Analysis of Simultaneous Equations for the Housing Market in Colombia 1998-2017

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Abstract

This paper discusses some elements of the housing market in Colombia in recent years. It is a reflection on housing as satisfier of needs. It estimates supply and demand equations, including an estimation simultaneous equations. This procedure allows to estimate the simultaneity that occurs in these equations. The article verifies the benefits of the models and makes a comparison between the techniques used.

Keywords: Housing market, satisfactory, simultaneous equations model, simultaneity

INTRODUCTION

Econometrics is the fundamental tool of economic analysis for the empirical confrontation of economic theories. It seeks to corroborate hypotheses by specifying models and obtaining results that revalue or refute these theories in a space of time or at a point in time. For this, econometric methods have used the contributions of statistics, mathematics and economic theory to quantify economic phenomena. Because economics is a social science, its method of study lacks laboratory and experimentation, similar to those used in the natural sciences. However, econometric methods have been largely responsible for filling this gap and allowing a positive character to economic science.

Within the process of econometric modeling four stages are distinguished, the first stage is perhaps the most important of the process, here we take an economic theory that allows us to formulate certain hypotheses that will later be tested. The importance of this first stage, not only lies in the theoretical justification of the model, but in the determination of the variables that will intervene in it, as well as its temporal or spatial definition. Although it is generally part of a predetermined model by theory, it is possible to design models in which the variables do not necessarily coincide with those of the theoretical model. Although this may be seen as a deficiency of the process is not necessarily so, sometimes do not have the necessary information and it is imperative to go to proxy variables or new variables, which at certain times to fill the missing and allow approaching the phenomenon under study.

Once the model is specified, it is sought to estimate the coefficients that explain the relation of the previously specified equation (s). At this point, different linear and non-linear estimation forms are used. In this respect, the estimates of ordinary least squares, maximum likelihood and estimation by the generalized method of moments stand out. Later in the third stage, it is sought to verify all the assumptions on which the estimation methods are based, which can be discriminated in two types, those related to the structure of the model and those related to the errors. Finally, we proceed to the use of the model, which is sometimes built to predict, or to simulate or perhaps to make a historical analysis of the behavior and the relationship of certain phenomena.

In this order of ideas, the intention of this work is to make a series of applications from econometric tools described above and estimate through a series of models, the determinants of the housing market from different instrumental approaches for Colombia, during the period 1998-2017 [1]. An analysis is made based on the behavior of the prices of the housing market, the income of the families, the level of unemployment, the mortgage interest rate and the wealth of the households to explain the demand, as well as the costs of the construction of housing, the DTF as a representation of the opportunity cost, and market prices to explain the offer, so that the degree of response of the variables of interest can be identified when the explanatory variables of the model are altered.

The article is organized in four parts. The first one does a reflection of the house as a satisfactory good of needs, in which some reflections of the theory of development are related to human scale, as a frame of reference that supports and justifies the completion of this document. The second one has an estimate of the market for the supply and for the demand. In the three part, it presents   an estimate of the housing market from a model of simultaneous equations. Finally, results and conclusions are presented.

HOUSING AS A SATISFACTOR OF NEEDS

Housing is possibly the biggest investment many homes make throughout their lives [2]. A middle-income household can last for up to thirty years, however, not all households can do so, since the chances of a low-income household having access to a housing loan are very low. These households meet their housing needs through the lease, because they lack the minimum conditions to think about owning their own home [3].

General Comment No. 4 of the Human, Social and Cultural Rights Committee (DHSC Committee), [4] defines the fundamental attributes of adequate housing. These attributes refer to: legal security of tenure, availability of forecast, materials and infrastructure, bearable costs, habitability, affordability, location and cultural adaptation. In our environment, these considerations are in default of being met

in their entirety, as it is evident that the existence of a housing deficit such as that which occurs in Colombia does not contribute to improving the quality conditions that the inhabitants of a society deserve.

