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Abstract

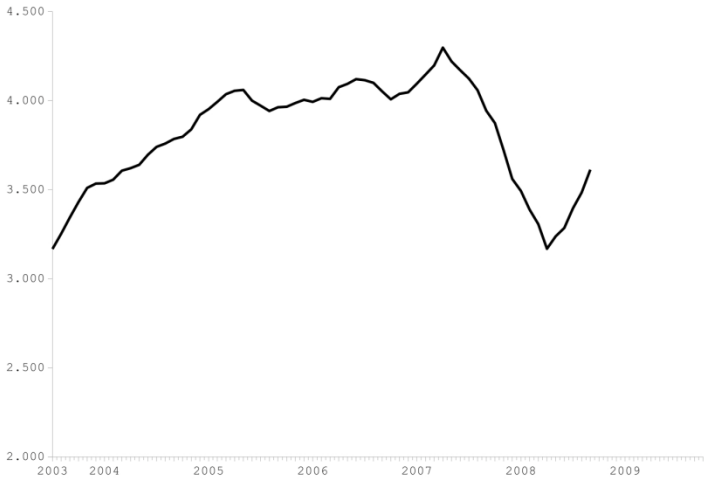
Given the numerous and widely acknowledged benefits of a well-functioning housing market, it is vital to understand the degree of competition in that market, which is the starting point for undertaking any policy tool aimed at improving its efficiency. This paper tests the extent of competition in the housing market in Santiago, Chile using a two-step methodology. In the first step, using a hedonic price model, the Santiago housing market is divided into sub-markets, which are analyzed separately. The second step is the tacit collusion test itself, which compares the industry markup with the business cycle in each sub-market using panel data regression models. Evidence of collusion is found in certain sub-markets.

JEL Classifications: O54, R21, R23, R28, R31, R38, R58
Keywords: Housing market, Housing sub-markets, Social housing, Chile, Latin America, Competition, Tacit collusion test

1. Introduction

The Chilean housing market has experienced a boom in the last decade. Nearly 50,000 dwellings were sold in 2007, the highest number of sales ever recorded in one year. In 2008, the effects of the financial crisis began to be felt. Figure 1 shows the seasonally adjusted series of sales, indicating significant growth and asubsequent decline due to the sub-prime crisis, which left sales slightly beneath the 2003 level.

Figure 1. Total Sales



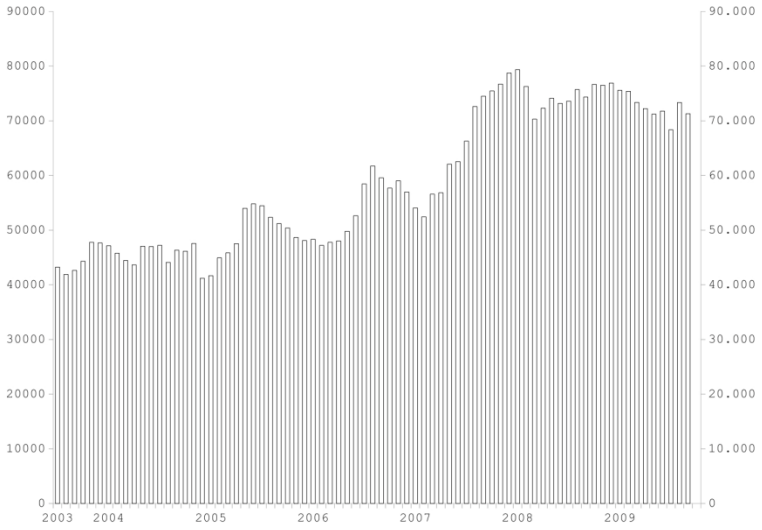
Source: Chilean Chamber of Construction

There are several reasons behind this boom, including the country's sustained economic growth, the 64.4 percent real salary increase between 1980 and 2005, government subsidies, and a deep and sophisticated mortgage market. Almost two-thirds of all dwellings built receive government support (Temiño, 2007). From 1998 to 2003, the number of mortgages grew by 100 percent. As Uprah and Marcano (2008) have pointed out, the key factors for the development of the mortgage market are the introduction of an in flation-adjusted index unit (UF), the 1980 pension reform, which created a privately run compulsory capitalization system, and an active process of

innovation infinancial products , which facilitated the transition from primary to secondary mortgage markets. The secondary mortgage market consists of three main instruments: mortgage debt, endorsable mortgages, and non-endorsable mortgages. All of these instruments are indexed to the consumer price index and have long maturities. These elements have increased available funding and have caused interest rates to decline.

The high level of sales has been accompanied by a massive increase in the supply (see Figure 2) of dwellings, built by a number of firms. Uprah and Marcano (2008) identified 253 different developers in Santiago in 2010 and a Herfindhal index of 1.1 percent, indicating a low level of concentration. This has been used as an argument supporting the idea that the Chilean housing market is very competitive.

Figure 2. Supply of Dwellings



Source: Chilean Chamber of Construction

While economic theory holds that a large number of suppliers can improve the level of competition in the market, competition still cannot be guaranteed due to the potential emergence of

tacit collusion. Discussions of this topic can be found in Tirole (1988) and Gibbons (1992). In addition, some particular features of dwellings can reduce competition in housing markets. Taltavull de la Paz (2001) categorizes these features as physical, institutional, and economic.

The most relevant features supporting the argument laid out above are the physical and economic characteristics. The physical characteristics are:

- Immobility: dwellings and land are physically immovable, which gives the market a local character.
- Indestructibility: the dwellings' durability makes them an object of investment.
- Heterogeneity: Given dwellings location and characteristics, no two dwellings are alike. In economic terms, this implies market fictions and monopolistic competition.

