The value of water connections in Central American cities: A revealed preference study*

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Abstract

We estimate annualized values of access to home tap water in three cities in El Salvador, and marginal “barrios” in four Guatemalan cities, using a hedonic price method for studying changes in capitalized home values from obtaining a water connection. A tap water connection is found to add from 10 to 80 % to sales values of homes in our sample. The estimated mean values of gaining tap water access represent 1 to 11 % of real household income, differing by city and with generally higher values in El Salvador. On average this gain eliminates around 3 % of the initial difference in real incomes between the groups of connected and unconnected households. We also find large differences in the value of a tap connection depending on the main source of non-tap water, with greatest values when the source is public tap or well in El Salvador.

Summary

In this paper we propose to derive economic values of tap water services in Central American cities, and to measure the role of such services in affecting real income levels, based on an extensive data set for households in three cities in El Salvador, and marginal "barrios" in four cities in Guatemala. Significant fractions of the households surveyed were without tap service at the time of the survey; indeed, a criterion for selecting a city for our analysis is that the available data from this city contain substantial fractions of both tap and non-tap households. In our data we observe wide disparities in average household water consumption and water price levels, between those households that enjoy tap water access and those that do not. We estimate average consumer surplus from current tap water access for each of the cities, based on econometric "hedonic price" analysis of housing prices and their relationship with water access. Overall, our results indicate that connected households enjoy substantial welfare gains from their connections, given current water prices and service levels, both absolutely and as fractions of their household incomes. Among non-tap households in El Salvador, access to a public well (public tap) is found to reduce house value by 45 % (36 %), ceteris paribus. In Guatemalan city "barrios", access to private and public tap is found to reduce house values by 24 % and 20 %, respectively. Since unconnected households on average have far lower incomes than connected ones, providing tap water access to more households also reduces overall income inequalities. One reason for this is clearly that many unconnected households today pay far higher water prices than connected households do. But another, and perhaps more important, reason is that tap water as such provides a high level of welfare to households, due to the convenience of having water in ones home versus needing to bring it in from the outside, and as tap water access facilitates a variety of water applications (such as use in washing machines and showers). When initially unconnected households obtain tap

water access (with quality and terms as for connected households), their real incomes thereby rise by between 1 and 11 % differing between cities and with generally higher values in El Salvador. This real income increase eliminates around 3 % of the initial difference in average real incomes between the groups. We take this as evidence that tap water access may serve as an instrument for eliminating welfare differences across households in Central American cities. We also discuss potential sources of bias in the estimations, and argue that the El Salvador estimates are more likely to be biased upwards due to greater heterogeneity of residence sites here than in the Guatemalan cities.

1. Introduction

Water is an essential resource and commodity for humankind. Securing the full benefit of water for a household requires that it has access to (clean) tap water within the residence. Considering the cities in Guatemala and El Salvador dealt with in this paper, tap water coverage is far from universal. A main purpose of this paper is to derive measures of the value of a tap water connection to households. A documentation of such values is of interest for several reasons. First, it may reveal the role of tap water access in alleviating urban poverty, as gaining tap water access contributes to increased real incomes. Equally important from a policy perspective, extending tap water service to additional households typically requires public investments whose returns need to be documented. This makes it important to compare the costs and benefits of connecting additional households to the piped water system. If benefits exceed provision costs, the connections ought to be added from a pure efficiency standpoint. Thus distribution and allocation factors are both important for motivating an analysis of the type undertaken here.

Estimating or calculating the value of tap water access can be done on the basis of either stated preference (SP) or revealed preference (RP) data. A typical SP approach would apply contingent valuation (CV), where a sample of unconnected households would be surveyed about their maximum willingness to pay for a water connection. Among possible RP methods, the "hedonic price" (HP) method implies that the value of water connections is inferred from differences in property values according to current connection status. Secondly, the integral under a (known) water demand function of a given household provides a measure of value (or consumer surplus) derived from that household's current water consumption, something that can be exploited for evaluation purposes.

