Access to water as a determinant of rental values: A hedonic analysis in Rwanda

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Abstract

In this paper, we study the determinants of rental values in urban housing markets in Kigali, Rwanda. In particular, we study the value of access to piped water; due to the high costs associated with installing new piped connections, renting a property with an existing connection is often the only way for low income households to access piped water. Our results indicate that extending the piped network to a new house will in many cases raise the rental value of the house enough to pay for the cost of installing the new connection in less than two years.

Keywords:

Africa, Rwanda, water access, hedonic price, real estate, non-market valuation

1. Introduction

Cities of developing and emerging countries are growing rapidly. The UN estimates that, for instance, the urban population of sub-Saharan Africa will more than triple by the year 2050 (United Nations Population Division, 2008). This urban explosion requires making significant investments to provide the necessary infrastructure for economic development and to satisfy populations' needs. These urban services are, among other, water access, electricity, transport and telecommunications.

Meeting this dramatic rise in demand for public services in urban areas is a huge challenge for public policy. In many urban areas in developing countries, such public services are provided in established neighborhoods dominated by middle and upper classes, but the necessary infrastructure is absent in the newer neighborhoods dominated by poorer segments of the population. An important part of the reason is that establishing new infrastructure is costly, and depending on how the costs of provision are financed, this often means either that public utilities lack the funds for new investments, that the households in question cannot afford to pay the connection costs, or both.

This is deeply problematic for a public service like water. There are important equity problems associated with the current situation, where the poorer households frequently end up paying more for their water, from private vendors, than the more affluent households do for their piped water. Moreover, water provision has huge positive externalities. Access to safe water reduces the risk of contagious diseases, not merely for the connected household, but for other households in the vicinity. It is therefore important for urban authorities to identify means of expanding access to piped water to larger shares of their populations.

Renting housing with established water connections is a potential means of gaining access to the water network, for those households that cannot afford the cost of establishing a new connection. It is, therefore, reasonable to assume that a connection to the piped water network will increase the rental value of a property. By studying the rental market in Kigali urban area in Rwanda, we can estimate this value in order to assess how important piped water is perceived to be by the target group.

The structure of this paper is as follows: firstly, we discuss the background and the existing literature. Section 3 presents the theoretical model of the Hedonic Price Method. Data and variables are presented in section 4. Section 5 covers the empirical strategy. Results are presented in section 6. They are then discussed in section 7.

2. Issues in water provision

Limited access to the public water network is an important problem in urban areas in many developing countries. An important part of the problem is the considerable cost frequently involved in extending the network to new recipients not previously covered. Because of the limited access to private tap connections, water use patterns differ from those in developed countries. Households that do not have private tap connections frequently use a range of different water sources for different needs, using somewhat safer water from e.g. public taps or private vendors for drinking and water from less secure sources (such as unprotected open water collections) for sanitation or laundry needs; see e.g. Nauges and Strand (2007), Onjala et al. (2013) or Uwera (2013).

Those households that are connected to the public water network and have private tap connections frequently have price and income elasticities similar to those in developed countries (Nauges and Whittington, 2010). However, even for these households, the public water network is frequently unreliable, due to the poor state of the water infrastructure in many cities. This may lead to shortages and contaminated water in the public networks, causing important welfare losses for the affected households (see e.g. Baisa et al., 2010, for water shortages or Jalan and Somanathan, 2008, for household responses to the threat of contaminated water). Health issues related to water use are of course even more important for those households that lack a private water connection altogether, and may have important impacts on their behavior (see e.g. Nauges and van den Berg, 2009, or Onjala et al., 2013).

In the high-growth countries in eastern and southern Asia one may expect that access to water networks will improve in the coming years, as incomes continue to rise and as these countries become sufficiently prosperous to finance large scale extensions in their water networks, analogously to the investments seen in many developed countries in the late nineteenth and early twentieth century (Briand et al., 2010). However, in poorer countries such as many of those in sub-Saharan Africa, such massive investment programmes are still a long way off; if new connections are established at all, a requirement is frequently that the household in question pays the entire investment cost up front (Stage and Uwera, 2012). For many liquidity-constrained households in these countries, this is unrealistic, and the only means of securing a connection is by renting a property which is already connected to the water network. Therefore, it is reasonable to expect property markets to reflect the value of water access.

