Comments

Raquel Bernal: In this paper, the authors seek to evaluate the effects of the cross subsidy–stratification system for public utility services on housing prices in Bogotá, Colombia. In addition, they use their estimates to assess the extent to which the distortions in housing prices associated with the subsidy–stratification system affect final subsidy beneficiaries. Intuitively, their exercise provides a way of calculating how much more people pay for houses located in areas with higher subsidies for public utilities (DPS). Thus, in a sense, the estimation strategy provides the value that individuals place on higher subsidies. Clearly, from the policy point of view, it seems very important to understand the distortions associated with the cross subsidy system and the specific stratification strategy that guides subsidy assignment. From both these perspectives, this paper is an important contribution.

The basic estimation strategy is to estimate a relatively standard hedonic price model in which public utility subsidies received or paid by a given dwelling have an effect on the price of the house, controlling for a variety of observed characteristics of the house and the neighborhood. The key issue dealt with in the paper is the endogeneity of the subsidy in such an equation. In other words, estimating the causal effect of DPS subsidies on housing prices is difficult because houses that receive high subsidies are located in lower socioeconomic strata (that is, poorer neighborhoods) and thus are associated with lower prices. Similarly, houses that receive low subsidies or pay contributions are located in higher socioeconomic strata (that is, richer neighborhoods) and thus are associated with higher prices. Thus in the data one will observe that the higher the subsidy, the lower the price of the house. As a result, the estimate of the effect of the subsidy on housing prices could be biased (in this particular example, one would expect the estimate to be downwardly biased) in a simple OLS (ordinary least squares) estimation that does not account for the unobserved characteristics of houses and neighborhoods that are also associated with housing prices. The critical issue is, then, that all

relevant characteristics pertaining to house, neighborhood, and stratum are not observed or measured. Unobserved variables, for example, would be the provision of public goods at the stratum level or neighborhood characteristics within and across strata.

To deal with this issue, the authors implement a type of regression discontinuity design (RDD) by taking advantage of the stratification system by which households are assigned to one of six socioeconomic strata that are then used to target differential subsidies for public utility services. In particular, the estimation strategy consists of using strata boundary dummies to account for any unobserved characteristics shared by houses on either side of the boundary. Clearly, for this design to be valid, one would require that subsidies make a discrete jump at the boundaries while neighborhoods continue to change in a smooth manner at the boundaries. Intuitively, the authors claim that while there is significant heterogeneity across strata and, as expected, homogeneity within stratum the location of the exact boundaries can be arbitrary to a great extent because a very large number of dwellings were assigned to very few groups (six in total). Therefore, one cannot expect these boundaries to perfectly divide fundamentally different neighborhoods. Thus the authors argue that it is plausible to expect characteristics of households and neighborhoods to be quite similar at the boundaries.

However, one must be aware of the fact that the key assumption of the regression discontinuity design would be plausible in cases in which boundaries are determined according to characteristics uncorrelated with the independent variables in the hedonic price equation (and, in particular, the subsidy, which is the variable of interest) and the unobserved error term. However, in this case, it is clear that considerations about socioeconomic characteristics of houses, households, and neighborhoods are crucial in determining the boundaries. The results reported in the paper indicate that, in fact, even for houses located very close to the boundary, at least 50 percent of the observed characteristics of dwellings are statistically significantly different on both sides of the boundary. These results might suggest that the stratification strategy does in fact successfully take into account differences in households to set the boundaries.

In table 8, the authors report a summary of their findings. In particular, the elasticity of housing prices to energy subsidies goes from 0.0270 in the OLS estimation to 0.0363 in the estimation with 500-meter boundaries.[1] This

1. The estimated elasticity is 0.0297 if, in addition, one uses instrumental variables to correct for measurement error present in the stratum reported by individuals.

implies that OLS produced an *underestimated* value of the effect of subsidies on housing prices, although the difference between the two estimators is not statistically significant. On the other hand, the effect of water (and sewerage) subsidies on housing prices goes from 0.0331 in OLS to 0.0258 with 500-meter boundaries (and 0.0295 with boundaries and instrumental variables). In other words, OLS *overestimated* the effect of water subsidies on housing prices. Yet again, the difference between the two estimators is not statistically significant.

