Determinants of Vacant Urban Land Evidence from Santiago of Chile

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Abstract

This paper presents evidence on the determinants of urban vacant land in Santiago, Chile. In resorting to a random utility approach to build a Logit model, we innovate in terms of the statistical strategy pursued vìs a vìs traditional financial approaches to determine the price of vacant land. At the same time, this effort is the first one of this sort done for a Chilean city and perhaps for a Latin American city. In asking to the data what are the main factors affecting the probability that a site stays vacant, we find that those elements that increase either the uncertainty of profitability or the costs of developing a site have a positive impact on such probability. Of particular importance is a legal provision that set several sites currently vacant – or parts of them – as subject to eventual expropriation by the State.

J.E.L Classification: R14, C13, H23

Keywords: Urban vacant land, Infill development, Logit model

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1. Introduction

We can observe the phenomenon of vacant urban land in every single city in the world, even in those cities where land prices are extremely high. For instance Bartholomew (1955), Niedercon and Hearle (1963), Northam (1971) and Pagano and Bowman (2004) have shown that in US vacant land occupies, on average, about 20% of the urban area. Besides, we can see that this average has been relatively constant at least for the last 50 years. But why are there vacant urban sites? Schenk (1978) proposes two types of vacant land borrowing terms from labour economics, namely, structurally unemployed land and frictionally unemployed land. The former, structurally vacant land, could be the consequence of, among other things, ownership problems, lack of utilities, strict regulation, expected flood hazard, slope or foundations problems, odd-sized or odd-shaped sites left over in neighbourhoods where land was deeded in fixed sites sizes, small lots resulting from old subdivisions, and neighbourhoods externalities. On the other hand, frictionally unemployed vacant land would arise in the absence of perfect and costless information about present and future prices, quantities and qualities. Under these circumstances markets clear but have an equilibrium level of unemployed land. The idea underneath this concept is that the landowner must wait for the optimal moment to develop an investment project by maximising its present value. A key model to understand the latter source of vacant land is developed by Titman (1985), which provides a valuation equation for pricing vacant sites. Following previous literature on irreversible investment decisions Titman concludes that it is often optimal to delay the project's start. The basic intuition is that it may be advantageous to wait for additional information before deciding upon the exact specification of the investment project. Titman's results have important policy implications. The main one is that if the authority implements a policy to stimulate building activity, it may lead to a decrease in building activity if there is uncertainty about such policy's duration or its effect. This result is common in the literature on vacant land (see Evans, 2004) and implies that the existence of vacant land is not necessarily bad or a signal that the market is not functioning. Hence the authority must be careful and aware about the type of vacant land trying to correct. Otherwise, as Schenk (1978) indicates, attempts to reduce the amount of vacant land may be damaging. For instance if vacant land is frictional or held for future use, any attempt to speed-up building on it could lead to uses which in the long run are undesirable. In contrast, Ohls and Pines (1975) show that there are several cases where the existence of vacant land implies an efficient use of the resources. But if vacant land is structural then some intervention may be required. In this sense it is very important to identify the real causes of vacant land in a city in order to be able to take the correct policy measures.

Inspired on such a predicament, this paper attempts to shed light on the variables that drive vacant land in the County of Santiago, one of the most populous and important counties of the Great Santiago area, the capital of Chile[1]. In order to achieve this we follow the approach of random utility to build a Logit model that inquires on the probability that a urban site is vacant. Such an approach is novel in terms of its application in the vacant land literature and, to the best of our knowledge, it is the first time in which it is applied to Chilean – and even Latin American – data. More generally, our approach is different from previous literature that have focused on determinants of the price of vacant land using a financial approach[2].

In setting up the variables affecting the probability for a site being vacant, we have place special attention into separating those that would leave to

[1] It hosts the downtown area.
[2] For instance see Geltner (1989), Isakson (1997) and Cunningham (2006).

frictional unemployed land from those that would yield structural vacancy. In the latter, regulatory variables play a central role.