The economic characteristics are:

- Location: one of the main factors affecting the economic component of location is physical accessibility, which is linked to commuting relative to cost of time, effort, and money. This factor is directly related to the dwelling's price.
- Scarcity: Given either lack of land or a small number of units, some kinds of dwellings can be in short supply. This can result from both market segmentation and heterogeneity.
- Interdependence: Property values are generally related, so the price of a neighbor's house has impact on the price of one's own house.
- Investment duration: the investment duration is defined as the period of time required to recover both location and construction costs. The purchase of a dwelling is understood to be a medium- and long-term investment, which is one of its main demand characteristics.

The housing market presents information asymmetry problems, because several aspects of dwelling or housing services have credence goods characteristics. As Darby and Karni (1973) define them in their seminal work, credence qualities are those which, although worthwhile, cannot be evaluated in normal use because they are difficult to judge even after purchase. Some examples are the degree of thermal and sonic isolation, soil quality, and the extent of seismic isolation (particularly relevant in the case of Chile).

Moreover, an accurate housing market analysis must be based upon sub-markets rather than a whole-city analysis. According to Alkay (2008), in a segmented housing market, housing price structure is different in each segment, and the whole city market does not represent the price of housing services. Consequently, the number offirms acting in each sub-market will be much smaller, which implies a greater chance of observing low levels of competition.

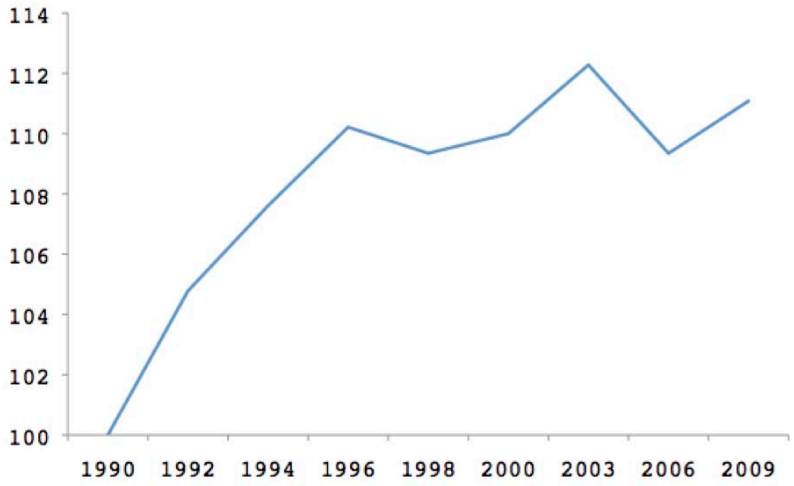
Given the segmentation that will be observed because of housing market characteristics, such as immobility, heterogeneity and location, the market should exhibit, in the best-case scenario, monopolistic competition behavior. Another reason is that the special features of housing goods, scarcity of dwellings, will be observed in some markets. On the other hand, indestructibility and the long-term investment feature of housing goods will generate a one-shot relationship between buyers and sellers, which will reduce the sellers' incentive to invest in reputation. The latter would have as a consequence a reduction in dwelling quality.

Finally, interdependence implies that externalities will exist within the housing market, given the fact that dwelling prices are linked to each other. For instance, if a poor-quality building offering cheap apartments is built alongside a better-quality one, the prices of apartments in the better-quality building will fall.

Consistent with the theoretical view that housing markets, in general, will present monopolistic competition, there is some indication of a low level of competition in the Chilean housing market. Particularly during the sub-prime crisis, housing demand experienced an important decline (see Figure 1). Nonetheless, prices did not show the same behavior (see Figure 3), as could be expected when facing a highly inelastic supply. Instead, special sales during limited

periods of time were observed. Every two months, special sales lasting just 72 hours were implemented by developers, indicating time-based price discrimination. This would only be done when firms have some degree of market power.

Figure 3. Hedonic Price Index



Source: Authors' compilation.

In summary, it can be argued that housing markets have a number of characteristics that tend to generate market failures. In addition, some facts observed in the Chilean housing market indicate the presence of market failures and a limited level of competition. Despite its importance, this hypothesis has not been yet tested. In this study, we propose to test this hypothesis using a segmentation of the Chilean housing market in order to analyze firm behavior appropriately. We thus intend to test the presence of tacit collusion in each sub-market.

This approach could have interesting policy implications. For example, while some sub-markets may be sufficiently competitive, others may have a very low level of competition. Therefore, a spatially differentiated policy intervention will be needed, treating each sub-market differently in accordance with its own level of competition and its effects upon households' well-being, which will differ depending on each sub-market's socio-economic structure.

Depending upon the results, some public policies actions will be recommended to improve market functioning in terms of better prices, better housing conditions, and quality.

In order to do that, the housing sub-markets must first be defined and a methodology implemented to identify the extent of competition within every sub-market. Santiago has been chosen because, according to the Chilean Chamber of Construction, it represents more than 50 percent of the total Chilean housing market.

In summary, the proposed methodology will characterize relevant housing sub-markets in Santiago. For each sub-market, firms' markups will be computed in order to test the degree of competition. Finally, we will recommend some policies which could be applicable to improve the competition.

2 Methodology

The methodology proposed here has been developed to test the presence of tacit collusion in the Santiago housing market. This test is based on the works of Rotemberg and Saloner (1986) and Green and Porter (1984), which establish that the relationship between firms' profits and business cycles will provide information about the level of competition in the market. However, in order to conduct a more accurate analysis of firm behavior, we need to identify sub-markets, given the particular features that these markets present. After the sub-markets have been identified, the tacit collusion test will be performed for each sub-market.

In general, sub-markets are related to prices. The housing market characteristics mentioned above need a particular treatment, which implies that the price analysis must be based on hedonic price models.

A simple algorithm of the methodology proposed here establishes the following steps:

- Estimation of a hedonic model for the city as a whole as a way to identify the variables that are behind housing prices.
- Clustering of basic geographical units of analysis, such as census tracks, according to a criterion based upon household socio-economic characteristics.

For instance, census tracks with similar average household incomes will be clustered.