The theory of development on a human scale considers actions aimed at solving fundamental human needs as paramount. As stated [5]: "(...) The person is a being of multiple and interdependent needs. Therefore, human needs should be understood as a system in which they interrelate and interact. Simultaneities, complementarities and compensations are characteristics of the dynamics of the process of satisfying needs. "

Similarly, [5] considers that from the point of view of the identification of the scale of basic human needs should be distinguished between the needs and needs satisfiers, that is, a satisfactory is one that can contribute to the satisfaction of diverse needs. In this context, housing may be identified as satisfying needs and not as a need, to the extent that it stimulates and allows the satisfaction of other needs. If housing is understood as satisfying needs, [5] it considers that the satisfiers: "(...) define the dominant modality that a culture or a society prints to the needs, (...) they are not economic goods available but they are referred to everything that by representing ways of being, having, doing and being, contributes to the realization of human needs, (...) can include, among others, forms of organization, political structures, social practices, subjective conditions, values and norms, spaces, contexts, behaviors and attitudes, all in a permanent tension between consolidation and change ".

Therefore, housing is understood as satisfactory for the population, where scenarios are dimensioned and tenure acquires an important factor depending if it is a home of your own, leased or any other way.

In this context, [6] the role of the owner of the house is important, apart from the other foundations of the characteristics of a dwelling, especially the one that corresponds to security and trust. This is how these particular attributes generate an important connotation for low- and middle-income households, given that housing has a different meaning for this sector than it would have for higher income sectors.

It can be considered that for lower income sectors, housing is a good of greater connotations than for the higher sectors. That is to say, for the low-income sectors, apart from constituting a satisfying need, to the extent that it guarantees a ceiling that allows other needs to be met, it is accompanied by a diverse range of opportunities, ranging from the consolidation of the family economic heritage. that very possibly in the future will correspond to a transfer to the heirs and the possibility of obtaining new income from income from leases of some section of the house (rooms, garages, commercial premises), up to the backing that enables the house to serve as collateral for various commercial operations such as credit or as references among others [6].

Under the same line, housing as a condition of ownership can be taken as part of the capital inventory of a country, which is an important asset for the development conditions of a country.

In this order of ideas, [7] considers that: "(...) When one focuses attention on the title of ownership of the house, for example, and not in the house itself as a tangible object, it has automatically taken the step of physical world to the conceptual universe where capital lives. He is reading a representation that focuses on the economic potential of the house after discarding the confusing clear-dark of its physical aspects and its local environment. Formal property forces us to think of the house as an economic and social concept. It invites us to perceive the house as something more than mere refuge - and therefore active inert - and to see it as living capital. " Returning again to [5] from the perspective of development theory on a human scale, the analysis of housing considers the attributes through which the satisfaction of axiological and existential human needs takes place, which, through the development of later theorical approaches transcend their physical, psychosocial and cultural categories, framed in a conception that also transcends the theory of human development.

In the same context and following [6] and taking as reference the thought of Amartya Sen: "human development provides a normative element for action; Its goal is to promote the quality of life, combining real freedom to choose one's own life projects and fair distribution and capacities to achieve it, without forgetting that income is a very important element but it is not everything in people's lives. Income is a means but the end is human development. " So we can establish that all the problems surrounding housing are perceived from a position around freedom in the sense in which development equals freedom.

In this order of ideas, the fact of wanting to find, know and interpret the determinants and the different references that explain the house is justified, every time in doing so, interesting conclusions can be found that allow the design of policies that promote the improvement of the quality of it and at the same time contribute to the reduction of the housing deficit that characterizes the country.

ESTIMATION OF THE DETERMINANTS OF THE HOUSING OFFER

The model

In this part of the work, the supply elasticities of new housing are estimated, in relation to market prices, construction costs and other variables that may affect the supply of new housing, such as the opportunity cost, which makes it possible to identify the degree of response of the variable of interest when the explanatory variables of the model are altered.

In (Clavijo et al., 2004) the offer is represented from

$$H^S = S(P_H, \bar{H}, S) \qquad (1)$$

Where Hs represents the housing offer, PH, the price of the same H the stock or inventory that affects the new houses) and S other variables that can displace the supply curve.