Only a few hedonic pricing studies have been done in African property markets, and even fewer have looked at access to water as a determinant of property prices. Those that have, have not found conclusive evidence that water access does matter. Asabere (1981a, 1981b, 2004), studying sales prices in different real estate markets in Ghana, found significant impacts from access to a package of services that included piped water, but did not study access to water separately in any of the listed studies. Megbolugbe (1989), looking at assessed property values in Jos in Nigeria, found that access to water mattered for the valuation of single-household dwellings but not for multi-household dwellings. Arimah (1992), studying rental housing in Ibadan (Nigeria), found no significant impact of access to piped water or of having a water-operated lavatory in the dwelling. Gulyani and Talukdar (2008), on the other hand, found access to piped water to be an important determinant of monthly rent in Nairobi slum areas. Els and von Fintel (2010), studying sales prices in South Africa, found that the number of bathrooms (which is, of course, likely to be linked to water access) mattered significantly, but did not study water access per se. Thus, it is not clear that access to piped water actually does affect pricing of real estate; it does seem to have an impact in some markets, but does not have an impact everywhere. Whether water access matters is therefore something that needs to be studied separately for different markets.

Rwanda is no exception from the problems with water provision experienced in the developing world. Most of the Rwandan cities do not have land use plans to guide their development (Byamukama et al., 2011). This means that housing development is generally made in an *ad hoc* manner, and that amenities are not properly planned in advance (Oyier, 2008). Providing public infrastructure and services such as roads, piped water, electricity, garbage collection, drainage, etc., therefore becomes something that is organized after the housing development has already taking place, making many of these services costly (REMA, 2009).

The provision of piped water, in particular, has been a great challenge for policymakers. Water provision is managed by the state-owned Energy, Water and Sanitation Agency (EWSA). EWSA has an increasing block tariff schedule such that meeting basic water needs is relatively inexpensive for those households that are connected to the piped water network; all households pay less for their water use than the cost of providing the water (Stage and Uwera, 2012). However, the connection itself is expensive and needs to be paid upfront; this fee is more than an entire monthly income for the median urban household. As a result, only a limited share of the population (6.6 % of the respondents in the survey used here, discussed later) have piped connections into their own dwellings. More common is a connection to the plot on which the dwelling is located, shared with other households on the same plot; this permits households to pool resources and pay the connection fee jointly. However, even this solution is expensive and excludes many poorer households; in the survey used here, fewer than half of the respondents had any piped connection at all. A common solution, instead, is to get drinking water either through a public tap, shared with hundreds of other households with consequent effects on the transmission of water-borne diseases, or through private vendors. Prices when accessing public taps, or for buying from vendors, are typically considerably higher than the prices charged by EWSA for piped water (Uwera, 2013), and the water quality is often lower. Stage and Uwera (2012) estimate that the extra cost of such coping water is high enough to pay for the cost of a piped connection within the span of two to three years; however, many households, especially poorer households, are severely liquidity constrained, and cannot pay the upfront cost of a connection even though it would save them money in the longer term.

For many poorer households, paying for the establishment of an own piped water connection, or even a joint piped connection to the housing plot, is thus out of reach financially. However, once a connection has been established, the connection cost can be internalized in the rental price if the dwelling is rented out. This means that it is possible to ascertain the value to Rwandan households of having access to piped water – in the dwelling or at least in the housing plot – by studying the rental market for housing.

3. The hedonic pricing method

The hedonic pricing method (HPM) has known an important development in the field of environmental and natural resources economics because of its ability to measure, from observed behaviours, values that households allocate to various amenities. The HPM allows monetizing non-market goods (water access, air quality, landscape amenities, noise, access to publicly provided amenities) by observing the behavior of households on the real estate market. Stakes are major for local decision makers and property developers. From the perspective of public policy, this method provides an overview of the functioning of residential markets and of the implicit prices of local amenities.

The HPM measures the value associated with residential use of amenities such as water access. When a household purchases or rents a house with water access, it gains privileged access.