- Once the potential sub-markets have been defined, the next step will be to run a hedonic regression for each one of them and then to test if the estimated parameters are different between sub-markets.
- Once the sub-markets have been defined, the firms' markups will be estimated for each sub-market.
- Finally, every sub-market firm's markups will be compared with the business cycle in order to undertake the tacit collusion test.

2.1 Housing Demand and Hedonic Price Estimation

Because dwellings and housing services are highly heterogeneous, it is difficult to estimate a generic demand function for them. Instead, dwellings can be decomposed into their constituent characteristics, and then prices and elasticities can be estimated for each of them. This is done by using the hedonic regression developed by Rosen (1974), which takes into account that observed choices over housing reveal to the researcher information about the underlying preferences for amenities or other characteristics of interest (Taylor, 2008).

Let us consider that P_i is the dwelling price, which is a heterogeneous good, and x_i is a vector that includes its structural attributes of size and quality, characteristics of the immediate neighborhood, and indicators of its environment and accessibility. b is a vector of parameters that must be estimated for the characteristics.

$$P_i = f(x_i;b) + u_i \tag{1}$$

Having estimated equation (1), it is possible to predict the price of any dwelling i with attributes x_i.

$$\hat{p}_i = f(x_i;\hat{b}) \tag{2}$$

For discrete characteristics, the implicit price of the attribute k[th] can be calculated as follows:

$$\hat{p}_k = f(x_k + 1; x_{-k}; \hat{b}) - f(x_k; x_{-k}; \hat{b}) \tag{3}$$

and for the continuous case:

$$\hat{p}_k = \partial f(x_i; \hat{b}) / \partial x_k \tag{4}$$

The implicit prices reveal the implicit marginal willingness to pay for an increment in any of the dwellings attributes.

As Taylor (2008) points out, the hedonic price function has no theoretical guidance for its specification, due to the fact that it is an envelope function. The most commonly used specification is a semi-log:

$$\ln(P_i) = a + \sum_{k=1}^{K} b_k x_{ki} + u_i \tag{5}$$

The most common way of estimating (5) is by either OLS or maximum likelihood.

The set of the relevant attributes for price determination can be categorized into three groups:

- characteristics of the dwelling and the lot
- features of the neighborhood, like crime rate
- locational characteristics, like proximity to employment centers

2.2 Definition of Sub-Markets

Despite the fact that, since their first appearance in the seminal work of MacLennan (1977), housing sub-markets have been widely studied in a theoretical framework, there is little consensus about how sub-markets should be identified for applied studies (Alkay, 2008; Royuela and Vargas, 2009). In empirical works, sub-markets have been defined in different ways such as by demand and

supply factors, geographic characteristics, spatial characteristics, structural characteristics, and neighborhood characteristics.

Researchers have proposed different stratification schemes for their definitions of sub-markets, including: age of the dwelling, floor area, lot size, number of rooms, number of bathrooms, parking lot, elevator, wall material, and roofing material. Socioeconomic characteristics and race have also been used, as have spatial dimensions such as census boundaries, neighborhood boundaries, municipal boundaries, school districts, and inner and outer urban areas. Income levels or household size, in addition to neighborhood boundaries or inner and outer urban areas or construction type, are examples of stratifiers of joint influence.

Jones et al. (2004) defined sub-markets based on households' intra-urban mobility. This approach is an attempt to avoid researcher bias. In turn, within this structure, different approaches can be found, such as travel-to-work areas and migration data.

Here, the methodology introduced by Schnare and Struyk (1976), following the explanation by Alkay (2008), is proposed. As sub-markets are not known in advance, the first step must be to determine if segmentation exists. In order to do that, potential sub-markets should be proposed, by clustering census tracks with a similar average household income, and then testing if the parameters estimated for these potential sub-markets are different. Second, if a segmentation structure is observed, a test should be conducted to determine whether the resulting variation in prices is significant.

This test procedure can be split into three stages:

- First, estimate a hedonic housing price function for each potential sub-market in order to compare these potential sub-markets prices. If there are large and significant differences in the estimated parameters of those potential sub-markets, the differences might be accepted as evidence of market segmentation.
- Second, compute the tests to establish whether significant differences exist between the sub-markets' specific prices.

- Third, since the primary interest is in the price of housing rather than the price of individual housing characteristics, the difference between the whole market model and sub-market models must be emphasized. By testing for the relative importance of this variation, the standard errors of the whole market model and the sub-market models can be compared.

2.3 Firm Markups and Sub-market Competition

Machin and Van Reenen (1993) propose a procedure based upon the supergame theoretic models developed by Rotemberg and Saloner (1986) and Green and Porter (1984) to test the extent of competition of an industry. These models have clear-cut predictions regarding the behavior of profit margins with respect to the business cycle: Rotemberg and Saloner (1986) predict that margins should exhibit countercyclical behavior, while Green and Porter (1984) suggest pro-cyclical markups. The former prediction relies on the assumption that firms can discriminate among aggregate and idiosyncratic shocks, while the latter prediction is based on the assumption that firms cannot do so. Therefore, if a systematic relationship between profits and the business cycle is found, it will be evidence of oligopolistic behavior.

The model estimated is the following:

$$y_{i,t} = \beta_0 + \beta_1 y_{i,t-1} + \beta_2 x_{i,t} + \beta_3 c_t + \mu_i + \nu_{i,t} \qquad (6)$$
$$i = 1,\text{K},10; t = 2008_i,\text{K},2010_i$$

where $y_{i,t}$ and $y_{i,t-1}$ correspond to each housing project markup in period t and $t-1$ respectively. $x_{i,t}$ is a market concentration measure, which in this case is sales' share in t. c_t is a business cycle variable, which is constant for all projects in a given period of time. In this case, two business cycle variables have been used: the monthly economic activity index (IMACEC) and the unemployment rate. μ_i corresponds to a fixed effect for every project, whose objective is to capture the effects of particular features that do not change over time. $\nu_{i,t}$ is a stochastic shock.