For this section of the work, secondary data taken from DANE and Banco de la Republica were used with the interest of identifying a relationship over time between the supply of new homes and their main determinants from the following functional form.

$$Supply = \beta_1 + \beta_2 IPVN + \beta_3 DTF + \beta_4 ICCVN + \mu_t \quad (2)$$

Where:
Supply = new housing offer (housing licenses), IPVN = New housing price index, DTF = Term deposit interest rate, ICCV = Housing construction cost index, μt = Term of disturbance

THE DATA

A study period was taken corresponding to data from 1998 to 2017. The data worked correspond to data measured by important institutions in the country (DANE, BANREP, DNP, CAMACOL) and in the models are managed in logarithms of the original variables with a quarterly periodicity. In the same way, some series were deflated to transform nominal values into real ones, as was the case of the mortgage interest rate and the new housing index, for which the CPI was used as a baffle based on the fourth quarter of the year 2000.

The demand for housing is a variable that is not commonly measured, however, the studies that are done in this regard use a proxy that corresponds to the licensed meters (Chart 1) for housing construction, since it is assumed that the licenses approved for housing are used and in the same way once it is built, there is not much time spent housing in stock [8]. Here it was decided to include the footage by building according to approved building licenses and only new housing (VIS and non-VIS) was taken into account. Monthly data that were quarterly were taken.

Figure 1

Source: National Administrative Department of Statistics (DANE)
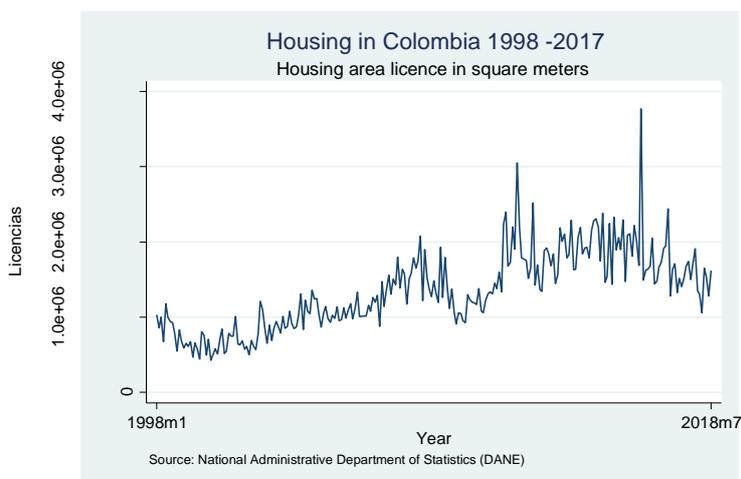
In turn, market prices were taken from the DANE calculations for the prices of new housing. The price index of new housing corresponds to the indicator that DANE measures from the building census; To be able to include it in the model, it was

deflated with the 2000 CPI. In this case, a direct relationship between these two variables is expected, which should show increases in the supply as prices increase as it encourages a higher production of housing.

Figure 2

Source: National Administrative Department of Statistics (DANE)
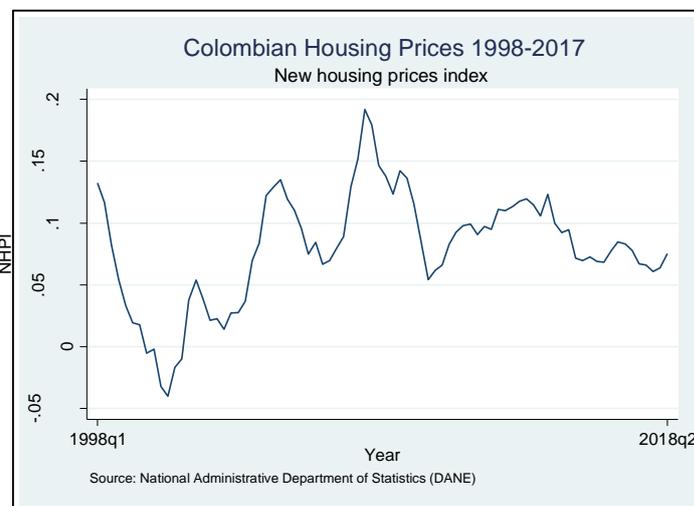
In order to have a variable that included costs, the construction cost index for single-family and multifamily housing was used, which were constructed with base year December 1989. Here an inverse relationship between construction costs and housing supply is expected.