2. The Model

First we define a set of *N* landowners. The landowner "*i*" chooses between holding the land undeveloped or developing it. We assume that all landowners are equal. Hence the observed decisions of keeping the land undeveloped will depend on the land's characteristics. The equation (1) represents the indirect utility function:

$$U_{ij} = V_{ij}(X_i;\beta) + \varepsilon_{ij} \qquad (1)$$

"*j*" represents the decision alternatives, where *j*=1 if the decision is not to develop and *j*=0 if the decision is to develop a project. $V_{ij}(X_i;\beta)$ is the deterministic component of the indirect utility function, and depends on a vector of land characteristics, *X,* and on a vector of unknown parameters $,\beta,$ which has to be estimated. ε_{ij} represents the random component of the utility function. U_{ij} cannot be observed. However the revealed preferences theorem tell us that if the landowner "*i*" is choosing "1" it is because by making this choice he will maximise his utility. If we define Y_i as a discrete variable that represents the landowner "*i*"'s decision we know that if $Y_i = 1$ then $U_{i1} - U_{i0} > 0$, and if $Y_i = 0$ then $U_{i1} - U_{i0} < 0$. Therefore the probability of $Y_i = 1$ can be written as:

$$\Pr(Y_i = 1) = \Pr(U_{i1} - U_{i0} > 0) = F(X;\beta) \qquad (2)$$

If we assume that ε_{ij} follows a logistic distribution then the expectation of Y_i is:

$$E(Y_i) = \Pr(Y_i = 1) = M_i = \frac{e^{V_i(X_i;\beta)}}{(1 + e^{V_i(X_i;\beta)})} \qquad (3)$$

Applying simple algebra to (3) we obtain the odd ratio, i.e. the ratio of the probability of the desired event to the probability of the non-desired event.

$$\frac{M_i}{(1 - M_i)} = e^{W(X_i;\beta)} \qquad (4)$$

Finally, applying logarithms to (4) and assuming a linear specification for $V(\cdot)$ we obtain the Logit which is the natural logarithmic scale of the odd ratio.

$$Ln\left[\frac{M_i}{(1 - M_i)}\right] = X_i\beta \qquad (5)$$

Now, using (5), we can estimate the vector of parameters β to understand how the land's characteristics impact on the landowner's decision of keeping the land vacant. An important feature of (5) is that it allows us to compare the lands' characteristics on the same scale.

3. Data and Main Results

We have used a cross section sample of 4,885 sites (16% of the total) of the County of Santiago (the most important one in the Great Santiago area)[3].

According to this source of information, the percentage of vacant sites is about 2% ot total land in the County of Santiago and 10% in the whole city. It is interesting to note that these percentages are very low if we compare them with the average percentage of vacant land in US and other Latin American cities. For instance, Bartholomew (1955), Niedercon and Hearle (1963), Northam (1971) and Pagano and Bowman (2004) have shown that in US vacant land occupies, on average, about 20% of the urban area. On the other hand Larangeira (2004) shows that many Latin American cities have even higher percentages of vacant land[4].

Every record of the sample has information about the land's characteristics that we consider have an impact on the landowner's decision of keeping the land vacant. We classify them in three groups: the regulations that affects the site, the urban environment where the site is located and the specific site's characteristics.

To estimate the parameters in our model we have used the maximum likelihood approach. Using this technique we tried different specifications

[3] The sources of this information are basically the Municipality of Santiago and the Santiago Intendancy.

[4] Larangeira (2004) shows that the percentage of sites that correspond to vacant land in Quito (Ecuador) is 21.7%, in Guadalajara (México) is 26.6%, in Buenos Aires (Argentina) is 32%, in Guayaquil (Ecuador) is 39.4% and in Río de Janeiro (Brasil) is 44%.

and explanatory variable combinations. Finally, the specification with the best fit was the following one:

TABLE 1

Variables	Coefficients	
Constant	β_1	-5.421515
MT_METRO	β_2	-0.002184
MT_METRO^2	β_3	9.73E-07
SUP_EXP	β_4	18.79422
HAB_HA	β_5	0.007631
HAB_HA^2	β_6	-1.70E-05
CALIDAD_ED	β_7	4.451347
CALIDAD_ED^2	β_8	-3.506956
MT_AVERDE	β_9	0.002296
SUP_PRED_H	β_{10}	5.455812
SUP_PRED_H^2	β_{11}	-3.029649

The parameters are significant with 1% of significance.