The main aim is to test the business cycle variable's impact upon the project's profits. Its parameter value is β_3. This parameter value will indicate if the empirical evidence is consistent with either countercyclical or pro-cyclical behavior. Either a negative IMACEC parameter value or a positive unemployment rate parameter value will be evidence of countercyclical behavior and the opposite of pro-cyclical behavior.

The inclusion of the lagged dependent variable as a regressor enriches the specification. The latter is due to the fact that this procedure allows the dynamic process that generates the project markups to be incorporated in an explicit way.

Machin and Van Reenen (1993) propose this methodology based upon an oligopoly theoretical model of homogenous products developed by Cowling and Waterson (1976).

Testing the lagged markups' significance will verify whether housing projects' markups show some inertia, as the Machin and Van Reenen (1993) model has predicted.

3. Data

In hedonic price modeling, three kinds of information are commonly used: dwelling characteristics, location characteristics, and environmental characteristics. Regarding the first one, the information used is sales of new dwellings in 2008. There are 17,696 geo-referenced observations. For each of them there is information about price, in CPI-Indexed Unit of Account, UF (1 UF is about US$20), type (either apartment or house), surface in square meters, number of bathrooms, and number of rooms. This information was purchased from COLLECT GFK, a market research company which compiles a real estate market micro-database every three months containing the information mentioned above.

Regarding location characteristics, data on the number of crimes committed in the neighborhoods were obtained from *Carabineros de Chile* (Chilean Police). Additionally, using the geo-referenced information, the distance from the dwellings to the nearest green area, urban highway access, urban highway (not to the access but the highway itself), cultural center, school, police station, hospital, and central business district were calculated.

In relation to the environmental characteristics, the records from 11 Santiago measurement stations were obtained from CONAMA (the Chilean environment agency).

For the tacit collusion test, the data base used contains information about housing projects from the first quarter of 2008 to the second quarter of 2010. Every record has information about the total number of dwellings supplied, prices, size, number of bedrooms, and number of bathrooms. It also contains information about each project's sales by quarter. This data base was purchased from COLLECT GFK. As can be gathered, the observations in this database correspond to housing projects, while in the database used for the hedonic model, the observations are the housing units.

Construction costs were calculated using the construction cost per square meter established by the Minister of Housing in order to calculate construction taxes.

Capital costs were calculated using the information on interest rates provided by the Central Bank of Chile. The Central Bank of Chile also provided the business cycle variables.

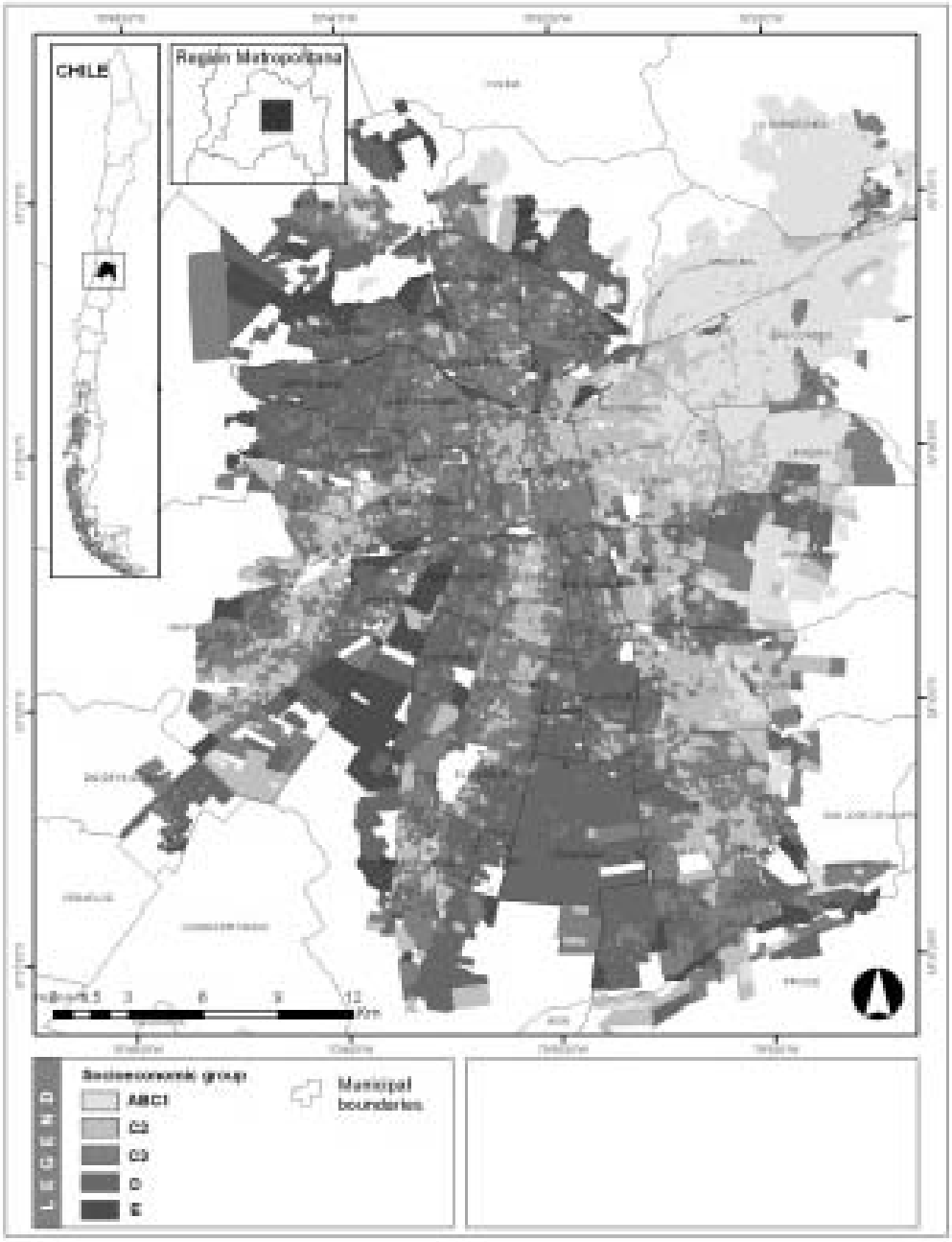
4. Hedonic Price Regressions and Santiago Housing Sub-Markets