Figure 3

Source: National Administrative Department of Statistics (DANE)
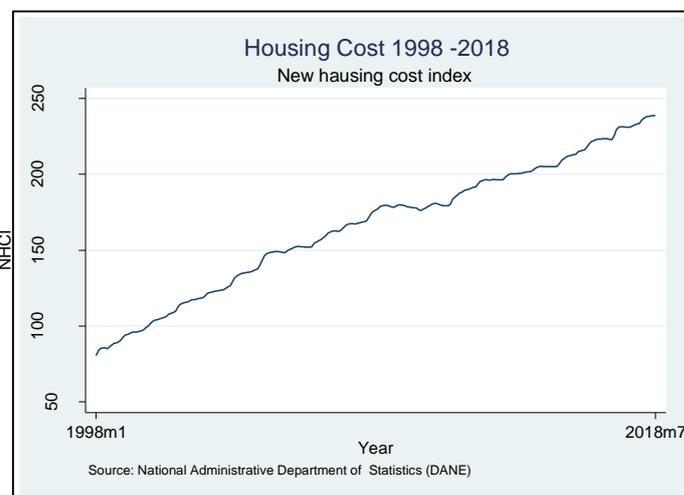
On the other hand, a builder takes into account the opportunity costs of building new housing, looking for an approximation to these costs, it was decided to take the real DTF to 90 days, which can be an adequate variable to represent this cost in the sector of the building. It is assumed that the DTF represents a good measure that affects the decision to offer new housing or not. When taking it as a cost, an inverse relationship is expected with respect to the new housing offer.

Figure 4
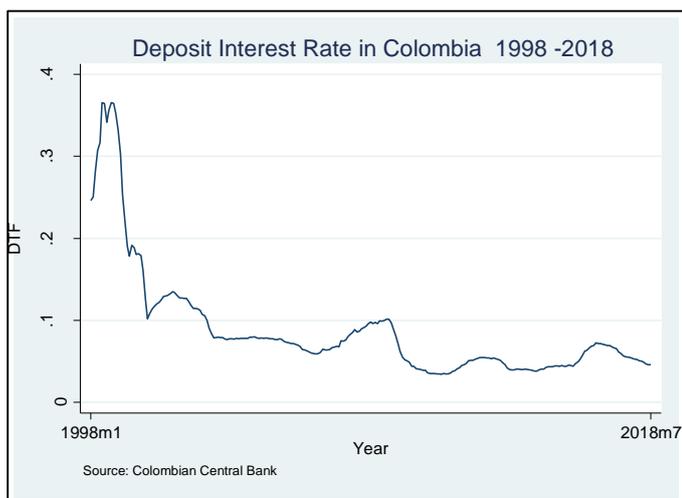
It is assumed that the DTF represents a good measure that affects the decision to offer new housing or not. When taking it as a cost, an inverse relationship is expected with respect to the new housing offer

ESTIMATION OF THE OFFER AND DEMAND OF HOUSING IN COLOMBIA: AN APPROXIMATION FROM AN ESTIMATION OF A SYSTEM OF SIMULTANEOUS EQUATIONS

The estimation methodology used in this part of the work corresponds to a methodology different from that of the first two and consists of estimating a system of two equations at the same time by the method of the MC3E (least squares in three stages), in which it is possible to calculate the residuals, estimate the variance and covariance matrix, and then use generalized least squares feasible to the model [9]. It is assumed that this model is more efficient than the OLS model if the model specification is correct and at the same time can have equal efficiency if the assumptions of no contemporary correlation are met, nor heteroscedasticity between the errors in each equation.

The problem of endogeneity

The problem of endogeneity [10] arises when one or more variables are determined together with the variable explained. This is a problem of many estimates in economics and a specific example is presented when estimating equations of supply and demand, where the price can appear both as explanatory and as explained in each equation.

