# THE IMPACT OF A NEW SUBWAY LINE ON PROPERTY VALUES IN SANTIAGO

*Claudio Agostini,* Ilades-Universidad Alberto Hurtado
*Gastón Palmucci,* University of Wisconsin, Madison

## INTRODUCTION

A NEW SUBWAY LINE STARTED OPERATING IN Santiago, Chile, at the end of 2005. The prediction of economic theory would be that housing prices near the subway stations would increase as a result of having better access and lower cost of traveling within the city (Alonso, 1964; Mills, 1967; and Muth, 1969). Furthermore, just the announcement of the construction of the new subway line and the announcement of the stations' locations should have such positive impact.

However, the empirical evidence on these predictions is mixed. On the one hand, Bajic (1983) estimates a positive impact of 3.9 percent of the Toronto subway on average housing prices; Voith (1991) and Al-Mosaind, Dueker, and Strathman (1993) estimate premiums for access to public transportations of 6.4 percent and 10.6 percent for the Philadelphia train system and the Portland transportation system, respectively; and Cervero (1996) finds a 10-15 percent positive impact of the BART in San Francisco on housing units located within a one-quarter mile of the stations. On the other hand, Armstrong (1994) finds a 20 percent negative impact of the Fitchburg Line in Boston on housing located within 120 meters of the train stations and Bowes and Ihlanfeldt (2001) find a 19 percent negative impact of the MARTA in Atlanta on housing located within 400 meters of the train stations.

A reasonable explanation for the mixed results in the literature is due to the existence of two compounding effects associated to a new mass transportation facility: the positive impact of a better access and the negative effect of noise and pollution (Chen, Rufolo, and Duecker, 1997). Therefore, the effect of a new subway line in Santiago becomes an empirical question and the goal of this work is precisely to estimate such impact.

### Santiago Subway and the New Line 4

The subway in Santiago has 4 lines with 92 stations covering 23 counties. Figure 1 shows the subway network.

Line 1 started operating between Moneda and San Pablo in 1975 and then in 1980 it was extended to Escuela Militar. Line 2 was inaugurated in March of 1978 between Los Héroes and Lo Ovalle, in 1987 it was extended to Puente Cal y Canto, in 2004 it was further extended north and south to Cerro Blanco and La Cisterna, respectively; and, finally, in 2005 it was extended north to Vespucio Norte. Line 5 started operating in 1997 between Vicuña Mackenna and Baquedano, it was later extended to Santa Ana in 2000, connecting with Line 2, and to Quinta Normal in 2004. These three lines cover 52.4 kilometers in railways, 54 stations, and 232 millions passengers were transported in 2004.

In 2004 the government announced the construction of a new subway line consisting of a primary (Line 4) and a secondary line (Line 4A), involving 32.7 kilometers of railways and 28 stations. The principal line starts at Plaza de Puente Alto and reaches the interconnection Tobalaba with Providencia, where there is a connection with Line 1. The secondary line is extended along Américo Vespucio, between Vicuña Mackenna and Gran Avenida, where it connects with Line 2.

Line 4 started partially operating in December 2005 (between Puente Alto and Vicente Valdés and between Tobalaba and Grecia) and was fully operational in March 2006. Line 4A was inaugurated in August 2006.

## DATA AND ESTIMATION

We have access to a database containing all apartment transactions in Santiago between December 2000 and March 2004. The database consists of around 21,000 transactions containing price, address, and the main characteristics of each apartment. We calculated the distance from each apartment to all, existent and future, subway stations and kept almost 7,000 observations for which the closest station was on Line 4 or 4A. For these apartments we also calculated the distance to the closest school, clinic, hospital, and parks.

*Figure 1:* **Metro Network**


There are two moments in time in which the price of the apartments closest to Lines 4 and 4A might have been affected by the information released by the government:

1. Announcement of Line 4: In May 2001 the government announced the construction of the new Line 4, but the location of the stations was not known at that time.
2. Station Locations: In December 2001, the location of the future Line 4 subway stations was announced.

If we start considering the unconditional means, the data shows that the apartments sold after the announcement of the new Line 4 were sold at prices 5.2 percent higher on average, and the apartments sold after the announcement of the stations location were sold at prices 7.4 percent higher on average. Obviously, these impacts might be also due to a change in apartment characteristics and not only to the existence of a future subway line that would provide better access to people living in these apartments. For this reason, it is important to empirically consider all the other determinants of

housing prices that might have affected the price over this period of time. Specifically, it is important to control for changes in apartments' physical characteristics and the access to local public goods.

