.00654]	0.00295 [0.0643]	-0.00403 [0.00728]	-0.0511 [0.0637]	0.00511 [0.00721]
2002q3	0.695 [0.117]	-0.0477 [0.0577]	0.00632 [0.00678]	0.0246 [0.0570]	-0.00595 [0.00635]	-0.0781 [0.0554]	0.0113 [0.00619]
2002q4	0.689 [0.118]	-0.0356 [0.0553]	0.00504 [0.00624]	0.071 [0.0573]	-0.0116 [0.00638]	-0.0398 [0.0562]	0.00524 [0.00620]
2003q1	0.747 [0.130]	-0.0284 [0.0575]	0.004 [0.00628]	0.0523 [0.0630]	-0.00961 [0.00697]	-0.0789 [0.0605]	0.0125 [0.00655]
2003q2	0.789 [0.115]	-0.0289 [0.0530]	0.00478 [0.00594]	0.0881 [0.0567]	-0.0156 [0.00641]	-0.069 [0.0543]	0.00935 [0.00597]
2003q3	0.874 [0.113]	-0.0468 [0.0540]	0.00723 [0.00621]	0.0705 [0.0552]	-0.0123 [0.00619]	-0.048 [0.0535]	0.00512 [0.00593]
2003q4	0.911 [0.110]	-0.0397 [0.0522]	0.00655 [0.00594]	0.0771 [0.0551]	-0.0132 [0.00630]	-0.0293 [0.0520]	0.00372 [0.00576]
2004q1	0.976 [0.118]	-0.0618 [0.0549]	0.00884 [0.00627]	0.0598 [0.0571]	-0.0113 [0.00637]	-0.0502 [0.0555]	0.00668 [0.00611]
2004q2	0.945 [0.111]	-0.0353 [0.0513]	0.00598 [0.00575]	0.101 [0.0541]	-0.0165 [0.00612]	-0.054 [0.0524]	0.0087 [0.00586]
2004q3	0.998 [0.129]	-0.0389 [0.0598]	0.00602 [0.00662]	0.0892 [0.0616]	-0.0158 [0.00680]	-0.0626 [0.0610]	0.00896 [0.00665]
2004q4	0.988 [0.116]	-0.0329 [0.0525]	0.00606 [0.00595]	0.088 [0.0571]	-0.0138 [0.00641]	-0.0435 [0.0552]	0.00692 [0.00610]
2005q1	1.082 [0.120]	-0.0847 [0.0558]	0.0122 [0.00626]	0.0665 [0.0574]	-0.0124 [0.00631]	-0.0502 [0.0561]	0.00632 [0.00605]
2005q2	1.051 [0.118]	-0.0299 [0.0547]	0.00533 [0.00621]	0.0948 [0.0570]	-0.0153 [0.00635]	-0.0206 [0.0553]	0.00378 [0.00613]
2005q3	1.035 [0.112]	-0.0492 [0.0529]	0.00935 [0.00607]	0.101 [0.0546]	-0.0151 [0.00615]	-0.0203 [0.0531]	0.00583 [0.00587]
2005q4	0.996 [0.115]	-0.0237 [0.0555]	0.00679 [0.00638]	0.133 [0.0554]	-0.018 [0.00624]	0.0379 [0.0550]	-0.0022 [0.00609]
2006q1	1.083 [0.114]	-0.0733 [0.0538]	0.0127 [0.00613]	0.11 [0.0556]	-0.0166 [0.00620]	-0.0187 [0.0534]	0.00392 [0.00590]
2006q2	1.093 [0.115]	-0.0564 [0.0544]	0.0103 [0.00630]	0.098 [0.0558]	-0.0149 [0.00627]	-0.0194 [0.0542]	0.00502 [0.00603]
2006q3	1.076 [0.116]	-0.019 [0.0541]	0.00512 [0.00611]	0.0965 [0.0560]	-0.0135 [0.00624]	-0.0291 [0.0540]	0.00665 [0.00597]
2006q4	1.191 [0.116]	-0.0822 [0.0542]	0.0129 [0.00608]	0.067 [0.0560]	-0.0116 [0.00621]	-0.0601 [0.0547]	0.00952 [0.00599]
2007q1	1.271 [0.118]	-0.0733 [0.0530]	0.0109 [0.00581]	0.0719 [0.0566]	-0.0124 [0.00626]	-0.0551 [0.0558]	0.00663 [0.00618]
2007q2	1.246 [0.117]	-0.0451 [0.0552]	0.0082 [0.00631]	0.0877 [0.0563]	-0.0138 [0.00625]	-0.0335 [0.0544]	0.00618 [0.00593]
