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Willingness to Pay for Access to Piped Water Using Hedonic Pricing Model

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Abstract

The main objective of this study is to estimate the determinants of drinking water supply on the housing rental value using survey-based data for the years 2013-14 in Pakistan. The hedonic pricing model is applied using the rental value of the houses per month as the dependent variable. Piped-water connection and several rooms significantly impact housing prices for rural and urban. Using the marginal implicit pricing method, Marginal willingness to pay (MWTP) is also calculated using the median of the rental values of the houses for both rural-urban regions and owned-rented houses. PKR 1676 and PKR 332 are willing to pay per month for urban and rural areas, respectively, to have water quality inside their houses. On the same lines, PKR 1087 and PKR 521 are computed values of WTP for those who have their own houses and living on rent, respectively.

Keywords:
willingness to pay, hedonic pricing models, access to clean water, unsafe water, metered connections

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INTRODUCTION

By the Joint Monitoring Program (JMP) of WHO and UNICEF, it is indicated that 91% of people in Pakistan have access to the sources of drinking water during 2014, approaching the MDG target (93% for the year 2015), but it is further observed that still 38.5 million people are deprived of clean drinking water, and scarcity of water is thriving rapidly. However, such facts sometimes do not indicate that low or bad services are provided. Reforms regarding better water services are required, particularly in rural areas. Usually, households quantify the benefits, including the time, energy, and money saved to get water inside. Households who do not have piped water connections at homes inside are facing many types of costs. First, they face carrying costs to fetch water from other sources, e.g., tube wells, filter plants, wells, taps, or tankers. They have to pay a massive cost per unit purchase of drinking water through other sources. Finally, water from other sources may be unprotected and cause several diseases.

On the contrary, water through piped might be considered protected, lower cost per unit relatively, less probability of suffering from water-borne diseases. There are two ways to measure the value of a piped water connection: one, stated preference, and two, revealed preference methods. We require information about the maximum willingness to pay the households for a water connection (Whittington et al. 2002; Pattanayak et al. 2004). The second approach is the most commonly used approach using the "hedonic property valuation method," which measures the WTP based on housing prices/property values (Whittington et al., 1990; Yusuf & Koundouri, 2005; North & Griffin, 1993). Most of the earlier studies estimated WTP as a percentage of monthly income or expenditures. Solo Montes et al. (2003) found 5.8% of HH monthly income as a WTP for Mexico City. Harapap and Hartono (2007) pointed out that there could be a 9.1% increase in the rental value of the house with one piped water connection in urban areas of Indonesia, while Folmer et al. (2014) found around 8 % monthly income in Indonesia. Nauges et al. (2009) estimated an increase in the sale value of a house by 10–52 % with one piped water connection in El Salvador.

Cebula (2009) also used a hedonic pricing model for Savannah city in Georgia, taking 2,888 single-family homes for five years for the period 2000-2005. Findings reveal that housing prices are significantly positively related to the number of bedrooms, covered area of a house, number of stories, garden, and pool of a house inside. Main findings show that the number of bedrooms positively relates to the actual sales price of the house, toilets, fireplaces, stories, garage car spaces, covered area in feet, garden, a pool, life of a house, i.e., old or newly constructed house. The sales price of the single-family house is negatively affected by the road/street due to heavy terrific and noise. It is further observed that 20-21 premium is also paid for its location per month.

Van den Berg & Nauges (2012) also evaluated WTP after applying the Hedonic price model for Sri Lanka for the survey-based data of 2003-04. Their findings indicate

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that Sri Lankan HHs are WTP only 5% of their whole monthly expenditures. Further, they also observed that people who do not have access to water are WTP lower than those who have easy access. It is viewed that providing awareness about the benefits of piped water connection leads to massive investment in installing water-related infrastructure.