The empirical specification used to estimate the impact of the new subway line on housing prices is the following:

$$\textbf{(1)} \quad P(i) = \theta + \pi X(i) + \varpi t(i) + \delta L(i) + \alpha ATE(i) + \tau D(i) + \varepsilon(i),$$

where $P(i)$ is the selling apartment price, $X(i)$ is a vector of apartment physical characteristics (area, number of bathrooms, number of bedrooms, if it is brand new, if it has basement, if it has parking, and if the building has an elevator), $L(I)$ is a vector of local public goods access (parks, schools, clinics), $D(i)$ is a vector of location (street, avenue), and $\varepsilon(i)$ is the error term capturing unobservables. The variable *ATE* is a dummy equal to 1 if the apartment was sold after the "treatment" and equal to zero otherwise. In the empirical analysis we consider two different "treatments": (1) the announcement of the construction of the new line 4, where the dummy variable *ATE* is equal to 1 after May 2001, and (2) the announcement of stations' locations, where the dummy variable *ATE* is equal to 1 after December 2001. The coefficient $\alpha$ captures the average increase in property values due to an exogenous shock, in this case the release of information related to a new subway line ("treatment").

The estimation of equation (1) is similar to a hedonic price regression (Rosen, 1974; Bartik, 1987; and Freeman, 1979), which captures the average value consumers give to each particular housing unit characteristic and its surroundings; but the inclusion of the *ATE* dummy variable also allows estimating the impact of the two subway announcements on property prices.

## RESULTS

Equation (1) was estimated with OLS and the standard errors were computed using the Huber-White estimator. Table 1 shows the results for both announcements: the construction of the new line and the locations of the subway stations.

In general, the results related to the physical characteristics of the apartments have the expected signs. The estimated coefficients for the variable's area, number of bathrooms, basement, and new apartment are all positive and statistically significant. The variables parking and elevator are not statistically different from zero.

The estimated coefficient for the number of bedrooms is negative and statistically significant, which may appear as the opposite of what is expected. However, what the negative sign shows, because we are controlling for area and number of bathrooms in the regression, is that the willingness to pay higher prices is related to larger living or dining rooms and kitchen more than to having extra bedrooms.

The estimated coefficients for the variables measuring closest distance to a clinic, hospital, or school are not statistically significant. One possible explanation for these results is that the quality of the local public goods in these cases is more important than the location distance and we are not controlling for quality in the regression. In the case of distance to parks, the coefficient is significant but positive. Again one explanation is that the quality and size of parks matter more than distance; but, additionally, it could be that in some cases parks are associated to crime and, therefore, being farther away from the park has a positive impact on housing prices.

The coefficient of variable *Treatment* is positive and statistically significant in both cases. As can be seen in Table 1, the point estimator for the construction announcement is 119 UF[1] and for the stations' locations announcement is 165 UF, which correspond to an average increase in apartment prices of 3.3 percent and 4.6 percent, respectively.

The interaction of the variables *Treatment* and *Distance* has a negative impact on apartment prices and is statistically significant in both cases, implying a non-homogeneous impact on prices. Depending on the treatment, the impact of the subway on prices decreases 0.09 UF or 0.065 UF per each meter farther away the apartment is located from the nearest station. Figures 2 and 3 show the impact on apartment prices of the construction announcement and the stations' locations announcement, respectively, depending on the distance of the apartments to the closest subway station.

Finally, it is important to mention that the impact of the new subway line on apartment prices has potential effects on property tax revenues. If the Chilean IRS reassesses the value of properties in the counties serviced by the new Lines 4 and 4A, property tax revenues would increase by 7.5 percent approximately.

*Table 1*
**Estimation Results**

| | *New Line 4* | *Stations' Locations* |
|---|---|---|
| Area (squared meters) | 29.1245* | 29.1364* |
| Bedrooms | -54.2966** | -53.6996** |
| Bathrooms | 145.3796* | 144.1968* |
| New Unit | 702.2500* | 696.4032* |
| DFL2 | -46.9339 | -21.6497 |
| Parking | -17.8348 | -17.9881 |
| Basement | 173.8318* | 175.1085* |
| Elevator | 0.5363 | -3.4978 |
| Avenue | 167.9563* | 165.4532* |
| Street | 274.8061* | 274.8886* |
| Clinic Distance | 0.0050 | 0.0124 |
| Hospital Distance | -0.0198 | -0.0227 |
| School Distance | -0.0180 | -0.0182 |
| Park Distance | 0.1799* | 0.1804* |
| Change in Housing Stock | -0.0134* | -0.0115** |
| Treatment | 119.0397* | 164.9638* |
| Treatment*Distance | -0.0883* | -0.0645* |
| Distance (meters) | 0.0000** | 0.0000 |
| Constant | -918.4153* | -983.0360* |
| County Dummies | Yes | Yes |
| Monthly Dummies | Yes | Yes |
| Annual Dummies | Yes | Yes |
| $R^2$ | 0.7154 | 0.7154 |
| F | 473.22 | 477.75 |