SP approaches have become popular and widely applied, but mostly for "intangibles" such as environmental, health and aesthetic goods. Water is a more standard marketable commodity lending itself more readily to RP valuation. We will here focus on RP analysis, in applying the HP approach indicated above. A traditional view among many economists is that RP data are generally superior to SP data, as only the former are based on actual market behavior. This should however not be taken to indicate that applying the HP method is unproblematic in our case, in particular since several assumptions lie behind it, as discussed further below.

Our basic data set contains survey data for more than 11,500 households in 17 cities in Central America and Venezuela. These data were collected in 11 different questionnaire sample surveys, where questions were asked in basically the same way in all. It permits meaningful hedonic price relationships to be derived from 7 of the cities in this data set. A criterion for selecting a city for our analysis is that the available data from this city contain substantial fractions of both tap and non-tap households. The surveys covered individual sample sizes from about 500 to 1,500 households, chosen at random among the entire populations in three El Salvador cities, and within marginal ”barrios” (poor unincorporated neighbourhoods) in four Guatemalan cities. For further description and discussion of the data, see Strand and Walker (2003, 2005).

Overall, our results indicate that connected households enjoy substantial welfare gains from their connections, given current water prices and service levels, both absolutely and as fractions of their household incomes. Welfare gains are generally larger in El Salvador than in Guatemala. In the 3 cities in El Salvador, average gains from water connections are found to constitute between 2 and 3 % of currently unconnected households’ incomes; equivalent figures for Guatemala are 1 % for three cities, and 3 % for the fourth (Mixco). Since unconnected households on average have far lower incomes than connected ones, providing tap water access to more households also reduces overall income inequalities. One reason for this is clearly that many unconnected households today pay far higher water prices than connected households do. But another, and perhaps more important, reason is that tap water as such provides a high level of welfare to households, due to the convenience of having water in ones home versus needing to bring it in from the outside, and as tap water access facilitates a variety of water applications (such as use in washing machines and showers).

This article adds to the scarce empirical literature on the valuation of access to water in developing countries. There are few studies with which our derived figures can be directly compared. North and Griffin (1993) find that average willingness to pay for access to domestic water in Philippines is approximately 2.4 % of income. Jiwanji (2000), analyzing 15 CV studies on willingness to pay for piped, pump and well water, found values of piped water in the range from 0.2 % to 10.7 % of income. Yusuf and Koundouri (2005), using data on the Indonesian housing market, estimate the willingness to pay for their dwelling to have access to piped water, pump water and well water, to be 3.6 %, 1.4 % and 0.2 % of monthly rent, respectively. The perhaps most closely related study to ours is Estache, Foster and Wodon (2002), who value water services in Honduras from hedonic price studies of differential house rents. The analytical basis for that study however seems weaker than that for our study; in particular, their house rent data are most likely quite imperfect due to widespread rent control. Their assessed monthly value of a water connection (almost certainly non-metered) is in the range 30-40 Lempiras per household, equivalent to about 8-10 USD (using the exchange rate of 13 Lempiras per USD for 1997, adjusting by a Purchasing Power Parity (PPP) factor of 3.16). The benchmark for comparison with that study should here probably be our results for Guatemala City and Villa Nueva (both in Guatemala), where our corresponding figures are found to lie in the range of 10 and 40 USD.

2. Some aspects of the household water situation in Central American cities

In this section we look briefly at some main aspects of the water situation in the three cities in El Salvador (Santa Ana, Sonsonate and San Miguel) and four cities in Guatemala (Guatemala City, Villa Nueva, Chinautla and Mixco) included in our analysis below. Table 1 shows distributions of households by mode of water service in our sample. The samples in El Salvador (Guatemala) were collected in citywide (marginal barrios) and random household interview surveys, conducted in 1996-1997, where sampled households were asked questions related to water and sanitation (with surveys conducted in essentially the same way in all the cities). We distinguish between three main groups of households, namely 1) metered tap-connected households, 2) non-metered tap households, and 3) unconnected (or non-tap) households. In each of the seven cities, a substantial fraction of households (ranging from 20 % in Mixco, to 65 % in Guatemala City) are not tap-connected. Among sampled tap-connected households, less than half are metered in El Salvador, and none in Guatemala.