The main goal of this study is to test tacit collusion in the Santiago housing market. However, in order to more accurately test for tacit collusion, it is necessary to identify sub-markets because of the segmentation of the housing market. Once this has been done, the test can be performed for each sub-market. The first step in identifying sub-markets is running a hedonic price regression, which allows the main variables explaining dwelling prices to be identified by decomposing them into their characteristics' implicit prices. Once this has been done, city blocks are pooled together following a socioeconomic criterion. All of the blocks with the same average socioeconomic characteristics are clustered together. A hedonic regression is then performed for each of the proposed sub-markets. A Chow test is the performed to see if the parameter values that have been obtained for the proposed sub-markets are different from each other. If the test results indicate that the parameters are different, then the hypothesis that the sub-markets are indeed different is not rejected.

4.1 Grouping Process

The criterion used to cluster the blocks is based on households' socioeconomic characteristics. These were obtained from Adimark GFK using 2002 census information. This classification is based on two main variables: educational attainment of the head of household and possession of certain goods. The goods considered are: shower, TV, refrigerator, water heater, microwave, cable TV, computer, Internet connection, and automobile. Using these variables, households were classified into five different groups, which were named ABC1, C2, C3, D and E, in descending order according to socioeconomic level. For instance, if a head of household has no education and has none of these goods, the household is classified as E, but if the head of a household has more 13 years of education and possesses all the goods mentioned above, then it is classified as ABC1. Following this procedure, 11.3 percent of the population in Santiago was classified as ABC1, 20.1 percent as C2, 25.6 percent as C3, 34 percent as D and 8.5 percent as E. The highest concentration of ABC1 households is in the northeast end of the city; the C2 and C3 groups are located in city center, and the D and E groups are located in the south and north ends. Figure 4 shows the spatial distribution of these groups. The ABC1 is blue, C2 light green, C3 brown, D orange, and E red.

Figure 4. Spatial Distribution of Socioeconomic Groups in Santiago Metropolitan Area



Source: Authors' compilation using Adimark GFK and Chilean 2002 Census data.

Every block with more than 50 percent belonging to one particular group was considered as a block of this group. That is, if more than 50 percent of households on one block are ABC1, then this block is considered as ABC1. All the blocks belonging to the same socioeconomic groups were determined to be one potential sub-market, even if they are not contiguous. Socioeconomic groups D and E were considered as one potential sub-market because the number of transactions related to these two groups is small, with just 32 observations. The reason is that, although the group D represents a high percentage of the total population, most of these households participate in social housing programs rather than private markets such as the ones being studied here.

4.2 Hedonic Regressions and the Identification of Sub-markets

Once the sectors have been identified, the next step consists of trying to determine whether or not these sectors belong to the same housing sub-market. A hedonic regression is performed to identify the variable explaining dwellings prices. Then, a regression for each sector is run. Given the common hedonic models' problems of multicollinearity and heteroskedasticity, the regressions were done using the heteroskedasticity and autocorrelation consistent covariance matrix. Table 1 presents the variables used.

Finally, a Chow test is performed to see if the potential sub-markets parameters estimated are statistically different from each other. If they are, it is because the potential sub-markets are effectively different sub-markets. Table 2 shows the whole city hedonic regression results, and Table 3 shows the regressions results for each sub-market.

After the tests for every potential sub-market have been performed, the results indicate that submarkets 1, 2, 3, and 4 correspond to different sub-markets, i.e., that markets for ABC1, C2, C3, D, and E are different from each other.

Table 1. Variables

Variable	Description
valoruf	house price in UF
tipo	a dummy variable which takes the value 1 if the dwelling is a house
velkmhr	the average speed, by car, from the house location to the city center
tiempomin	the minimum time needed to reach, by car,the city center from the house location
valorsuelom2	land price in UF
gsecodigo	a code that indicates the potential sub-market where the house is located
metraje	dwelling surface in square meters
bao	number of bathroom
total_delitos	number of crimes committed in the dwelling municipality
d_areas_verdes	distance in meters to de nearest green area
area_verde2	square distance to the nearest green area
d_acceso_autopista	distance in meters to the nearest urban highway entrance
d_autopista	distance in meters to the nearest urban highway
d_colegio	distance in meters to the nearest schoo
col2	square distance in meters to the nearest school
d_comisaria	distance in meters to the nearest police station
com_2	square distance in meters to the nearest police station
d_hospital	distance in meters to the nearest hospital
hosp2	square distance in meters to the nearest hospital
d_metro	distance to the nearest underground station
vmh	average maximum value of air pollution measure by the three nearest pollution measurement stations
d_subcentro	distance in meters to the nearest central business district

Table 2. Estimation Results: Regress

Variable	Coefficient	(Robust Std. Err)	p-value
tipo	-.1124945	.0064871	0.000
velkmhr	-.0028969	.0001867	0.000
tiempomin	.0009739	.0003822	0.010
gsecodigo	-.2478184	.0032129	0.000
valorsuelom2	.0139352	.0003129	0.000
metraje	.0052485	.0001597	0.000
bao	.1112603	.0055585	0.000
total_delitos	-3.39e-06	1.69e-07	0.000
d_areas_verdes	1.83e-06	4.72e-06	0.684
d_acceso_autopista	-.0000231	9.62e-06	0.012
d_autopista	.0000107	9.25e-06	0.229
d_centro_comercial	-8.36e-06	1.39e-06	0.000
d_colegio	.0000804	7.39e-06	0.000
d_comisaria	-4.27e-06	1.98e-06	0.029
d_hospital	7.18e-06	1.35e-06	0.001
d_metro	3.52e-07	2.74e-06	0.895
vmm	-.0044038	.0003034	0.000
metro2	-2.53e-10	2.75e-10	0.347
cons	8.215.717	.0272126	0.000
Number of obs	12202	R-squared 0.9462	
Root MSE	.14695		