**Significant at 10 percent.
*Significant at 5 percent.

*Figure 2:* **Price Increase after the Announcement of New Line 4**

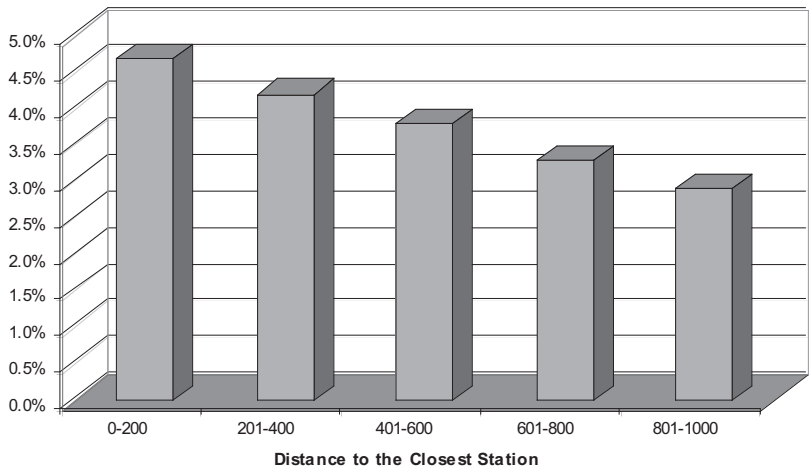
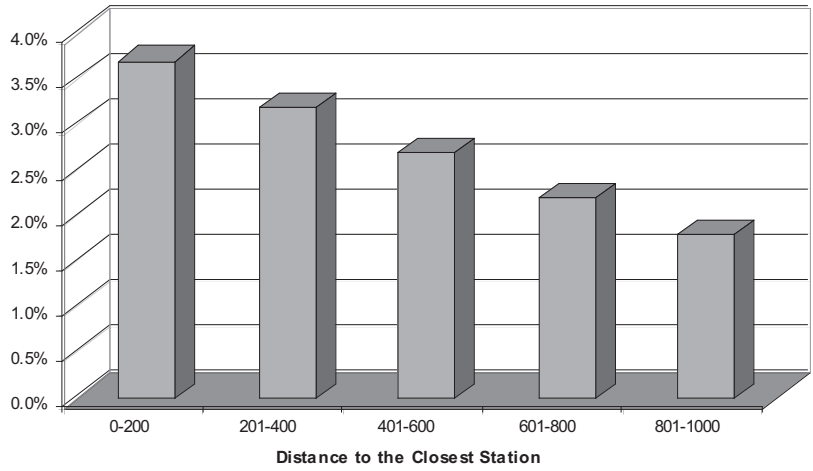


*Figure 3:* **Price Increase after Announcement of the Subway Stations' Locations**




## CONCLUSIONS

The subway is one the largest investments in public infrastructure in the city of Santiago and the government has continued constructing new subway lines with the goal of reducing congestion and pollution in the city. However, the construction of a new subway line might also have an impact on housing prices. The results of this paper show that those effects are not negligible. The announcement of the construction of new Lines 4 and 4A in Santiago increased the price of apartments 3.3 percent, on average, and the announcement of the stations' locations increased the price of apartments 4.6 percent, also on average. These impacts are larger the closer the apartment is to the subway station and decrease with distance at a rate of 0.09 UF for the former announcement and at a rate of 0.065 UF for the latter announcement.

One of the interesting implications of the positive impact of the new subway line on housing prices is the associated increase in property tax revenues. Our estimations imply a tax revenue increase of at least 7.5 percent, which could potentially be earmarked for investment in subway lines.

### Note

The UF is an inflation-indexed unit calculated by the Central Bank of Chile. In November 2009, 1 UF = Ch$ 21,017 equivalent to US$ 41.8.

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