Table 2 shows average sampled household water consumption, by city. For metered tap households, these are measured directly. For non-metered tap households, individual figures are not directly observed; however, total city-wide consumption is observed, and individual household figures are imputed on the basis of these observations in combination with estimated water demand functions for non-metered tap households (where, typically, all variables except water demand are observed also for non-metered households). Non-tap households were in the survey asked to state their water consumption, payment and hauling cost, for different categories of water, over the last month prior to the survey.

The data reveal enormous differences in average water consumption levels, between tap and non-tap households. Average monthly tap consumption is 30-35 m^3 in most cases, similar across cities at least for metered households where data are most reliable. By contrast, average non-tap consumption is only 5-8 m^3 per month, less than one fourth of average tap consumption, and much more variable across cities, but in no case more than one third of the average tap water consumption level (with the highest figures for San Miguel). The differences between metered and non-metered tap households are small with slightly higher consumption levels in the latter group. These small differences in average consumption levels are however deceptive. Non-metered households face a zero marginal water price, and have a more wasteful water consumption than metered households, which increases their water consumption. On the other hand, they tend to have characteristics correlated with low water consumption, such as relatively small incomes and residences, and face more frequent rationing, factors that tend to make their water consumption lower than otherwise.

Water consumption is lower among non-tap households than tap households, for at least five different reasons. First, non-tap water prices are higher for most households, at least for marginal water consumption (some households have some "free" water through own wells, but most often pay dearly for additional supply). Secondly, water access itself is less convenient for those without tap, who in most cases must haul their water to the house. Thirdly, without tap many potential uses of water are made less convenient (or sometimes even ruled out), such as using washers or even perhaps taking showers. Fourthly, non-tap households tend to have characteristics (e.g. low income) correlated with low water consumption. Other characteristics of non-tap households (such as large family sizes and living in highly polluted neighbourhoods) however oppose these effects, implying that the fourth argument is unimportant overall. Fifthly, water quality is often higher and better controlled for tap water than for non-tap water (see Strand and Walker 2005, for an estimation of water demand functions for tap and non-tap households using data from the same survey).

Table 3 shows water prices (in 2001 US dollars, PPP converted) paid by metered tap and non-tap households.[1] Most strikingly, the average ratio of purchase prices for non-tap to

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[1] All price variables are translated into current 2001 USD values corrected using purchasing power parity (PPP) exchange rates published annually in the World Development Report. PPP conversion factor for El Salvador and Guatemala is 1.55 and 2.56 respectively. To find figures in current USD, the figures in table 3 must be divided by these conversion factors.

tap water is almost 10, and is nowhere less than 6 (except in San Miguel, where many households rely on private wells, and the average ratio is only 1.7). The right-hand column of table 3 shows times spent on water hauling by non-tap households. The average household hauling time is about 11 hours per month, varying widely (3 to 24 hours) across cities. These figures indicate considerable inconvenience in obtaining water for non-tap households.

Non-tap household access to the different water sources (private and public wells, private and public taps, trucks) varies across cities. Table 4 shows average water consumption by source for non-connected households. Consumption of households purchasing water from trucks is higher on average than consumption of households getting water from other sources, most likely since time costs of water hauling are lower for truck water than for water from other public wells or taps. In cities in El Salvador average consumption from private wells is higher, as more households own private wells. In the Guatemala cities, households in marginal barrios do not have private wells, and water has to be brought from someone else's private tap or from public sources, at substantial pecuniary and hauling cost. This suggests that private wells or access to particular water sources may be valued highly by non-tap households. Even more, a tap connection is likely to be highly valued due both to the higher pecuniary and hauling costs associated with non-tap water, and to the range of water uses made possible by tap connections.