Table 3. Sub-Market Estimation Results

Variable	S1	S2	S3	S4
tipo	-.0695365*	-.1785544*	-.1654532*	-.0320305
velkmhr	-.0024668*	-.0044234*	-.0014514*	-.0014515*
tiempomin	.0041538*	.0004031	-.0030328*	-.0074586*
valorsuelom2	.0221933*	.0151692*	.0232607*	.0101972*
metraje	.0047248*	.0077098*	.0106327*	.0065206*
bao	.0934039*	.0285029*	.0459215*	.0934484*
total_delitos	-.000026*	-4.71e-06*	-2.94e-06*	6.00e-08
d_areas_verdes	-4.58e-06	.0000305*	9.34e-06	-.0000216
d_acceso_autopista	-.0000347	-.0001504*	-.0001033*	.0001358
d_autopista	.0000335	.0001193*	.0000821*	-.0001238*
d_centro_comercial	4.65e-06	3.95e-06	6.56e-06*	-3.09e-06
d_colegio	.0000209	.0001056*	-.0000577*	.0001585*
d_comisaria	-.0000121*	1.67e-06	2.70e-06	4.55e-06
d_hospital	-.0000292*	-8.33e-06*	4.59e-06*	4.21e-06
d_metro	1.08e-06	.000014*	2.00e-06*	-.0000522*
vmm	-.0312665*	-.0018121*	-.0063237*	.0006588
metro2	5.28e-10	-4.21e-09*	-2.11e-09*	5.41e-09*
cons	10.26064*	7.576059*	7.357675*	6.654473*
Obs.	2884	2645	5854	819
R^2	0.8815	0.7284	0.6635	0.3253

5. Testing Tacit Collusion

The simultaneous inclusion of the lagged dependent variable and the housing projects' fixed effect as a regressor in equation (6) generates an endogeneity problem. As a consequence, the OLS estimations will not be consistent. To deal with this issue, the methodologies proposed by Arellano and Bond (1991) and Blundell and Bond (1998) (AB and BB hereafter) and introduced to economic analysis by Caselli et al. (1996) will be used. These approaches are modi fied versions of the Generalized Moments Method (GMM), with the particular feature that instrumental variables are lags of the same explanatory variables. To get a clearer understanding of this issue, let us consider the following model:

$$y_{i,t} = \alpha y_{i,t-1} + x'_{i,t}\beta + \varepsilon_{i,t}$$

$$\varepsilon_{i,t} = \mu_i + \nu_{i,t}$$

$$E[\mu_i] = E[\nu_{i,t}] = E[\mu_i \nu_{i,t}] = 0$$

Within the GMM framework developed by Hansen (1982), Arellano and Bond (1991) propose to differentiate the model variables to eliminate the fixed e ffect, which is one of the sources of endogeneity. After applying this process, the model will be:

$$\Delta y_{i,t} = \alpha \Delta y_{i,t-1} + \Delta x'_{i,t}\beta + \Delta \nu_{i,t}$$

However, despite the fact that the fixed effect has been eliminated by this procedure, $\Delta y_{i,t-1} \equiv y_{t-1} - y_{t-2}$ is still an endogenous variable, because it is correlated with $\Delta v_{i,t} = v_{i,t} - v_{i,t-1}$.

Consequently, the inclusion of instrumental variables is needed. If $v_{i,t}$ does not present serial autocorrelation, then y_{t-2} will be a valid instrument to Δy_{t-1}.

By extension, y_{t-3}, ...,y_{T-1} will be also valid instruments. If the variable is predetermined and it is not endogenous, then y_{t-1} is added to the available instruments set. Blundell and Bond (1998), argue that when the lagged dependent variable is close to 1, the instruments used in AB are

weak, which reduces the estimator's efficiency. To address this problem, the BB methodology proposes to expand the set of orthogonality conditions. Particularly, this methodology proposes to differentiate the potential instruments in order to make them exogenous to the fixed effect.

Thus, if changes in $y_{i,t-1}$, are orthogonal to the fixed effect μ_i, i.e., $E[\Delta y_{i,t}\mu_i] = 0$, for all $\boldsymbol{i}$ and t, and there is no serial autocorrelation in $v_{i,t}$, then $\Delta \boldsymbol{y_{i,t-1}}$ is a valid instrument for y_{t-1}. As in the AB case, the BB methodology also includes as valid instrumental variables Δy_{t-1}, Δy_{t-2}, ..., Δy_{T-1}.

The results of the tacit collusion test for the whole system are shown in Tables 4 and 5. Table 4 shows the results when the cycle variable used is the IMACEC, while Table 5 shows them when the variable used is the unemployment rate. The dependent variable is the project's markups in UF. *L.beneficio2* corresponds to the one period lagged markups, and *venta_trim* corresponds to the project's quarter sales. The markups have been calculated as the difference between the total sales and costs. The costs are obtained as follows: first, the project 's total construction cost is calculated using the square meter cost proposed by the Minister of Housing in order to tax the construction projects plus the land cost; second, each quarter's cost is calculated as the percentage of the total cost of the quarter's sales (for instance, if in a quarter the 30 percent of one project is sold, then the quarter's cost will be the 30 percent of the total cost), plus the alternative cost of money, calculated as the investment multiplied by the quarterly interest rate.