Rosen (1974) formalized the HPM in his article that, since then, is the seminal reference in the field. The HPM assumes that an housing is an heterogeneous good consisting of a set of characteristics Z = (z_1 ,...,z_k , ...,z_K) sold in bulk. Houses are distinguished from each other, both through their intrinsic characteristics (number of rooms, presence of a bathroom, etc.) but also through their extrinsic characteristics, i.e., access to amenities (landscapes, clean water) and proximity to nuisances (factory, dump, noise, etc.). The HPM is designed to reveal, in a first step, the implicit marginal price of these different characteristics from the overall price P(Z) of the house. Each implicit marginal price p_k is calculated in the case of quantitative variables as the derivative of the aggregate price P(Z) relative to the quantity z_k.The empirical calculation of the different marginal implicit prices then needs the estimation of the hedonic price function by regressing transaction prices (or rents) of homes on the various intrinsic and extrinsic characteristics of the latter.

4. Data and variables

Data

The data used in this article comes from a household survey, in three cities of Rwanda, undertaken between January and April 2011. This sample covered a total of 700 respondents; of these, 193 rented properties in Kigali, the capital city, and are the focus of the analysis reported in this paper.

The dataset includes 193 dwellings. It comprises the monthly rent of each dwelling (*monthrent)* and intrinsic characteristics: the number of bedrooms (*bedroom*), the construction material (*wood* or *brick)*, and the roof material (*metal sheet* or *tiles*).

The dataset also provides district variables (*Kicukiro*, *Gasabo* or *Nyarugenge*). We employ a district variable in order to control as far as possible for other structural and location effects; the coefficient of the district variable will show the overall positive or negative effects associated with uncaptured neighborhood effects within each district.[1]

Regarding water access, we use a dummy variable. The *pipedconnection* variable is a dummy indicating a household is connected to piped water to either dwelling or yard. This variable captures the value of having access to piped water. Thus, a household with piped water into dwelling and or into the yard would get a "1" for this dummy.[2]

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[1] Note that although we have information about proximity to a school, a police station and a health facility, these are not included in the analysis as they present no variability. All households have access to a school in the neighborhood, 98 % to a police station and 95 % to a health clinic.

[2] We also have information on whether there is piped water into the dwelling itself; however, very few dwellings have this, and including a dummy for this does not give significant results and does not affect the results for the other variables relative to the results when we only include a dummy

Variables are presented in table 1.

TABLE 1. Descriptive statistics

Variables	Mean	Std. Dev	Min	Max
Monthrent	40699.48	38072.2	3000	200000
Bedroom	2.461	1.030	1	5
Wood	.129	.336	0	1
Brick	.870	.336	0	1
Metal sheet	.994	.071	0	1
Tiles	.005	.071	0	1
Pipedconnection	.326	.470	0	1
Kicukiro	.248	.433	0	1
Gasabo	.440	.497	0	1
Nyarugenge	.310	.464	0	1

The survey also included questions on income; renters report an average monthly household income of some 165000 RWF/month while households that own their dwelling report an average income of 195000 RWF/month, although the difference is not statistically significant. Both renters and owners report high discount rates; in response to a question about what sum in six months' time would be equivalent to receiving 100000 RWF in three months' time, renters stated an average sum of 389000 RWF while owners stated an average sum of 344000 RWF. Thus, both groups are clearly severely liquidity constrained, but renters on average somewhat more so.

5. Empirical analysis

Numerous hedonic pricing studies have used Box-Cox transformations; however, several authors (Cassel and Mendelsohn, 1985; Cropper, Deck, and McConnell, 1988; Sheppard, 1999) have argued that it is problematic to use Box–Cox transformations in hedonic pricing studies, both because the resulting parameter estimates tend to be highly sensitive to small variations in the data and also because those parameter estimates are frequently difficult to interpret. These authors have suggested using simpler functional forms which produce more stable parameter estimates. We follow that recommendation here and estimate four functional forms: lin-lin, lin-log, log-lin and log-log.

Housings are heterogeneous goods. This heterogeneity can create heteroscedasticity in the residuals of the estimation of the hedonic price function. Indeed we detect heteroscedasticity in our model. Therefore, we estimate robust models[1] (cf Table 2).

Due to the high number of characteristics available multicollinearity may be a serious concern. Recall that multicollinearity leads to unstable coefficients and inflated standard errors.

[1] We use the Huber/White/sandwich estimator in order to have robust standard errors.