2007q3	1.182 [0.110]	-0.0272 [0.0514]	0.00712 [0.00580]	0.127 [0.0537]	-0.0176 [0.00599]	0.00225 [0.0523]	0.00305 [0.00581]
2007q4	1.257 [0.114]	-0.0575 [0.0521]	0.0096 [0.00578]	0.0779 [0.0553]	-0.0122 [0.00619]	-0.0347 [0.0536]	0.00678 [0.00597]
2008q1	1.285 [0.117]	-0.0406 [0.0534]	0.00581 [0.00593]	0.0737 [0.0565]	-0.0123 [0.00628]	-0.0438 [0.0544]	0.00628 [0.00592]
2008q2	1.139 [0.113]	-0.0556 [0.0524]	0.0106 [0.00588]	0.108 [0.0557]	-0.0157 [0.00629]	0.00109 [0.0534]	0.00151 [0.00589]
2008q3	1.097 [0.110]	-0.0239 [0.0511]	0.00567 [0.00577]	0.107 [0.0547]	-0.0151 [0.00618]	0.00919 [0.0517]	0.000668 [0.00575]
2008q4	1.17 [0.116]	-0.0599 [0.0537]	0.00937 [0.00602]	0.066 [0.0575]	-0.0119 [0.00646]	-0.0682 [0.0550]	0.0104 [0.00603]
2009q1	1.133 [0.113]	-0.0546 [0.0526]	0.00927 [0.00592]	0.0728 [0.0551]	-0.0115 [0.00621]	-0.0278 [0.0536]	0.00537 [0.00599]
2009q2	1.167 [0.116]	-0.0459 [0.0532]	0.00787 [0.00595]	0.0948 [0.0559]	-0.0152 [0.00619]	-0.0277 [0.0552]	0.00454 [0.00610]
2009q3	1.164 [0.113]	-0.0277 [0.0531]	0.00639 [0.00601]	0.0885 [0.0548]	-0.0136 [0.00611]	-0.0348 [0.0540]	0.00655 [0.00601]
Observations				16245			
R-squared				0.927			
Number of house				5729			

Table A2: Results for Distance Effect with Pre-/Post-Announcement Groupings

VARIABLES	Time Fixed-Effect Terms	Station Group 1		Station Group 2		Station Group 3	
		Linear Distance Interaction Terms	Quadratic Distance Interaction Terms	Linear Distance Interaction Terms	Quadratic Distance Interaction Terms	Linear Distance Interaction Terms	Quadratic Distance Interaction Terms
1993q4	0.125 [0.127]	-0.0704 [0.0593]	0.00966 [0.00686]	0.025 [0.0630]	-0.00587 [0.00716]	0.000237 [0.0624]	-0.00401 [0.00723]
1994q1	0.0171 [0.131]	0.0284 [0.0589]	-0.00115 [0.00652]	0.0385 [0.0652]	-0.00414 [0.00748]	0.0368 [0.0641]	-0.00461 [0.00729]
1994q2	0.0832 [0.141]	-0.0315 [0.0717]	0.00672 [0.00843]	0.0498 [0.0681]	-0.00723 [0.00774]	0.0269 [0.0661]	-0.00171 [0.00716]
1994q3	0.282 [0.148]	-0.0314 [0.0676]	0.00374 [0.00753]	0.0256 [0.0719]	-0.00627 [0.00801]	-0.0515 [0.0686]	0.00663 [0.00741]
1994q4	0.365 [0.124]	-0.0965 [0.0592]	0.0127 [0.00688]	-0.0356 [0.0651]	0.00186 [0.00759]	-0.0847 [0.0597]	0.00995 [0.00659]
1995q1	0.395 [0.118]	-0.0552 [0.0548]	0.00671 [0.00613]	-0.0272 [0.0606]	0.000148 [0.00711]	-0.0506 [0.0580]	0.00366 [0.00672]
1995q2	0.306 [0.151]	-0.0463 [0.0670]	0.00711 [0.00717]	0.0593 [0.0707]	-0.0098 [0.00768]	-0.00534 [0.0695]	0.000447 [0.00747]
1995q3	0.361 [0.119]	-0.0235 [0.0563]	0.00415 [0.00643]	0.0708 [0.0600]	-0.0113 [0.00693]	-0.00447 [0.0564]	0.00108 [0.00633]