If we have:

$$Y_{1t} = \alpha_0 + \alpha_1 Y_{2t} + \alpha_2 Z_{1t} + \alpha_3 Z_{2t} + \varepsilon_{1t} \quad (5)$$

$$Y_{2t} = \beta_0 + \beta_1 Y_{1t} + \beta_2 Z_{1t} + \varepsilon_{2t} \quad (6)$$

In this system of equations an example is shown in which ($Y1t$) is determined from Y2, Z1 and Z2. However, the care that must be taken is that in order to estimate these equations, the system must be well identified or over-identified, since if it is sub-identified it is not possible to calculate the solution to the

system. Hence, we must meet two conditions that allow us to determine if the system is. These conditions are known as the condition of order and the condition of rank in which the following is established:

That the number of exogenous variables excluded from the equation is greater than or equal to the number of endogenous variables minus one included within the equation. .Or that the number of exogenous variables excluded from the equation is at least equal to the number of endogenous variables included in the equation minus one [9].

Therefore you have to:

If ki ≥ gi -1 it can be said that the equation is overidentified
If ki = gi -1 it can be said that the equation is identified
If ki <gi -1 it can be said that the equation is sub identified
The management of instruments that allows to consider the endogeneity of the estimation and to do it by least squares in two stages or in three stages. Likewise, they can be handled. A sub identified equation does not allow an estimate. So this rule must be confronted when you want to estimate a model of simultaneous equations.

The main aspects of methodological order and results obtained are presented below.

The model

Definition of the main determinants of the housing market in the housing market in Colombia from supply and demand:

$$Q_o = B_{11} + B_{12} Price + B_{13} Costs + B_{14} Oportunity\ cost + \varepsilon_1 \quad (7)$$

$$Q_d = B_{21} + B_{22} Price + B_{23} Weath + B_{24} Incom + B_{25} Unemploym + \beta_{26} tiH + \varepsilon_2 \quad (8)$$

Where: Q = Square meters of buildings according to licenses, Price = Index of new housing prices, Costs = Construction cost index, Opportunity cost = 90 day DTF, Wealth = IGBC, Income = Real salary income of the industry, Unemployment = Unemployment rate 7 cities, Tih = mortgage interest rate.

As is known, the price and the amount of equilibrium in a market are determined by the ratio of supply and demand curves, so it is not difficult to observe that both price and quantity are dependent variables together. Due to this dependence it is not possible to suppose that the price variable is independent of the errors, which violates an important assumption of the classical linear regression model [11]. If this factor is not considered, a simple uniecuational estimate by ordinary least squares provides inconsistent and biased coefficients. For this reason, estimates such as these should suppose a simultaneity problem in the system that should be considered at the time of estimation. The alternative is to look for instruments that filter the price effect on demand and limit the correlation that this variable has with model errors [12]. When you have a system like this, there are several alternatives according to the system's identifiable conditions, that is, according to whether the system is sub identified, identified or overidentified, which in turn allows different mechanisms to estimate the system considering that there is a relationship

between some of the explanatory variables and the term of disturbance. In this line you can choose to estimate the system by indirect least squares, especially when you have exact identification or you can consider other tools as an estimate for maximum verosimility with complete information.

Within the approach of simultaneous equations can be expressed the reduced form of the system that for the present case corresponds to the mechanism of market classification and assuming that the endogenous variables are quantity and price must be in condition of equilibrium:

$$Qd = Qo \tag{9}$$

$$\beta_{11} + \beta_{12}price + \beta_{13}Cost + \beta_{14}Opportunytycost + \mu_1 = \beta_{21} + \beta_{22}Price + \beta_{23}Wealth + \beta_{24}Income + \beta_{25}Unemployment + \mu_2 \tag{10}$$

$$Price = \Pi_1 + \Pi_2 Cost + \Pi_3 OpportunityCost + \Pi_4 Wealth + \Pi_5 Unemployment + \Pi_6 Income + v_t \tag{11}$$

Where the coefficients represent the coefficients of the reduced form, that is, the equation in function only of explanatory variables.

In a model like this which could be assumed to be overidentified given the number of independent variables that make up the system of two endogenous variables, a two-stage or three-stage estimate can be used that considers the endogeneity of price and quantity within the estimate. These methods allow estimating one or several equations of the system, so they are very useful mechanisms in practice.