McFadden R^2: 0.073

Let's now analyse how each of the variables that we identify affects the probability that a site stays vacant.

With respect to the variables corresponding to regulation, we considered the following ones: minimal site's surface allowed; constructability coefficient[5]; occupation coefficient[6]; maximum height allowed; a dummy variable that indicates if the site is in a zone defined as "typical zone",

[5] This norm regulates how many square meters can be built given a particular site's size.

[6] This norm regulates the site's surface that can be effectively used.

which implies that it has special regulation; a dummy variable that indicates if the site is in an area defined as "conservation area", which implies that it has special regulation; a dummy variable that indicates if the site is in a block where there is at least one listed building, which implies special regulation in that block; and the fraction of the site's surface that could be expropriated (SUP_EXP).

Among them, only the last one, *the fraction of the site's surface that could be expropriated* (SUP_EXP) was statistically significant and for that reason it remained in our specification. This specific regulation means that sites – or parts of them - are subject to eventual expropriation by the State, in order to expand the city infrastructure (streets, roads) in the future. However, many of these potential expropriations never materialized. The problem about this regulation is the uncertainty that it generates with regard to the effective size of the sites that are affected by it and the exact time in which the expropriation will take place, if ever. This uncertainty has an obvious implication on the profitability of an investment project to be undertaken to develop the vacant site. Following Titman (1985), this uncertainty may delay building activity. Accordingly, we would expect that SUP_EXP would have a positive impact on the probability of a site being vacant.

The positive sign of the estimated parameter in Table 1 indicates that our result is consistent with the theory. The larger the surface that could be expropriated, the higher the probability of the site being vacant

The high value of this estimated parameter and its high level of significance reveals that this regulatory factor is very important in determining the amount of vacant land that exists in the County of Santiago.

It is worth noting that this result could have been anticipated, if we would have directly observed the data of Santiago, were 20% of all the sites of the County of Santiago – or parts of them - are subject to this regulation. This percentage increases to 44% if we consider just the sites that are vacant. The latter suggests that this regulation has an important and positive impact upon the existence of vacant land, suggestion that we confirm with the estimated parameter of our model.

This result has important policy implications. Vacant land in the County of Santiago would be mainly caused by this strict regulation and could be classify as structural vacant land. This sort of vacant land could have been prevented if this particular regulation were not in place.

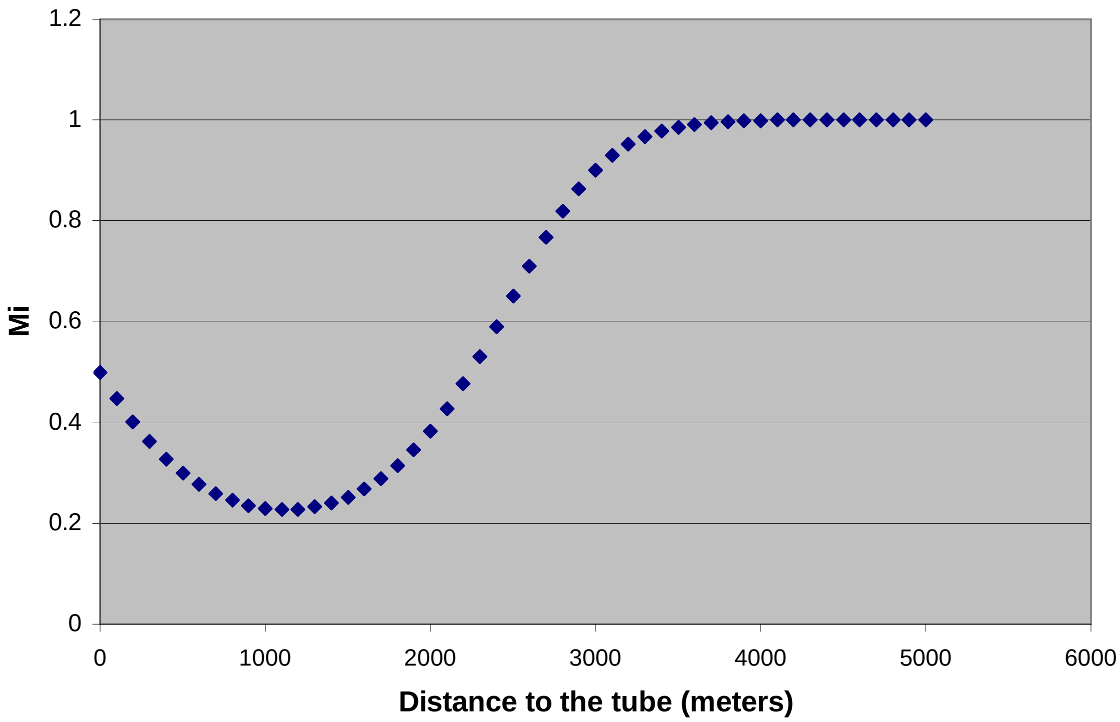
The obvious negative effects of this regulation were acknowledged by the authority, who changed it in the year 2004 by defining a precise duration of the potential expropriation areas. However, it is not clear if this would help to solve the identified problems. Anyway, this policy change does not show up in our results because the data we used are previous to the year 2004.