Two things are worth emphasizing about these results: the OLS bias for energy subsidies and that for water subsidies go in opposite directions and the difference between the OLS estimate and the estimate with stratum boundaries is not statistically significant (for energy and water subsidies). On the one hand, the latter finding could suggest either that the proposed strategy does not handle the endogeneity issue adequately or that there were no endogeneity issues to begin with. Unfortunately, there is little discussion in the paper about the expected direction of the bias and the RDD results in this sense. On the other hand, the former finding might suggest that the explanatory variable of interest—the subsidy for public utilities—is not appropriately measured and might be capturing other dimensions of heterogeneity (which, in addition, differ by type of utility service) that are not fully captured by the strata boundaries.

In particular, note that the explanatory variable is calculated as the total monthly subsidy (contribution) received (paid) by the household. That means that the subsidy variable captures both: variations in prices associated with the cross subsidy structure and variations in prices associated with differences in demand. In other words, a high subsidy amount (the key explanatory variable) might be due to the subsidy schedule, that is, the subsidy amount per unit or the total demand for that particular public utility. In fact, in figure 1 and tables 3 and 4, the authors show that there is significant variation in monthly subsidy amounts within stratum, which suggests significant differences in demand even within stratum.[2]

The identification assumption in RDD requires that the only difference between houses at each side of the boundary be that houses located to one side are subject to a given intervention and the ones on the other side are not (or are subject to a different intervention). In this case, however, the intervention S (subsidy) is a composite of the intervention per se, that is, the differences in DPS price associated with the cross subsidy structure and differences

2. Recall that all housing units within one stratum face the same subsidy (or contribution) schedule by the public utility service.

in demand that exist even conditional on observed characteristics of houses and neighborhoods. So, for example, if households that demand more utility services are better off, presumably living in better houses (in dimensions that might be unobserved for the researcher), then the effect of the subsidy on housing prices might be upwardly biased and the boundary dummies can be controlling for that type of heterogeneity.[3]

An interesting component of the paper consists of using the estimated elasticities to assess the effects of subsidies on final beneficiaries. In particular, the authors compare the net present value of average annual subsidies (by utility service) with the change in housing prices due to a 100 percent change in the subsidy, with the objective of evaluating how much of the subsidy is really appropriated by the beneficiary household. These results are presented in table 9. Using a 10 percent annual real interest rate, the authors find that the DPS subsidies are transferred almost entirely to housing prices. The rationale behind this policy experiment is that a 100 percent change in the subsidy is equivalent to moving from "no subsidy" to "subsidy," that is, it is equivalent to changing stratum.

Although this is an interesting thought experiment, it is unrealistic in the sense that not every move between any pair of strata is associated with a 100 percent change in the subsidy (or contribution) that the household receives (or pays). In other words, the percentage change in the subsidy amount received (or contribution paid) associated with a move crucially depends on the origin and the destination. One way to do this more accurately is to calculate the percentage difference in *average* subsidies (contributions) received (paid) by households in different strata and to use the estimated elasticities to assess the effect of each move on housing prices.[4]

These results are presented in table 13 below. I use the data presented in table 5 to calculate the percentage change in average subsidy amounts between two adjacent strata.[5] I then use this number and the estimated elasticities of subsidies on housing prices to assess the average effect of moving from one stratum to another on housing prices.

3. As mentioned before, the OLS effect of subsidies for water and sewage on housing prices seems to be in fact upwardly biased, contrary to the initial intuition that pointed to downward biased estimates.