1995q4	0.424 [0.117]	-0.0392 [0.0551]	0.0075 [0.00630]	0.0536 [0.0611]	-0.00761 [0.00722]	0.00758 [0.0553]	-0.00084 [0.00614]
1996q1	0.457 [0.119]	0.000741 [0.0551]	0.00344 [0.00618]	0.1 [0.0573]	-0.0136 [0.00639]	0.0257 [0.0554]	-0.00135 [0.00607]
1996q2	0.473 [0.134]	-0.017 [0.0614]	0.006 [0.00686]	0.12 [0.0659]	-0.016 [0.00725]	0.0295 [0.0652]	-0.00095 [0.00716]
1996q3	0.508 [0.113]	-0.0236 [0.0565]	0.00448 [0.00688]	0.0959 [0.0572]	-0.0131 [0.00666]	-0.0009 [0.0534]	0.00158 [0.00590]
1996q4	0.493 [0.116]	-0.00829 [0.0550]	0.00447 [0.00623]	0.074 [0.0580]	-0.0097 [0.00653]	0.0172 [0.0587]	-0.0002 [0.00665]
1997q1	0.61 [0.118]	-0.0693 [0.0538]	0.0115 [0.00595]	0.072 [0.0583]	-0.0111 [0.00668]	-0.0122 [0.0555]	0.00374 [0.00615]
1997q2	0.566 [0.115]	-0.0376 [0.0529]	0.00804 [0.00589]	0.0855 [0.0569]	-0.0115 [0.00649]	0.0303 [0.0566]	-0.00205 [0.00645]
1997q3	0.524 [0.118]	-0.0193 [0.0540]	0.00626 [0.00605]	0.0871 [0.0583]	-0.0109 [0.00665]	0.0144 [0.0579]	0.00208 [0.00652]
1997q4	0.656 [0.131]	-0.0743 [0.0588]	0.0116 [0.00642]	0.0425 [0.0636]	-0.00779 [0.00716]	-0.0231 [0.0595]	0.00442 [0.00650]
1998q1	0.446 [0.123]	-0.00062 [0.0552]	0.00395 [0.00646]	0.127 [0.0621]	-0.0155 [0.00714]	0.00979 [0.0578]	0.00339 [0.00628]
1998q2	0.379 [0.119]	-0.00688 [0.0554]	0.00638 [0.00634]	0.0953 [0.0621]	-0.00963 [0.00740]	0.0383 [0.0578]	-0.00045 [0.00660]
1998q3	0.449 [0.113]	0.000314 [0.0539]	0.00218 [0.00625]	0.113 [0.0567]	-0.0159 [0.00651]	-0.00459 [0.0551]	0.00409 [0.00622]
1998q4	0.43 [0.118]	-0.0138 [0.0551]	0.00616 [0.00628]	0.0884 [0.0586]	-0.0107 [0.00659]	0.045 [0.0577]	-0.00397 [0.00662]
1999q1	0.537 [0.116]	-0.042 [0.0530]	0.0078 [0.00592]	0.0978 [0.0575]	-0.0151 [0.00649]	-0.0181 [0.0567]	0.00504 [0.00638]
1999q2	0.466 [0.118]	0.00745 [0.0551]	0.00227 [0.00631]	0.0804 [0.0609]	-0.0106 [0.00711]	0.0249 [0.0567]	-0.00052 [0.00642]
1999q3	0.525 [0.112]	-0.00087 [0.0524]	0.00231 [0.00589]	0.076 [0.0560]	-0.0116 [0.00635]	0.0046 [0.0542]	0.00118 [0.00612]
1999q4	0.53 [0.118]	-0.0359 [0.0546]	0.00661 [0.00605]	0.0831 [0.0591]	-0.0117 [0.00666]	-0.02 [0.0559]	0.00519 [0.00605]
2000q1	0.569 [0.114]	-0.0545 [0.0539]	0.00939 [0.00616]	0.0197 [0.0601]	-0.00441 [0.00714]	-0.00347 [0.0548]	0.000544 [0.00617]
2000q2	0.486 [0.117]	-0.0652 [0.0645]	0.0121 [0.00824]	0.0167 [0.0625]	-0.00181 [0.00776]	0.0152 [0.0551]	-1.32E-05 [0.00612]
2000q3	0.432 [0.123]	0.0336 [0.0577]	-0.00184 [0.00655]	0.0967 [0.0615]	-0.0131 [0.00693]	-0.0202 [0.0600]	0.00571 [0.00729]
2000q4 *(Pre-announcement)*	0.567 [0.112]	-0.0388 [0.0505]	0.00595 [0.00554]	0.0634 [0.0537]	-0.0111 [0.00593]	-0.0477 [0.0520]	0.00693 [0.00563]