Table 4. Dep = beneficio2

Variable	Coefficient (Std. Err.)
L.beneficio2	0.344**
	(0.100)
_venta_trim	2208.357**
	(474.378)
imacec	223.744**
	(83.500)
Intercept	-23344.377*
	(10797.789)
*5% significant	**1% significant
Obs.	635
$X^2_{(3)}$	38.572

Table 5. Dep = beneficio2

Variable	Coefficient (Std. Err.)
L.beneficio2	0.364**
	(0.102)
_venta_trim	2241.545**
	(479.384)
desempleo	-14713.643*
	(5877.501)
Intercept	128430.486**
	(49204.650)
*5% significant	**1% significant
N	635
$X^2_{(3)}$	37.634

As can be observed, the cycle variables are significant for the system as a whole, which means that there is evidence to affirm that the entire Santiago housing market exhibits behavior consistent with tacit collusion. However, as was argued above, in order to be more accurate, the analysis must be conducted at the sub-market level. Table 6 shows the test results for each sub-market when the cycle variable is the IMACEC, and Table 7 shows the test results for each sub-market when the cycle variable is the unemployment rate.

Table 6. Panel Data Sub-Market Estimation Results: Cycle Variable IMACEC

Variable	**S1**	**S2**	**S3**	**S4**
L.beneficio2	-0.008	0.637*	0.913**	1.865
_venta_trim	4876.900**	2351.452*	1180.431*	1049.008
imacec	-164.538	2351.452*	407.191**	435.048
Intercept	30542.619	-54670.744*	-53025.830**	-62106.418
Obs.	195	140	246	37
X2(3)	15.649	13.606	20.006	1.497
*5% significant	**1% significant			

Table 7. Panel Data Sub-Market Estimation Results: Cycle Variable Unemployment Rate

Variable	S1	S2	S3	S4
L.beneficio2	-0.008	0.637*	1.034**	1.865
_venta_trim	4876.900**	2351.452*	1214.123*	1049.008
desempleo	11622.416	-31023.429**	-28275.059**	-30730.295
Intercept	-86992.532	259568.685*	235068.383**	249460.623
Obs.	195	140	246	37
$X^2_{(3)}$	15.649	13.606	17.694	1.497
*5% significant	**1% significant			

The cycle variables are highly significant (1 percent) for submarkets S2 and S3, but they are not in sub-markets S1 and S4. Besides, sub-markets S1 and S4 do not show evidence of inertia. Consequently, the hypothesis of tacit collusion is rejected for sub-markets S1 and S4. This result in the case of sub-market S4 can be explained by the fact that it is based on only 32 observations. This hypothesis cannot be rejected for sub-markets S2 and S3. This result can have momentous welfare implications, because these two sub-markets represent 63 percent of the sample. This means that most of the population faces a colluding housing market.

6. Results, Analysis and Policy Recommendations

The methodology of this study consists of two parts. First, sub-markets were identified, and then tacit collusion tesst were conducted on each sub-market. The reason that the study worked on sub-markets was that, given the segmentation of the housing market, the behavior of the sub-markets would differ. Sub-markets were defined by grouping together blocks with households having similar socio-economic characteristics. Then, a hedonic regression was carried

out for the whole city and for each potential sub-market. Finally, a Chow test was performed to cast light upon whether the potential sub-market parameters diverged. Following this procedure, four sub-markets were identified.

The second part consisted of a set of GMM panel data regressions conducted to test the tacit collusion hypothesis in each sub-market. Using this procedure, no evidence of tacit collusion was found in the sub-market of well-off households. However, in those sub-markets where lower-income households reside, the tacit collusion hypothesis was not rejected. The exemption was the sub-market of the lowest-income households, where no statistically significant evidence was found to support the tacit collusion hypothesis. Nevertheless, this result could be explained by the fact that the number of observations in this sub-market was only 32.

This conclusion is strengthened by the fact that the average return on investment in the ABC1 sub-market, S1, is lower than that observed in sub-market S3. This may be the result of a higher level of competition, as can be seen in Figure 5. Although the average return is slightly higher than sub-market S2's average return, it is more volatile. Higher returns can be observed in sub-market S2, as shown in Table 8.

Figure 5. Quarter Average Return per Sub-Market

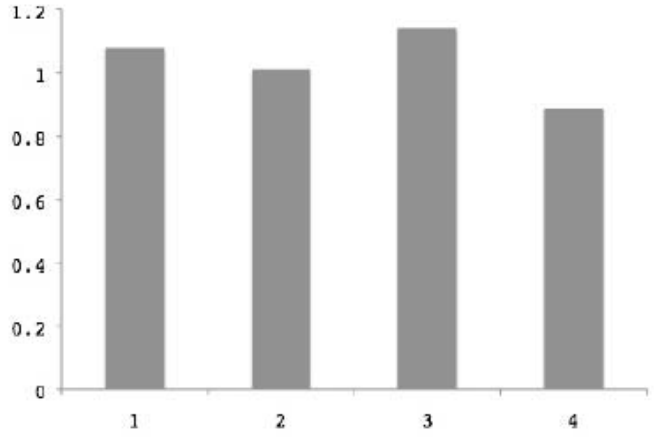
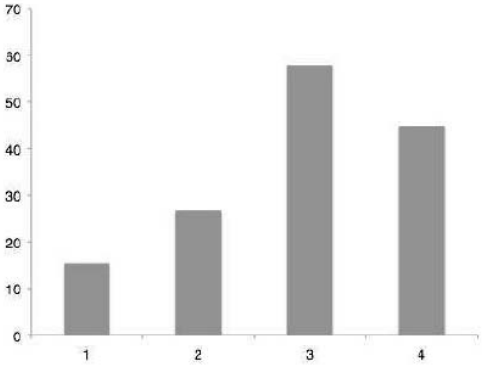


Table 8. Returns Statistics

Sub-market	Mean	Std. Dev.	Min	Max
S1	1.078539	0.610884	0.0606789	4.52968
S2	1.01006	0.482516	-0.0252673	6.391478
S3	1.142149	0.404284	0.1181575	3.056268
S4	0.888908	0.4154843	-0.0226455	2.842898

Housing projects belonging to this sub-market are smaller (see Figure 6) which could be due to the fact that developers in a more competitive environment will search for differentiation and because of that, economies of scale cannot be exploited as in the case of larger projects with lower levels of differentiation. It is also possible that due to the fact that they have higher levels of education and higher incomes, S1 sub-market households may have access to better information and it is easier for them to deal with searching costs, which in turns put more pressure on developers. As access is more limited for the others sub-markets, developers will face less pressure to exhibit differentiated dwelling features. Moreover, the S1 market is spatially more concentrated, which means that is easier for the different companies participating in this market to understand their competitors' behavior.