4. In addition, we evaluate the effect on average housing prices at destination, instead of on city average housing prices.

5. Note that, in fact, the percentage difference between subsidies received in two adjacent strata vary significantly depending on the pair of strata being compared. This difference ranges from 21 to almost 150 percent.

TABLE 13. Average Effects of Moving from One Stratum to the Adjacent Stratum

	A	*B*	*C*	*D*	*E*	*F*	*G*
	Elasticity	*Δ avg S*	*Percentage Δ avg S*	*Implied percentage Δ in house price (A*C)*	*Δ housing price (at average within stratum)*	*NPV Δ annual subsidy (B*12/0.1)*	*NPV/ Δ price (F/E)*
Electricity							
Δ from stratum 2 to 1	0.0297	2,614	21.7	0.64	132,143	313,680	2.37
Δ from stratum 3 to 2	0.0297	7,185	147.9	4.39	1,229,686	862,200	0.70
Water							
Δ from stratum 2 to 1	0.0295	6,331	23.7	0.70	143,396	759,720	5.30
Δ from stratum 3 to 2	0.0295	13,617	104.1	3.07	859,714	1,634,040	1.90

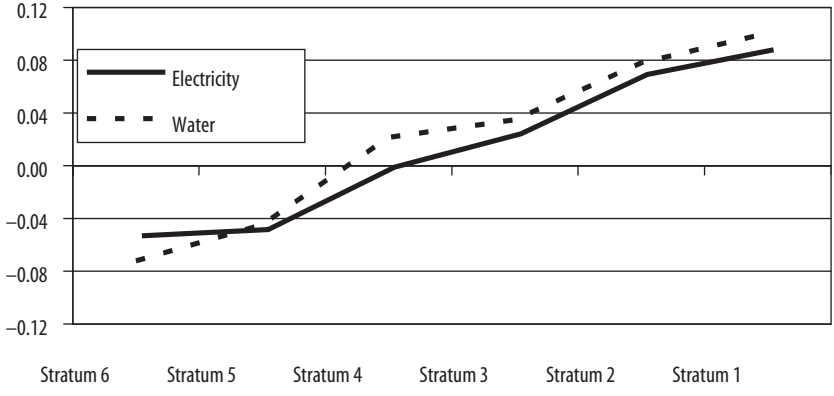
Source: Author's calculations based on data reported in tables 5 and 8.
NPV = net present value; *S* = subsidy; Δ = change; avg = average.
a. Average subsidies, housing prices, and annual subsidies (B, E, and F) are in Colombian pesos.

Note that only in the case of a change from the average electricity subsidy in stratum 3 to the average electricity subsidy in stratum 2 is the net present value of average annual subsidies lower than the implied effect on housing prices. That means that in this case the change in DPS subsidy is entirely transferred to housing prices. However, note that in all other cases, the number in column G is bigger than 1, which implies that the net present value of annual subsidies due to a move from one stratum to another (for example, from stratum 2 to stratum 1) is significantly larger than the implied effect of this change on housing prices. In some cases, this difference is actually large. For example, the net present value of the change in water subsidies due to a move from stratum 2 to stratum 1 is five times bigger than the increase in housing prices due to that particular move.

In sum, while there is evidence that in one case the subsidy might be entirely transferred to housing owners, in all other cases beneficiary households actually benefit from the subsidy even after one takes into account the change in housing prices associated with the change in the subsidy amount.

Finally, although the authors estimate a flexible quadratic function of the subsidy, these nonlinearities are not fully exploited in the analysis, although most of these quadratic terms are actually statistically significant. In figure 3 below, I show average elasticities of housing prices to subsidy amounts by stratum. The results are interesting in the sense that they suggest that the estimates imply significant differences across strata. In particular, the elasticities in stratum 1 (which corresponds to the poorest neighborhoods) are close to 8 percent while elasticities in the top strata are, of course, negative but half

FIGURE 3. Average Elasticity of Housing Prices with Respect to DPS Subsidies, by Stratum



Source: Author's calculations based on data reported in tables 5 and 8.

the size of those found in the poorest neighborhoods. The reduction in the elasticity is about 65 percent when one moves from stratum 1 to stratum 3 (both of which receive subsidies).