2001q1 *(Pre-announcement)*	0.557 [0.112]	-0.0388 [0.0505]	0.00595 [0.00554]	0.0634 [0.0537]	-0.0111 [0.00593]	-0.0477 [0.0520]	0.00693 [0.00563]
2001q2 *(Pre-announcement)*	0.545 [0.112]	-0.0388 [0.0505]	0.00595 [0.00554]	0.0634 [0.0537]	-0.0111 [0.00593]	-0.0477 [0.0520]	0.00693 [0.00563]
2001q3 *(Pre-announcement)*	0.545 [0.113]	-0.0388 [0.0505]	0.00595 [0.00554]	0.0634 [0.0537]	-0.0111 [0.00593]	-0.0477 [0.0520]	0.00693 [0.00563]

2001q4	0.559	-0.0388	0.00595	0.0634	-0.0111	-0.0477	0.00693
(Pre-announcement)	[0.112]	[0.0505]	[0.00554]	[0.0537]	[0.00593]	[0.0520]	[0.00563]
2002q1	0.621	-0.0388	0.00595	0.0634	-0.0111	-0.0477	0.00693
(Pre-announcement)	[0.112]	[0.0505]	[0.00554]	[0.0537]	[0.00593]	[0.0520]	[0.00563]
2002q2	0.628	-0.0388	0.00595	0.0634	-0.0111	-0.0477	0.00693
(Pre-announcement)	[0.112]	[0.0505]	[0.00554]	[0.0537]	[0.00593]	[0.0520]	[0.00563]
2002q3	0.657	-0.0388	0.00595	0.0634	-0.0111	-0.0477	0.00693
(Pre-announcement)	[0.113]	[0.0505]	[0.00554]	[0.0537]	[0.00593]	[0.0520]	[0.00563]
2002q4	0.69	-0.0388	0.00595	0.0634	-0.0111	-0.0477	0.00693
(Pre-announcement)	[0.112]	[0.0505]	[0.00554]	[0.0537]	[0.00593]	[0.0520]	[0.00563]
2003q1	0.739	-0.0388	0.00595	0.0634	-0.0111	-0.0477	0.00693
(Pre-announcement)	[0.113]	[0.0505]	[0.00554]	[0.0537]	[0.00593]	[0.0520]	[0.00563]
2003q2	0.777	-0.0388	0.00595	0.0634	-0.0111	-0.0477	0.00693
(Pre-announcement)	[0.112]	[0.0505]	[0.00554]	[0.0537]	[0.00593]	[0.0520]	[0.00563]
2003q3	0.86	-0.0388	0.00595	0.0634	-0.0111	-0.0477	0.00693
(Pre-announcement)	[0.112]	[0.0505]	[0.00554]	[0.0537]	[0.00593]	[0.0520]	[0.00563]
2003q4	0.918	-0.0388	0.00595	0.0634	-0.0111	-0.0477	0.00693
(Pre-announcement)	[0.112]	[0.0505]	[0.00554]	[0.0537]	[0.00593]	[0.0520]	[0.00563]
2004q1	0.951	-0.0388	0.00595	0.0634	-0.0111	-0.0477	0.00693
(Pre-announcement)	[0.112]	[0.0505]	[0.00554]	[0.0537]	[0.00593]	[0.0520]	[0.00563]
2004q2	0.964	-0.0388	0.00595	0.0634	-0.0111	-0.0477	0.00693
(Pre-announcement)	[0.112]	[0.0505]	[0.00554]	[0.0537]	[0.00593]	[0.0520]	[0.00563]
2004q3	0.985	-0.0388	0.00595	0.0634	-0.0111	-0.0477	0.00693
(Pre-announcement)	[0.113]	[0.0505]	[0.00554]	[0.0537]	[0.00593]	[0.0520]	[0.00563]
2004q4	1.023	-0.0388	0.00595	0.0634	-0.0111	-0.0477	0.00693
(Pre-announcement)	[0.112]	[0.0505]	[0.00554]	[0.0537]	[0.00593]	[0.0520]	[0.00563]
2005q1	1.051	-0.0388	0.00595	0.0634	-0.0111	-0.0477	0.00693
(Pre-announcement)	[0.112]	[0.0505]	[0.00554]	[0.0537]	[0.00593]	[0.0520]	[0.00563]
2005q2	1.026	-0.0412	0.00773	0.0917	-0.0139	-0.0215	0.00468