We use Variance Inflation Factors (VIFs) to detect it. VIF values do not exceed 1.6 (and mean VIFs not exceed 1.3) in all models, which goes in line with the most conservative rules of thumb.[1]

6. Results

The results are shown in Table 2. As one might expect, a higher number of bedrooms leads to an increase in the rental value (for instance 18 705 RWF for one additional bedroom in the lin-lin model). As one might also expect, the quality of the construction materials matters. Renting a dwelling constructed in wood (widely seen as cheap, low-quality housing) is substantially cheaper than renting one constructed in bricks, and having a metal sheet roof increases the rental value compared to tiles. District variables are not significant; thus, the exact location of the dwelling within Kigali seems not to matter.

Our estimates highlight the importance of access to piped water. It increases rental values of 10 476 RWF in the lin-lin model, corresponding to some 25% of the average rental cost, and results for other specifications also clearly indicate the importance of piped water for the rental value. In the log-log specification (model 4), access to piped water corresponds to a 30 % increase in the rental value.[2]

[1] The most conservative rule of thumb advocates that the mean of VIFs should not considerably be larger than 1 (Chatterjee and Hadi, 2006).
[2] The effect is calculated following : exp(coefficient) - 1

Table 2. Estimation results

VARIABLES	(1) Monthrent	(2) monthrent	(3) lnmonthrent	(4) lnmonthrent	(5) monthrent	(6) monthrent	(7) lnmonthrent	(8) lnmonthrent
Bedroom	18,705***		0.406***		18,769***		0.410***	
	(2,620)		(0.0501)		(2,636)		(0.0505)	
Wood	-19,578***	-19,483***	-0.575***	-0.567***	-20,817***	-20,749***	-0.596***	-0.589***
	(4,251)	(4,278)	(0.144)	(0.147)	(4,481)	(4,483)	(0.146)	(0.148)
Metal sheet	6,520*	4,374	0.942***	0.858***	10,619**	8,585*	1.015***	0.935***
	(3,468)	(3,378)	(0.0944)	(0.101)	(5,308)	(5,184)	(0.128)	(0.131)
Pipedconnection	10,476**	9,037*	0.299***	0.270***	10,040*	8,665	0.299***	0.272***
	(5,054)	(5,225)	(0.102)	(0.104)	(5,316)	(5,467)	(0.101)	(0.102)
Gasabo					-3,810	-3,130	0.00891	0.0283
					(6,608)	(6,844)	(0.135)	(0.137)
Nyarugenge					3,180	3,919	0.115	0.138
					(6,320)	(6,566)	(0.135)	(0.138)
Lnbedroom		37,436***		0.857***		37,654***		0.868***
		(4,918)		(0.105)		(4,955)		(0.106)
Constant	-12,705***	6,000	8.293***	8.700	-15,949**	2,081	8.174***	8.561***
	(2,620)		(0.0501)	(0)	(6,886)	(6,566)	(0.144)	(0.138)
Observations	193	193	193	193	193	193	193	193
R-squared	0.314	0.275	0.336	0.322	0.320	0.281	0.339	0.326

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

7. Conclusion

In this paper we have studied the rental housing market in Kigali, Rwanda. In particular, we study the value of access to piped water, as renting housing with a piped connection is often the only way for poor households to access piped water. We find that a piped water connection raises the average rental value of a dwelling by some 25 to 30 %, or approximately 10000 RWF per month; this is greater than the effect of having a high-quality metal roof, and comparable in magnitude to that of having brick housing rather than wood. Even with a relatively high interest rate of 10-15%, the additional rental value linked to piped water access is enough to pay off the cost of installing a piped connection over the span of less than two years. Since the normal setup is a piped connection to a collection of dwellings, rather than into a dwelling, a landlord renting out several properties in the same area can recoup the connection cost even faster.

That poor households are unable to pay for the connection cost of a piped connection upfront is not surprising; our descriptive statistics indicate that respondents renting their dwelling have extremely high discount rates, suggesting that they are severely liquidity constrained. However, given that installing a connection in a dwelling that is being rented out is profitable in fairly short order, our results indicate that many of the households renting out dwellings are liquidity constrained as well; if this were not the case, then presumably most of the rental housing would have water connections installed by now.

Thus, although renting housing can let some poor households access piped water connections that they would otherwise be unable to gain access to, this is not a panacea. Many of the landlords renting out housing are clearly poor and liquidity constrained as well, and also unable to access the piped water system. Dealing with the credit market constraints that preclude poor households from borrowing to pay for their connections, or setting up other policy measures to help poor households gain access to piped water, remains imperative. The results presented here demonstrate just how valuable such improved water access would be to the affected households.

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