With respect to the variables corresponding to the urban environment where the site is located, we considered the following ones: the distance to the nearest subway station (MT_METRO); the distance to the nearest health service; the distance to the nearest school; the distance to the nearest park or green area (MT_AVERDE); the quality of edification in the block where the site is. It is an index that goes from 0 to 1, where a value of 1 corresponds to the highest level of quality (CALIDAD_ED); the density of the block where the site is located (HAB_HA); the distance to the nearest commercial area; variables that stratify people in each block based on household income (five quintiles); and the crime index in the block where the site is. Among them, only MT_METRO, HAB_HA, CALIDAD_ED and

MT_AVERDE were significant and for that reason they remained in our specification.

Concerning *the distance to nearest subway station* (MT_METRO) we expect that a greater distance of a site to the nearest subway station would imply a higher probability that the site stays vacant, because the site would be less attractive since its access to the rest of the city decreases. However, if we consider exclusively the effect of this variable by using MT_METRO and MT_METRO^2 we can see that within a radius of 1,100 mts. the closer the site is to the subway station, the higher the probability for it to be vacant. Nevertheless this situation changes when the sites is farther than 1,100 mts. In this case it is exactly the opposite (see chart 1).

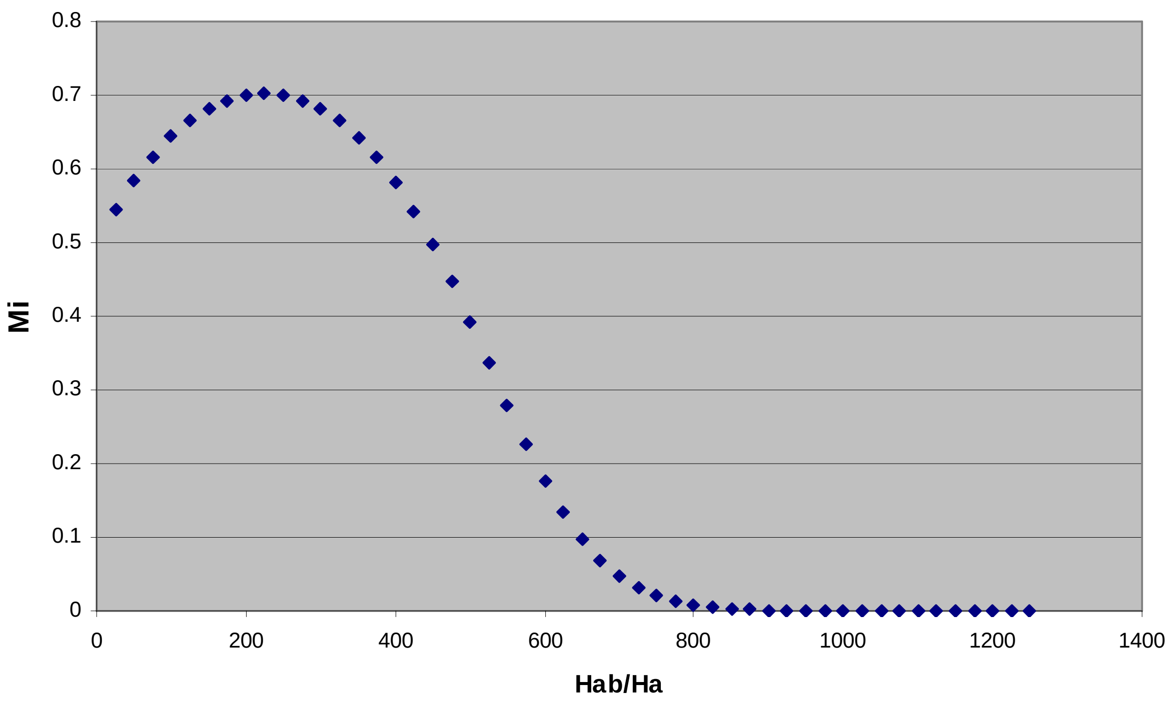
Chart 1: Distance to the nearest subway station impact on the probability of being vacant