Kwak et al. (2013) tried to examine the tap water quality in Pusan, which is the second biggest city in Korea. They used the CVM and Spike model to estimate the odor of taped water, income, gender, age, and education as core variables for estimating WTP. Their principal findings showed that households are WTP $2.2 per month on average using the spike OOHBDC CV model. It was revealed that Pusan residents are WTP $ 32.1 million per year.

Dendup and Kuenzeg (2015) also estimated the hedonic price model for both drinking water and sewage connection for Bhutan using survey-based data compiled from BLSS of 18,766 HHs for two sample periods 2007 and 2012. They applied a fixed effect model by fixing sub-districts to avoid heterogeneity issues. The main results showed that HHs have significant demand for both facilities inside the house. They evaluated the WTP for both facilities for urban residents and found that people of Bhutan who do not have connections at home inside are willing to pay 6% of their monthly, whereas only 2% for rural residents are WTP to avail themselves these facilities. Shazia et al. (2016) also estimated the HHs WTP for Nowshera city obtaining clean water at home inside. They also concluded that awareness, education, and income significantly affect the decision of the household to have clean water at home, which might reduce the risk of water-borne diseases such as cholera, diarrhea, dysentery, and typhoid. They also found that wealthy people are relatively more WTP than poor.

Akhter et al. (2018) also estimated WTP for Lahore city using primary data from the Contingent Valuation Method (CVM). They found a resident of Lahore is WTP only $0.70 and not happy with the water supply. Islam et al. (2019) estimated WTP for one of the Khulna District in Bangladesh and found average WTP is BDT 263, which is relatively low. Islam et al. (2009) examined and measured the WTP for southwest coastal Bangladesh for improved drinking water using contingent valuation survey data of 215 households. Their estimates show that the average WTP for improved drinking water was BDT 193/month (3% of monthly income). They also observed that educated HHs having high income are WTP more for improved water supply.

After going through all related studies, it is observed that WTP is estimated worldwide by different methods, but there is hardly a study that estimated WTP for rural-urban ad rented, and owned house residents WTP for safe drinking water for Pakistan. How the price of water is measured and how much citizens of Pakistan are willing to pay for that utility at home inside. How the affordable prices could be implemented and how the safe water could be provided to their residences conveniently. Such a study is hardly found in literature, and we try to fill this gap by considering all these queries.

The study's objectives are to examine the effect of drinking water on the housing rental value, see the impact of some other factors on the housing rental value, and estimate the WTP for having clean drinking water at home inside. These papers are organized to introduce the main water-related issue and studies on related issues, objectives, and study gaps in section 1. Data and the method used in our analysis are explained in section 2. Section 3 comprises results and discussion. Conclusion and recommendations are highlighted in the last section.

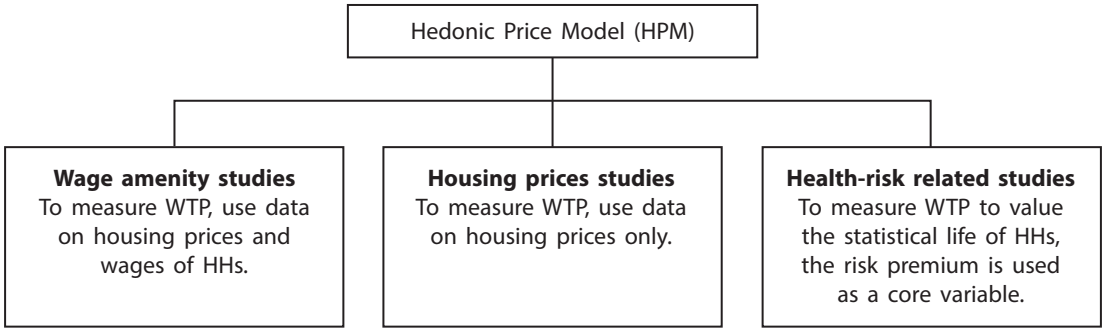
METHODS

Data has been compiled from PSLM 2013-2014 covering 17989 households. It provides information on drinking water sources of households for both rural and urban areas. It also gives information province-wise for all possible drinking sources available and used by HHs. The rental value of the house per month is considered the market value of the house per month, ranging from PKR 2400 to PKR120000 (domestic purpose excluding commercial rent of buildings plazas) is core variable used as the dependent variable in our analysis. Extensive data on utilities, including electricity gas availability, is also being provided. Information of garbage collection from HHs and their neighbors, payments towards this service to the municipality, number of rooms is also given in detail.