Figure 6. Average Project Units Supply per Quarter



Consequently, and given housing's characteristic as a highly differentiated good, the regressions results, and the particular features of S1 sub-market, it is possible to say that in the well-off household sub-market, S1, there is monopolistic competition.

However, this is not the case for sub-markets S2 and S3. Regressions results have shown that in these sub-markets, the markups exhibit pro-cyclical behavior. These results are consistent with Green and Porter (1984), who show that tacit collusion is possible but not stable, which implies periodic price wars. When there is some uncertainty related to the demand and firms' sales turn out to be lower than expected, firms cannot know if the lower level of sales was the result of competitors' price-cutting process or a decrease in demand. This is due to the fact that, although some monitoring is feasible, the outcome that is monitored—price or market share—is an imperfect predictor of competitors' behavior. Green and Porter (1984) point out thatfirms in a colluding industry with imperfect monitoring will react by assuming that competitors had cheated when the price falls under some predetermined trigger price. Consequently, firms' markups will be pro-cyclical.

S2 and S3 sub-markets have bigger projects on average (Figure 6), which means that the initial investment must be larger than in the case of the other sub-markets. This larger investment must be mostly related to the money needed to buy larger lots of land, to hire more sophisticated legal services, and to have more sophisticated construction teams and equipment to deal with this kind of housing project. This is an important barrier to entry.

Another important fact to take into account is the role of government housing subsidies. Using the 2006 CASEN survey, Simian (2010) shows that 49 percent of the subsidies given to purchase a dwelling were received by the C2 and C3 groups, which means that almost the half of these subsidies were given to households belonging to S2 and S3 sub-markets, and 82 percent to households in sub-markets S2, S3, and S4. Until 1996, these subsidies were given only to buy new dwellings. However, Simian (2010) indicates that between 1976 and 2007, on average 67 percent of new dwellings were built using one of these subsidies. As a strategy to sell their projects, developers assist customers in applying for the subsidy. This limits the chance that customers will

resort to the existing housing market as an alternative to new housing in sub-markets S2 and S3, increasing the possibility of colluding behavior.

A simple exercise has been conducted here to try to measure the importance of subsidies as an ownership driver. A probit regression was conducted, using ownership as the dependent variable and the gender of the head of household (1 if female), unemployment, education and income, number of household members, and subsidy (1 if one was received) as independent variables. The data base used is the 2009 CASEN survey. The results are found in Table 9. As can be seen, the subsidy is an important ownership driver. Consequently, housing policy has played an important role in household access to housing solutions, which is positive, but at the same time it demands a very careful assignment methodology to avoid the possibility of financing excessive profits.

Table 9. Estimation Results: Probit

Variable	Marginal effect	P-value
head of household gender	0.0122745	0.251
income	3.78e-08	0.000
umeployment	-0.1229176	0.000
subsidy	0.5076745	0.000
head of households level of education	0.0856939	0.000
family members	-0.0052887	0.071
Obs.= 7762	Psuedo R2= 0.2050	

Because S2 and S3 sub-markets show evidence of tacit collusion, the majority of the population must face a housing market with a low level of competition. This implies important welfare costs, the most important among them being price, which will tend to be higher than those that guarantee economic efficiency. Second, the supply of dwellings will be lower than would be

the case in a more competitive environment. Third, an important segment of the population will not be able to access the market. Fourth, as developers will not have incentives to differentiate, households will have a lower chance of finding a unit that fully satisfies their requirements. Fifth, developers will not have incentives to improve the quality of dwellings. Sixth, given higher prices, developers will extract rents from households belonging to the lower income segment, creating a problem of income distribution. Finally, developers will have no incentives to provide information about the quality and characteristics of the dwellings, increasing search costs and reducing the households' possibility of making an informed purchase.

Given the costs mentioned above, it is important for policymakers to try to design policies focused on improving housing market competition. It is important to generate an accurate micro database of housing projects and sales and to identify dwelling features (size, location, amenities, etc.), transaction prices, and household characteristics. This information will allow sub-markets (which should be the geographic unit of analysis) to be identified. It is also important to have detailed information about housing projects, including size, quality, and cost. All of this information should be geo-referenced. Having a database with these characteristics will enable market behavior and the level of competition at a sub-market level to be analyzed, as has been done in this study.

Once this database has been compiled, it must be processed and the results made freely available. Households' free access to this sort of information will reduce their search costs, which is particularly important for lower-income families. Consequently, households will be able to compare quality and prices which, in turn, can encourage competition. It is important to keep in mind that if policymakers want to facilitate this comparison, analysis and information processing must be done using the hedonic methodology. Otherwise this comparison will not be valid.

It is important also to review the subsidy scheme. In the Chilean case, the majority of subsides have been granted to those families belonging to the S2 and S3 markets. In fact, according to Simian (2010), 49 percent of all subsidies have been given to households belonging, in accordance with sub-markets classification made here, to sub-markets S2 and S3. Consequently,

although the aim of these subsidies has been to facilitate those families' access to the housing market, they may have been funding excessive profits. Therefore, conducting a competition analysis would enable the government to grant subsidies based on the amount of competition observed.

As the real estate market is an important driver of the economy, it is relevant to be cautious in order to avoid implementing a policy that has the unintended consequence of reducing interest on the part of investors and developers in participating in the market. In view of this risk, the policy recommendations given here focus on monitoring market behavior, household access to information, and the improvement of the system of subsidies rather than proposing regulations that may negatively affect not just the housing and real estate market but the economy as a whole.

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