The part of this result sounds counterintuitive. However, the explanation could rest on the fact that subway stations have some negatives externalities such as congestion and noise. Therefore, the benchmark distance of 1,100 meters could be interpreted as some sort of optimal distance to the subway.

In order to analyse the impact of *the block's density* on the probability that a site stays vacant we use HAB_HA and HAB_HA^2. A high density should be related to a high level of demand in this area. Therefore we could expect an inversely proportional relationship. We observe this result, by and large, for densities greater than 224 inhabitants per hectare (see chart 2). Before 224 the slope is slightly positive, almost flat, meaning no impact for small densities.

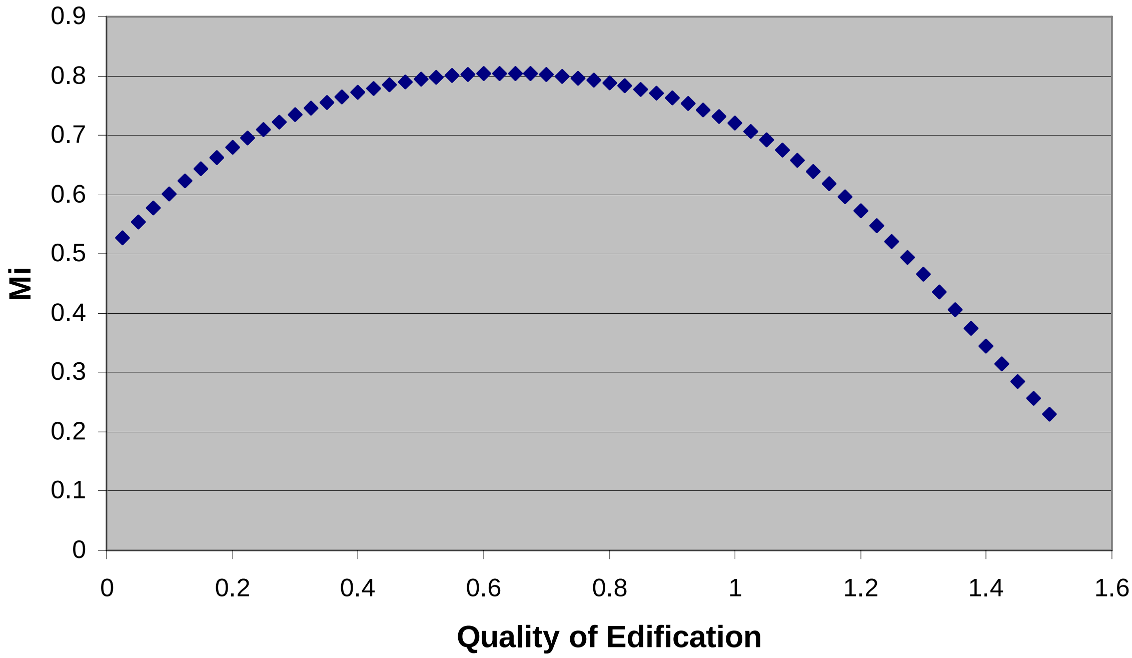
Chart 2: Block's density impact



With respect to *the quality of edification* (CALIDAD_ED) we can expect two different effects. First, the higher the quality of edification, the higher the demolition cost. Hence the impact on the probability of being vacant is positive, because it is difficult to incorporate in a particular project adjacent sites. On the other hand, a good quality of edification generates positive spillovers and then it motivates landowners to develop projects. This effect has a negative impact on the probability of the site being vacant.