Limited information on neighborhood variables is available in this survey, e.g., less than 1% of data is given for the distance of schools near houses, while 99% did not provide any information about school distance. Using PSLM survey-based data and housing prices of the residents of HHs, we have to employ the Hedonic price model, which is the best model for this type of study (Ahmed et al., 2020). It caters only when housing prices are available and provides the best estimates for WTP. Many studies applied the same technique to estimate WTP (Whittington et al. 1990; North and Griffin, 1993; Harapap & Hartono, 2007; Cebula, 2009; Van den Berg & Nauges, 2012; Dendup & Kuenzeg, 2015).

Various approaches are available to value environment-related goods and services; mainly two including revealed preference (RP) and two stated preference (SP) techniques (see Figure 1).

Figure 1. Applications of hedonic price method



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The house's market value or rental value is treated as a dependent variable (Hp), whereas explanatory variables combine all three categories, including Env, Hs, and Nb.

$$Hp = Hp(Env,\ Hs,\ Nb)$$

It also reduces the problem of heteroskedasticity and is easy to calculate. Semilog model may be written as symbolically.

$$\ln H_p = \beta_o + \sum_{i=0}^{n} \beta_i Z_i$$

Marginal implicit price or marginal willingness to pay (MWTP) is calculated as:

$$H_{pzi} = \frac{\partial H_{pi}}{\partial Z_i} = (e^{\beta_j} - 1)H_{pi}$$

In this study, the *hedonic price* model is modified to comply with the first, second, and third goals of the study, i.e., identifying the effects of drinking water supply on the rent price of a house and calculating the value of *implicit marginal price (marginal willingness to pay)* for drinking water. The *hedonic price* model in this study is explicitly written as:

$$H_p = \gamma_0 + \sum_{i=1}^{m} \ln \gamma_1 Hs_i + \gamma_2 N_b + \gamma_4 Wc + \gamma_5 St + \gamma_6 \Pr + \gamma_7 Rg + \varepsilon$$

Where:

H_p = Rent price of a house per month
Hs_i = vector of house related variables
N_b = Neighborhood related variables
Wc = water connection dummy variable
St = Sanitation vector dummy variable
Pr = Provincial categorical variable
Rg = Regional dummy variable

In order to estimate the MWTP, we have applied the simple formula:

$$H_{pzi} = (e^{\beta_j} - 1)H_{pi}$$

Where β_j shows the coefficients of regression estimation, e is the simple natural logarithmic numeral, and H_p is the median of the rental value of a house per month.

RESULTS AND DISCUSSION

Table 1 shows the summary statistics of the variables. The statistics show that the rental value of houses starts from 2400 and ends up at 120000 of 15884 households. On average rental value per annum is Rs 30495.8 for all rural and urban regions, not showing a clear picture of rents.

Table 1. Summary Statistics of the Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
The rental value of the house per annum	15884	30495.8	26821.3	2400	120000
Piped water connection	15884	0.2303	0.4210	0	1
Number of rooms	15884	2.2240	1.2780	1	15
Availability of gas or not	15884	0.3056	0.4607	0	1
Garbage collected or not	15884	0.2093	0.4068	0	1
Neighbor pay for garbage collection	15884	6.4385	27.0579	0	600
Garbage collection from a neighbor	15884	2.7117	0.6107	1	3
Employment status	15884	1.1400	0.3469	1	2
Educated or not	15883	1.4427	0.4967	1	2
Income per month	15700	28182.8	12515.3	0	249000
Expenditure per month	15771	33767.0	15164.0	0	250100
Provinces of Pakistan	15884	2.3210	0.8784	1	4
Rural-urban region	15884	1.3242	0.4681	1	2
Age of a household	15884	45.1457	13.8027	15	99