3. Deriving capitalized values of water services from home price data

Home prices are likely to embed values of amenities supplied at or near the home. This corresponds to the theory of hedonic prices presented by Rosen (1974), with application to the housing market by Freeman (1993), Palmquist (2000) and Taylor (2003), and recent applications by Lake et al (1998), Boyle, Poor and Taylor (1999), Bateman et al (2000), Day (2001), and Strand and Vågnes (2001). Water service quality is one important such amenity.

In principle, when a house is purchased, the buyer also purchases the net (expected present) value of water services (and other relevant services) provided at the house, at all future dates. Consider two houses differing only in the value of water services provided, in a perfectly competitive housing market where all households have the same demand for water services. Different prices of the two houses will then perfectly reflect differences in present values of water services provided. In practice the issue is more complicated, for several reasons: housing markets are often not perfectly competitive; household preferences differ in other (systematic and non-systematic) ways; and water access may be correlated with other, often unobserved, valuable house attributes. Different household preferences also imply that households who value water services highly, have already chosen houses with access to such services, leaving households with lower values in houses without service. Correlation between attributes may imply that a high house price in part reflects high quality of other services than water, leaving water services to explain only part of the house price difference. House prices may also embed expectations about future changes in amenity values (e.g., when an improved water service is expected to be provided at some future date, this should increase the house price for a given current service). The two first of these factors imply that house price differences tend to overestimate the value of water services, while the latter factor implies the opposite.

Our data set contains about 2,400 households in the 7 cities for whom individual residence values are recorded (assessed by respondents at the time of interview), together with information on square-meter sizes of residential units and lots and types of ownership. In table 5 average home values for metered, non-metered tap, and non-connected households are reported for each city in the sample. Home values vary considerably by city and category. We must again stress that the figures are not fully comparable between the two countries as the survey was conducted in marginal barrios in the Guatemalan cities, and in the entire El

Salvador cities. Average house prices are in all cities far higher for houses with tap water access than for those without (apart from Chinautla, Guatemala, where the difference is small). For all surveyed households in aggregate, house prices average about 13,000 USD (PPP adjusted) for houses with no water connection, and about 25,000 and 38,000 USD for homes with non-metered and metered tap connections, respectively, generally higher in the El Salvador sample than in the Guatemala sample. There however seems to be little difference in house prices among tap households by whether they do or do not have meters; this is evident from the data for the El Salvador cities, which are the only cities where metered and non-metered water service coexist. We also find that most metered tap households, and somewhat fewer non-metered tap households, live in residential units with titled ownership, while most of the rest live in units with untitled ownership. By contrast, less than a third of non-tap households have ownership title.[2]

4. Model specification and estimation results

Hedonic regressions are used to derive the value of tap water connections, relative to access to specific water sources for non-connected households. Because of different sampling principles (city-wide in El Salvador, and marginal barrios only in Guatemala), we carry out two separate sets of estimations, one for each country. Specification tests have confirmed that data from El Salvador and Guatemala cannot be pooled, but have not rejected a similar hypothesis for data from different cities within each of the two countries. This gives a basis for pooling the data across cities in each of the two countries.

We estimate log-linear regressions where house prices are explained by water service variables, in addition to several other observed variables. The main objective is to identify the value of alternative available sources (private well, public well, private tap, public tap, and

[2] Statistics on ownership title are not shown here but are available from the authors upon request.

truck delivery), using dummy variables taking the value of one if and only if the household uses the particular source in question. The number of households combining more than one non-tap source is quite small (less than 10 % in each of the countries), implying that water in most cases comes primarily from one source. In line with this, and without making a large error, we assume in the following that non-tap households use only one non-tap source, namely the most important one used during the month of survey.[3] Relevant sources for both cities are private and public tap, public well and trucks, and for El Salvador private well. To correct for other house characteristics, these relations include residence and lot size in square meters, floor main material, and the existence of electricity service at the property. Variables in the relationships that serve to control for overall neighbourhood quality, are composite material used in the street, availability of electricity access, and average household income. We also include dummy variables to correct for ownership title to the property, and for city.[4] Table 6 presents some descriptive statistics for these variables, for tap and non-tap households in the two countries.