We can see that when the level of quality is less than 0.63 the first effect predominates. Nevertheless for higher levels of quality of edification the second one dominates because the neighbourhood quality is so high that it increases the incentives to develop projects in such neighbourhood (see chart 3).

Chart 3: Quality of edification impact

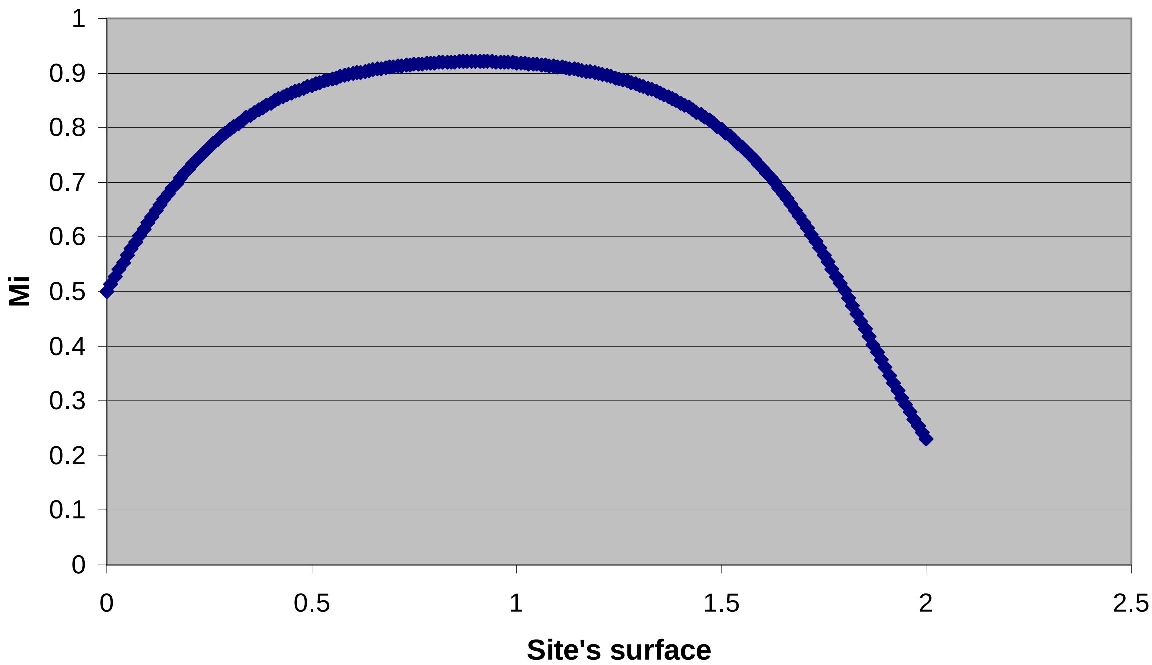


In terms of *distance to the nearest park or green area (MT_AVERDE)* we know that a park or green area increases the value of the land, therefore a proportional relationship should be observed. Hence the empirical finding, β9 > 0, is consistent with what we expected.

Finally, the following variables corresponding to the specific site's characteristics were considered: the site frontage and the site surface (SUP_PRED_H). As it turns out, only the latter was statistically significant.