RESULTS

Testing endogeneity in the system, a version of the specification test is applied [13]. Here an estimate for the reduced form is run, then the errors are obtained, to run a regression for Qt including the calculated errors of the reduced form.

Figure 5

Vardependiente	lnlicencias	
Variable	Coeficiente	estadístico t
lnprecio	1.542	4.47
lnicc	-0.92	-0.86
lndtf	-0.35	-5.09
error	-1.29	-2.41
		Probabilidad
D.W	1	
SW	0.994	0.991
Test White	8.39	0.86
F	12	0
R2	0.46	

Source: Authors

The coefficient that accompanies the error variable turns out to be significant at 5%, for this reason there is no evidence to

reject the hypothesis of simultaneity in the system, that is, the price variable is an endogenous variable and should be considered as such.

Once it proved the existence of simultaneity, it is necessary to think of a methodology like the one proposed, that is, to perform a least squares estimate in three stages in which the need to include instruments for the price variable is considered, which is directly the one that generates problems of endogeneity in the system.

To determine the elasticity, the model that implicitly considered the problem of endogeneity between price and supply was estimated. From this estimation we obtained the coefficients that represent the degree of response of the variable explained to percentage changes in the explanatory variables

Table 5
Estimation of the determinants of supply by MC3E

Ecuación de oferta				
Coef.	Std.	Err.	z	P>z
Lnlicen				
Lnprecio	1.0347	0.3419	3.0262	0.0021
lncostos	-0.8449	0.5211	-1.6213	0.0562
Lndtf	-0.2151	0.1124	-1.9135	0.0312
_cons	10.164	1.6481	6.1673	1.1E-07
R-sq	0.4191			
chi2	44.69	S.W	0.9823	
P	0	Dw	1.68	

Source: Authors

The results presented are consistent with the expected signs and the t statistics are significant at 10% for the offer, in the same way the assumptions of the basic regression model are fulfilled. In this first equation it is verified that the results are more consistent and contrary to that found in the individual estimate if it is found that the price is elastic to the supply of new homes, the construction costs as well as the opportunity cost are not but if they affect the decision to offer new homes

Figure 6
Estimating the determinants of demand by MC3E

Ecuación de demanda				
Coef.	Std.	Err.	z	P>z
lnlicen	-0.90816	0.295	-3.069	0.003
lndesemp	-0.42405	0.219	-1.933	0.059
lnigbc	0.138388	0.069	1.983	0.053
lnsalarios	1.214008	0.624	1.942	0.051
ltih	-0.27175	0.143	-1.892	0.065
_cons	0.541294	2.863		
R-sq	0.8111	S.W	0.974	
chi2	246.46	Dw	1.74	
P	0			

Source: Authors

The second equation is significant at 10% for all the coefficients, it is highlighted from this equation that the signs obtained are those expected according to the theory. It is also found that the variables are significant, the only higher than 1 is the income, the other determinants from the demand side do not show that there is an overreaction of the same to changes in their explanatory because these coefficients are inelastic.

CONCLUSIONS

Housing represents an important satisfaction of needs, given that their tenure or non-possession mobilizes in the individual a series of emotions and affective states in which security and trust ratify family ties, identity and belonging.

Access to a home by a household is a situation that within the society ends up deriving from a set of socio-economic factors. Among them are the assets that the family possess (wealth), its debt capacity, the positive relationship between its salary and its ability to save a percentage of it, the relationships established with the financial sector as well as the expectations of maintaining a job at medium and long term. Such conditions undoubtedly pose serious difficulties for those whose income does not provide them with sufficient capacity to access the financial conditions demanded by the market.

The importance of the housing market from the point of view of the need it covers, by acting as a satisfying element of needs and by constituting itself as a multiplier element of growth and economic development are justifications for the design of policies to improve the quality of housing. Housing and the conditions of access to it.

From the different applied estimation methodologies, the most robust and with the best results consistent with economic theory, corresponds to the estimation of a least squares model in three stages since it allows to correct the bias in the errors obtained from the simultaneity of the equations where the market price appears as an explanatory variable.

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