(Post-announcement)	[0.111]	[0.0498]	[0.00548]	[0.0530]	[0.00586]	[0.0511]	[0.00555]
2005q3	1.054	-0.0412	0.00773	0.0917	-0.0139	-0.0215	0.00468
(Post-announcement)	[0.110]	[0.0498]	[0.00548]	[0.0530]	[0.00586]	[0.0511]	[0.00555]
2005q4	1.081	-0.0412	0.00773	0.0917	-0.0139	-0.0215	0.00468
(Post-announcement)	[0.111]	[0.0498]	[0.00548]	[0.0530]	[0.00586]	[0.0511]	[0.00555]
2006q1	1.082	-0.0412	0.00773	0.0917	-0.0139	-0.0215	0.00468
(Post-announcement)	[0.110]	[0.0498]	[0.00548]	[0.0530]	[0.00586]	[0.0511]	[0.00555]
2006q2	1.101	-0.0412	0.00773	0.0917	-0.0139	-0.0215	0.00468
(Post-announcement)	[0.110]	[0.0498]	[0.00548]	[0.0530]	[0.00586]	[0.0511]	[0.00555]
2006q3	1.105	-0.0412	0.00773	0.0917	-0.0139	-0.0215	0.00468
(Post-announcement)	[0.111]	[0.0498]	[0.00548]	[0.0530]	[0.00586]	[0.0511]	[0.00555]
2006q4	1.138	-0.0412	0.00773	0.0917	-0.0139	-0.0215	0.00468
(Post-announcement)	[0.110]	[0.0498]	[0.00548]	[0.0530]	[0.00586]	[0.0511]	[0.00555]
2007q1	1.198	-0.0412	0.00773	0.0917	-0.0139	-0.0215	0.00468
(Post-announcement)	[0.110]	[0.0498]	[0.00548]	[0.0530]	[0.00586]	[0.0511]	[0.00555]
2007q2	1.232	-0.0412	0.00773	0.0917	-0.0139	-0.0215	0.00468
(Post-announcement)	[0.110]	[0.0498]	[0.00548]	[0.0530]	[0.00586]	[0.0511]	[0.00555]
2007q3	1.245	-0.0412	0.00773	0.0917	-0.0139	-0.0215	0.00468
(Post-announcement)	[0.110]	[0.0498]	[0.00548]	[0.0530]	[0.00586]	[0.0511]	[0.00555]
2007q4	1.24	-0.0412	0.00773	0.0917	-0.0139	-0.0215	0.00468
(Post-announcement)	[0.110]	[0.0498]	[0.00548]	[0.0530]	[0.00586]	[0.0511]	[0.00555]
2008q1	1.225	-0.0412	0.00773	0.0917	-0.0139	-0.0215	0.00468
(Post-announcement)	[0.110]	[0.0498]	[0.00548]	[0.0530]	[0.00586]	[0.0511]	[0.00555]
2008q2	1.165	-0.0412	0.00773	0.0917	-0.0139	-0.0215	0.00468
(Post-announcement)	[0.110]	[0.0498]	[0.00548]	[0.0530]	[0.00586]	[0.0511]	[0.00555]
2008q3	1.129	-0.0412	0.00773	0.0917	-0.0139	-0.0215	0.00468
(Post-announcement)	[0.110]	[0.0498]	[0.00548]	[0.0530]	[0.00586]	[0.0511]	[0.00555]
2008q4	1.11	-0.0412	0.00773	0.0917	-0.0139	-0.0215	0.00468
(Post-announcement)	[0.110]	[0.0498]	[0.00548]	[0.0530]	[0.00586]	[0.0511]	[0.00555]
2009q1	1.114	-0.0412	0.00773	0.0917	-0.0139	-0.0215	0.00468
(Post-announcement)	[0.110]	[0.0498]	[0.00548]	[0.0530]	[0.00586]	[0.0511]	[0.00555]
2009q2	1.139	-0.0412	0.00773	0.0917	-0.0139	-0.0215	0.00468
(Post-announcement)	[0.110]	[0.0498]	[0.00548]	[0.0530]	[0.00586]	[0.0511]	[0.00555]
2009q3	1.165	-0.0412	0.00773	0.0917	-0.0139	-0.0215	0.00468
(Post-announcement)	[0.110]	[0.0498]	[0.00548]	[0.0530]	[0.00586]	[0.0511]	[0.00555]
Observations				16245			
R-squared				0.926			
Number of house				5729			