For this purpose, a detailed breakup of the rent per month is given in Table 2. Table 2 shows that about 65 HH pay rent in the range of 2400-30000, rest of 35% (23% pay 30 thousand to 60 thousand, 60 thousand to 90 thousand pay 6.2%). Only 5.1 HH out of 15884 pay more than 90k, only 5.1% of the sample.

Table 2. Main sources of Drinking water (2013-14)

What is the main source of drinking water	Frequency	Percent
piped water	4,421	24.58
hand pump	5,392	29.98
motorized pumping/tubewell	4,954	27.54
open well	612	3.4
closed well	185	1.03
pound/canal/river/stream	717	3.99
Spring	615	3.42
mineral water	48	0.27
tanker/truck/water bearer	638	3.55
filtration plant	349	1.94
Others	57	0.32
Total	**17,988**	**100**

Descriptive statistics of main variables used for the analysis using the Hedonic pricing model are shown in Table 3 shows that PKR 35265 is the rental value per month for urban, while PKR 12735 for rural. On average, around 24 thousand and 495 rupees

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is the rent of house per month for overall Pakistan. Only 23% piped water connection (PWC) is available for households in Pakistan, where maximum urban households enjoy this facility and 45 % of urban HH have connections inside their houses. In comparison, only 13 % of rural have PWC inside their residents, and still, 87% are deprived of this facility and use other water sources.

Overall, in all regions, most people have two rooms accommodation, 69% have gas facility about 97% electricity facility. In contrast, 74% have toilets inside their house in urban areas, whereas in rural 88% are still deprived of gas facilities, and about half of the populations in rural still do not have toilets inside their houses.

We have a proper garbage collection system through community and self-help, and 56% use this facility while still in rural they dump in open areas, and no system prevails for garbage collection. It also shows that urban areas for their garbage collection have paid only PKR 54 while it is quite nominal for the whole month, whereas rural residents pay PKR 4. Overall, the people of Pakistan for this facility have paid PKR 20. We have limited information for neighborhood characteristics in PSLM 2014-15. Only 0.4% of people of urban areas provide information about school distance from their residents, while 0.2% rural responded in this respect. We have covered 15884 household data in this study, out of which 32 % are urban HH while around 68 % belong to the rural part of Pakistan.

Table 3. Descriptive Statistics of Hedonic-related variables

Variable	Urban Region	Rural Region	Pakistan
Dependent Variable			
Rent price per month(Pak rupees)	(35265)	(12735)	(24495)
Drinking water sources			
Piped water connection (%)	0.45	0.13	0.23
(No of HH have PWC)	(2321)	(1337)	(3658)
Household characteristics			
No. of room	(2.34)	(2.16)	(2.21)
The gas facility at home	(0.69)	(0.12)	(0.30)
Electricity facility at home	(0.97)	(0.86)	(0.89)
Toilet facility inside house	(0.74)	(0.54)	(0.50)
Environmental characteristics			
Formal garbage collection	(0.56)	(0.04)	(0.21)
Payment for garbage collection/mth	(54.2)	(4.20)	(20.04)
Neighborhood characteristics			
Formal garbage collection from neighborhood	(2.91)	(2.29)	(2.71)
Payment for garbage collection from neighborhood/mth	(17.30)	(1.22)	(6.44)
Distance to school	(0.004)	(0.002)	(0.003)
Total No. of HH	(5149)	(10735)	(15884)
(%age of total sample)	(32.42)	(67.58)	(100)