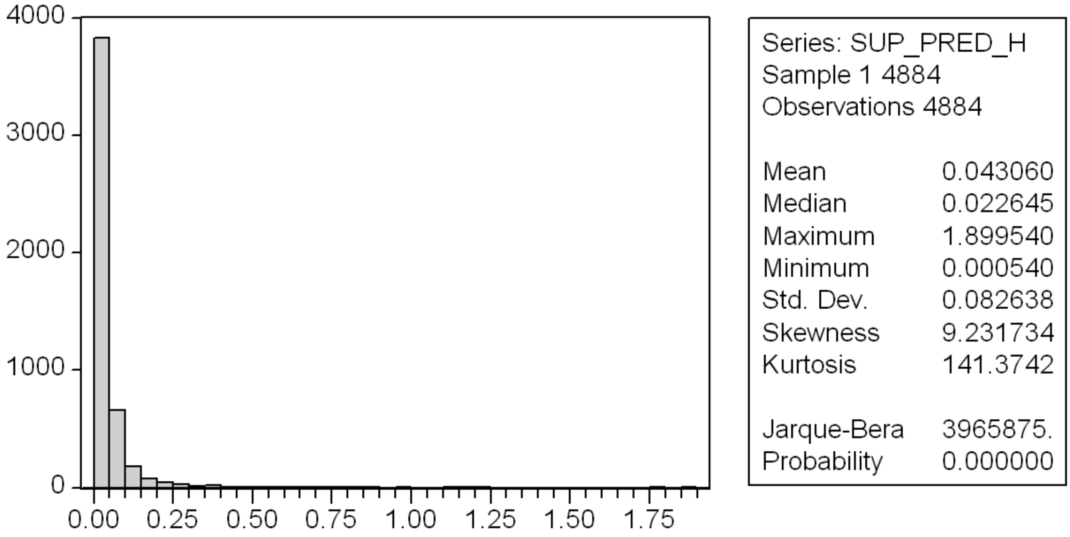
In the case of the *site's surface* ((SUP_PRED_H)) we do not have an unambiguous *prior* of what could the impact be. For this reason we are going to focus on the results themselves. We can see that 0.9 is the turning point (chart 4). Before it the site's surface impact is positive and for values greater than 0.9 the impact is negative.

Chart 4: Site's surface impact



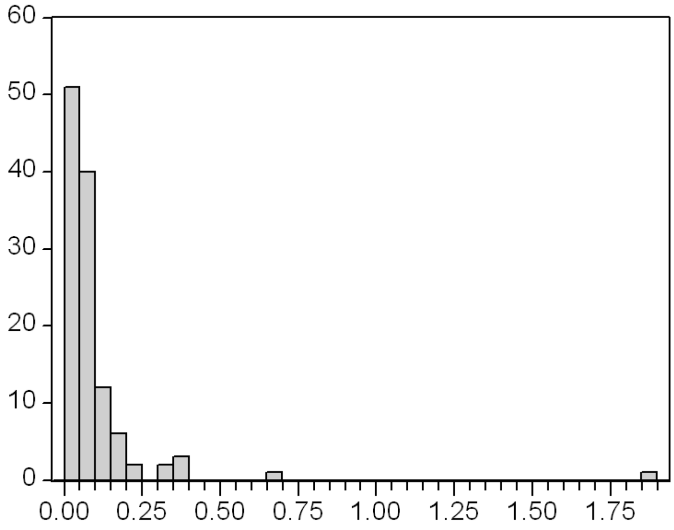
It is worth noting that there are just 6 sites with a surface greater than 0.9 hectares in the sample (see histogram 1), and among them just one is vacant. Therefore for our analysis we considered just those sites with a surface less than 0.9 hectares.

Histogram 1: Sites surface for the whole sample



Using this "sub-sample" we can see that the larger the site, the higher the probability of it being vacant (see chart 4). As a matter of fact the vacant sites have, on average, a surface greater than the developed ones (see histograms 2 and 3).

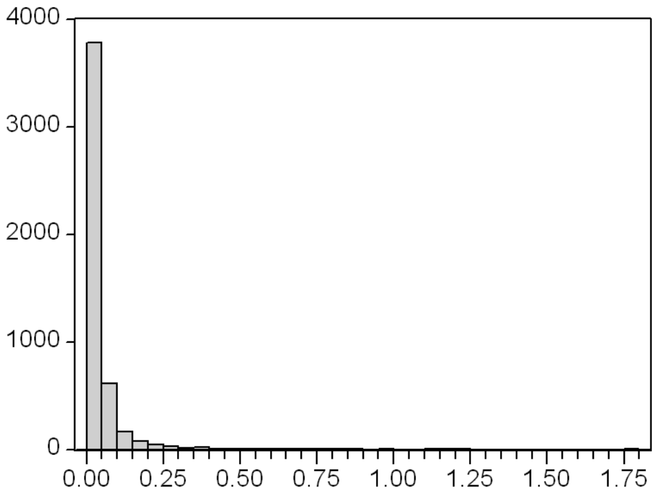
Histogram 2: Vacant sites surface



Series: SUP_PRED_ERIAZO
Sample 1 118
Observations 118

Mean	0.098717
Median	0.056735
Maximum	1.899540
Minimum	0.014360
Std. Dev.	0.190478
Skewness	7.600044
Kurtosis	69.85124
Jarque-Bera	23108.97
Probability	0.000000