In sum, the results presented in the paper are interesting, as they suggest that people are willing to pay more for houses located in areas with higher subsidies for public utilities (DPS). Although the different estimation strategies do not provide statistically significantly different estimates of the relevant elasticities (which as we have discussed might be disappointing), the various estimates indicate that housing prices are quite responsive to DPS subsidies and that in some cases these elasticities are actually quite high (for example, the elasticity of housing prices in stratum 1 with respect to DPS subsidies is around 8 percent). However, if one makes careful comparisons of what would happen were an individual to move from one stratum to another, in most cases, the change in the net present value of subsidies would still be higher than the implied change in housing prices. That means that the benefit for the beneficiary of the DPS subsidy is higher than the cost implied by it in terms of changing housing prices.

Maximo Torero: This paper assesses the hypothesis that the flow of subsidies for utility services is discounted by real estate agents' transferring most of them to the prices of targeted houses. In this sense, these subsidies would not stay in the pockets of households that reside in them.

The authors find that the estimated increment in house value due to subsidies is similar to the present value of the flow of subsidies discounted at reasonable market rates. Analogous effects are found in the value of rents. Thus targeting subsidies for public services to poor strata may generate a distortion of house prices in different socioeconomic strata.

The authors are taking advantage of the unique characteristics of the real estate market, which are that housing cannot be easily moved, that it is durable and expensive, and that moving to a new place is costly both monetarily and emotionally. In this sense, these characteristics allow the authors to effectively track the housing subsidies in Colombia and thus to tackle some important issues. I would like to organize my comments in two areas. First, I would like to raise some concerns regarding the difficulty of modeling the real estate market under heterogeneous conditions. In particular, I would like to address two issues: first, the vast array of characteristics that have to be accounted for so as to avoid bias in the estimations and the challenges one faces in finding equilibrium prices. Second, I would like to discuss possible problems of endogeneity, the potential presence of spatial autocorrelation, and differences in elasticities across sectors in the methodology.

Modeling the Real Estate Market under Heterogeneity

There is an inherent heterogeneity in the real estate market as each house or apartment offers a different bundle of housing "services," such as dwelling characteristics (size, layout, kitchen appliances, heating and air conditioning systems, structural integrity, and so on), and community features (accessibility to jobs, shopping centers, entertainment venues, parks, good schools, police control, air quality, noise levels; among others). Other sources of heterogeneity come from housing cross subsidies, as raised by the authors, and direct subsidies, which are not considered in the analysis. The problem is that, if all these characteristics are not accounted for, bias could arise from significant measurement error. This is crucial when one estimates the equilibrium price.

One alternative could be to summarize the characteristics of the household using Polychoric Principal Component Analysis.[1] Polychoric indexes have a

1. Kolenikov and Angeles (2004).

number of advantages. The most important one comes from its use of ordinal data. Many assets can be described as ordinal. Specifically in this paper the authors are interested in the quality of house construction, which might be recorded on a 1 to 4 scale. Filmer and Pritchett advocate splitting this ordinal variable into four binary ones.[2] Nevertheless, this introduces a large amount of distortion into the correlation matrix, as these binary variables have, by construction, a perfect negative correlation with each other. Furthermore, the notion that some values are better than others is lost, as the dummy approach gives equal treatment to all the variables. Polychoric indexes solve these problems by assigning each category a discrete value and ensuring that the coefficients of an ordinal variable follow the order of its values. Finally, another of their advantages is that they allows one to compute coefficients of both owning and not owning an asset. This is desirable because sometimes not owning something conveys more information than owning it. For example, if most households have indoor plumbing except for the poorest ones, having this service will not provide useful information to distinguish wealth levels. Nevertheless, not having it will certainly help identify those worse off in the distribution.