It is pertinent to estimate rural and urban regions separately to capture the effect of water connectivity and housing prices in most rural regions. Water through pipes is unavailable, and rural regions sometimes have water facilities through boring tubewells,

wells, lakes, and streams. Table 2 indicates the estimation results using equation (1) for the rural and rural regions and Pakistan overall. All variables are significant at 5% and consistent results except a few variables. Regression results for the urban region show that, for example, one unit increase in piped water connection, 8.45% rental value of a house increase as exp (0.07087) = 1.08454. No of rooms also vary significantly, contributing to enhancing the house rent. In order to increase the one room in a house, it increases the house rent by 26% as exp (0.20409) =1.26327. Similarly, the toilet facility inside the house is large, and every household prefers to have it inside their house. It also plays a significant part in increasing house rent, and it contributes significantly by 7.3% exp (0.06167) =1.07315.

We have also examined the willingness to pay off the HH for piped water connection by computing the implicit marginal price for the drinking water, and the results are presented in Table 4. We have used equation two and the median of the housing prices for both urban and rural regions and owned and rented houses for estimation. The median house rent for rural shows around PKR 12000 per month, and for urban it is up to PKR 23500, which is quite apparent. Also rented house and owned the house the median prices of the house as PKR 14000 and PKR 18000 respectively.

Table 4. Calculation of *Marginal Implicit Price (WTP)* for Drinking Water

	Rural			Urban		
	Coef	**WTP (Pak Rs)**	**WTP towards Expenditures**	**Coef**	**WTP (Pak Rs)**	**WTP towards Expenditures**
Drinking-Water Characteristics	0.0238	332	0.93%	0.07087	1676	3.05%
Median of house rent per month	12000			23500		
Median of expenditure per month	35684			55000		
	Rented House			Owned-house		
Drinking-Water Characteristics	0.03192	521	1.21%	0.05122	1087	1.46%
Median of house rent per month	14000			18000		
Median of expenditure per month	43210			74321		

Marginal willingness to pay is calculated for both, and it shows that in rural parts of Pakistan, people are willing to pay PKR 332 to avail of this facility, which is 0.93% of their running expenditures. Also, for the urban art of Pakistan, people are already paying some nominal amount for the water usage as water bills. This study shows that they are willing to pay PKR 1676 per month, which is 3.05% of their expenditures, providing clean water inside their houses. Our results are consistent with Caroline and Celine (2012) and Dendup et al. (2015). The rented and owned house dwellers are

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willing to pay PKR 521 and PKR 1087, 1.21% and 1.46 % of their monthly houses, respectively. In this, it is viewed that the HHS save their time, energy, and botheration to collect water from other sources, and they prefer to pay more money to enjoy this facility inside their houses (Caroline & Celine, 2012).

CONCLUSION

The study is designed to estimate the people's willingness to pay for piped water connection inside the house along with some other environmental factors, house-related variables, and neighborhood variables by applying the Hedonic pricing model for the survey-based data of PSLM 2013-14 for both urban and rural regions of Pakistan. It is observed that more than 80% of the households pay rent in the range of PKR 2400 to 50k, whereas less than 20% pay huge rent of PKR 50k-120k. It is also viewed that only 25 percent of households avail themselves of the water facility inside the house while the rest of 75 percent are still deprived of such facility and use other water sources declared as un-protective. Surprisingly, more than 85 percent of the HHs have their own houses, while less than 25 percent stay in rented houses.

Using the marginal implicit pricing method, MWTP is also calculated using the median of the rental values of the houses for both rural-urban regions and owned-rented houses. Table 6 shows that PKR 1676 and PKR 332 are the money value households are willing to pay per month for urban and rural areas, respectively, to have water quality inside their houses. On the same lines, PKR 1087 and PKR 521 are computed values of WTP for those who have their own houses and living on rent, respectively.

Water is an asset for any economy, and we also value them, and the government of an economy has to provide it to all citizens. On the one hand, the households must pay water usage price, and waste should be controlled. On the other hand, the government must provide clean and safe drinking water at reasonable rates. Also, the cost of water use must be determined by the availability, area of the house, locality of the house.

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