Histogram 3: Developed sites surface



Series: SUP_PRED_NO_ERIAZO
Sample 1 4766
Observations 4766

Mean	0.041682
Median	0.022115
Maximum	1.799000
Minimum	0.000540
Std. Dev.	0.077645
Skewness	8.388166
Kurtosis	116.5554
Jarque-Bera	2616589.
Probability	0.000000

The explanation of this phenomenon can rest on the fact that a greater surface implies that the site has no subdivisions. In general a site has no subdivisions if the demand for land in that area is low. Consequently there are no incentives to develop projects there and the landowner prefers to keep the site vacant.

It is important to note that all the significant variables, except for the regulation variable, have to do with frictional vacant land. Accordingly, attempts to reduce vacant land which can mostly be explained by those variables may be damaging.

4. Conclusions and Policy Implications

The objective of this paper has been to shed light on the causes of vacant land inside an important and populous county part of a large Latin American capital city, Santiago of Chile. In order to achieve this we have employed the Logit approach and a rich database. This approach is different from previous literature that has focused on the determinants of vacant land prices. Our results indicate that the variables that have impacts on the probability of land being vacant are: the distance to nearest subway station, the surface that could be expropriated, the block's density, the quality of edification, the distance to the nearest green area and the site's surface. In general we found that those variables that could increase the site value have a negative impact on the probability of land being vacant. On the other hand those variables that could reduce the profit of an investment project or that could increase the uncertainty of profitability of an investment project have a positive impact. Our results are consistent with the theoretical literature. Besides, we found that in the County of Santiago the variables that explain vacant land are mainly connected with frictional vacant land. However it is worth noting the statistical relevance of the variable "surface that could be expropriated", a regulatory factor that has to do with structural vacant land. This suggests that the authority should be careful with the implementation of regulations and policies that may increase uncertainty about the profitability of an investment project, because this could diminish building activity and increase the amount of vacant land in a city. Additionally, the authority must be aware about the kind of vacant land that it wants to confront, structural or frictional, if it is willing to take the correct measures about it. As we explained, if the vacant land is frictional or held for future use, to force it into use quickly could push it into uses which in the long run are undesirable, but if it is structural then some intervention may be required. However, not every intervention is adequate in this case. It should be in the form of going directly to solve the problem that is impeding the land market to function well. For example, in the case of land uses that imply negative externalities on the surrounding area and a consequent delay in the development of it, like suburban trains or a rubbish dump, the policy implemented by the government should go in the direction of making this land uses to internalise the negative externalities that they generate and this will increase development in the surrounding area without the necessity of additional measures.

On the other side, independently of the causes of vacant land, the existence of it may imply negative externalities on the surrounding area, like dirtiness or potential crime and in this sense some intervention is required. However, also in this case not every intervention is adequate. It should go in the direction of making vacant land internalise the negative externalities that it may generate.

For instance the policy implemented in Santiago, Chile, to treat vacant land is to overtax all the sites that are vacant in order to penalize the delay in their development. However, this policy treats all of them in the same way, without distinguishing the source of vacant land or the possible negative externalities that it may generate. Instead a more adequate policy would be to leave frictional vacant land as it is, to solve directly the problems that may be causing the existence of structural vacant land and to impose a fine to those vacant sites that effectively generate negative externalities with an amount proportional to it.

Finally, it is important to mention one still open question that would be interesting for future research. This is about the possible existence of a "natural" or "normal" rate of vacant land inside cities. Although we have identify for the County of Santiago those variables that cause frictional vacant land, it is still pending the calculation of the amount of land that is vacant for this reason and which could be called a "natural amount of vacant land" in the sense that its existence can be considered a natural component of efficient urban growth rendering government intervention unnecessary.

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