Furthermore, the literature on the hedonic approach has focused on the complications that arise from heterogeneity of households. In the heterogeneous case, the equilibrium price function is an upper envelope of the bid price function. In this sense, it is a bid price function, and not the equilibrium price function, that represents a household's willingness to pay for properties. Since the paper uses the latter instead of the former, it is implicitly assuming identical preferences of households and may overestimate the benefits of amenities.

In addition, apparently there is an important variability in the public services targeting mechanism. The targeting mechanisms of public services change over time, and specifically this seems to happen in the Colombian case. But how do agents capture this? Would it not be better to calculate the expected value of future flows of subsidies without correcting for uncertainty?

Finally, from the document it is not clear what subsidies are being taken into account. Initially, there is some detail on electricity and later on water; but this needs to be clarified. This point is crucial because different utilities offer different subsidy schemes. For example, subsidy schemes may be based on consumption, they may have nonlinear schedules, they may be metered or

2. Filmer and Pritchett (2001).

not, they may impose minimum consumption, and so forth. As all these factors may vary across utilities, as well as in time, it would be useful to know how the authors have dealt with these issues. Also of interest are details on how other subsidies at the municipality level (such as property taxes or schools of different qualities, to name a few) are considered in the analysis.

Methodological Issues

As mentioned before, household heterogeneity imposes some modeling and estimation complications. In this sense, controlling for heterogeneity requires a vast set of characteristics. But even assuming there is no problem of omitted variables, there are three issues that the authors need to be concerned about in their future research.

A first issue comes from the endogeneity of the potential subsidy. Families might probably select themselves to areas with high subsidies, so there is a need to instrumentalize this subsidy. Even when strata from the Living Standards Measurement survey (*Encuesta de Calidad de Vida* [ECV]) of 2003 are instrumentalized using the Administrative Department of District Real Estate Appraisal (DACD) of 2000, the endogeneity problem is likely to persist. On one hand, there is a three-year lag in the instrument, and on the other, this instrument is still based on household self-reports. Under these circumstances, it is still not clear if the instrument should be necessarily orthogonal to the error term.

Secondly, with regard to the regression discontinuity method, there are three problems I would like to mention. One is that the authors assume that houses in near neighborhoods have similar characteristics. This might be problematic since characteristics might not be the same among households in neighbor boundaries. In any case, this assumption needs to be validated, and some robustness tests are required. Moreover, if the assumption of neighborhood homogeneity is accepted, there is a likelihood of spatial correlation problems: housing prices may be determined by using comparable dwellings in similar neighborhoods as benchmarks.

A third problem arises from the fact that the authors use a vector of dummies instead of a matrix of dummies (that is, dummies should be specific to the two strata, so sets of dummies should be created for different pairs of neighbor districts and not one common dummy). This is important because if dummies are not specific for particular strata then households are being compared on joint neighbors, while they are treated the same as pairs from

different districts. Why not restrict the data to the neighbor pairs? For future research it will be interesting to see whether the authors use "distance between neighborhoods" instead of dummies, which could also help control for spatial autocorrelation and help implement regression discontinuity as discussed by Hahn, Todd, and Van der Klaauw.[3]

Finally, elasticities of demand price used to calculate the subsidies are imputed from López, Castaño, and Vélez and Vélez, Botero, and Yánez, and the same elasticity is used across socioeconomic sectors.[4] Nevertheless, it has been shown that the elasticity changes between socioeconomic strata, as discussed by Wolak and by Pollak and Wales.[5]

3. Hahn, Todd, and Van der Klaauw (2001).
4. Lopez, Castaño, and Vélez (1992); Vélez, Botero, and Yánez (1991).
5. Wolak (1995); Pollak and Wales (1980, 1981).

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