Table 7 shows results from these key estimations in the paper, for the relationship between house price, water access variables, and background variables. These estimations are done separately for each of the two countries. In each case, the estimation is done using the entire sample of connected and non-connected households, with connected households as the reference group. We only report log-linear relationships. Linear and semi-log relationships were also fitted, but give inferior fits. The coefficients related to the dummy variables for non-tap water supply (corrected for the background variables) here indicate the relative reduction in house price for households with such water access, when compared to house prices for connected households. All non-tap source indicators are found to be negative for

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[3] We checked the sensitivity of our results to this assumption. Estimated coefficients and standard errors of the parameters of interest were found quite robust.

[4] The dummy variable indicating whether a private connection is metered or not was never found statistically significant.

both countries (but not always significant), implying that non-tap water is always less attractive than a tap water connection, everything else equal. This is of course as expected. It is particularly disadvantageous to rely on public sources (either public tap or public well) in El Salvador, while private tap (from other households) is the least valued water access in Guatemala. A house in El Salvador without connection to the water network but with access to a public well is priced 45 % lower (1-exp (-0.6001) = 0.45) than a house with a private connection, everything else equal. The corresponding figure for public tap is 36 %. The result that public non-tap sources are associated with low house values is intuitively reasonable, from the discussion above, in particular since hauling costs are large for such households. On the other hand, houses in El Salvador with access to private non-tap sources (private tap or private well), or served by trucks, are found to have prices in the same range as those enjoying private connections.

For our Guatemala households, relying on (other households') private tap as the main non-tap supply reduces house value by 24 % on average, relative to connected houses. This effect if highly significant. Access to a public tap is found to lower house values by 20 % on average and is "almost" significant (with associated probability value just above 0.10). For truck supply, the coefficient is significant at the 15 % level. The public well indicator variable is not significant, which is unsurprising as we have only 8 households in this group.

Lack of tap-water service does not reduce house values significantly when the household instead has access to private well (something that is observed only for the El Salvador sample). This is not surprising, for two reasons: first, own well water is typically costless and may need little hauling; and secondly, from table 4, monthly water consumption per household is quite high for these households, in particular in San Miguel where private wells are the dominant kind of non-tap supply. Overall water consumption in these households is thus not significantly held back by lack of tap-water access.

Table 7 also shows us the effects on house values of the other variables included in the regressions, hereunder city-specific effects, house characteristics and overall neighbourhood quality effects. Most of these variables are highly significant, and have the expected signs. In particular, characteristics of the house such as floor area of the residence, size of the lot, and floor material, have highly significant impacts on house values.

A common objection to this type of hedonic analysis is that other, unobservable, variables may be correlated with both house prices and tap water access, something that will tend to bias the estimated results. In particular, houses located in nondesirable neighbourhoods of a given city tend to have less desirable types of water access as well; and not all aspects of a “nondesirable” neighbourhood may be picked up by the explanatory variables we have been able to include. In such cases, there will be a tendency for the effect of water access on house prices to be exaggerated or overestimated in our estimations. It is in this context of some interest to compare the results from the El Salvador and the Guatemala. For the Guatemala data, the entire sample of households is from marginal “barrios”, consisting generally of non-incorporated, and the least desirable, sections of the respective cities. In the El Salvador cities, by contrast, the samples are from the entire cities. This may indicate that the estimations conducted on the Guatemalan data are more trustworthy, as there may be less “noise” in the part of the relations attempting to pick up the water variables.

We also see that most of the indicator variables for non-tap access have lower coefficients in Guatemala than in El Salvador (including also the variable for electricity access), and are also significant in fewer cases. Since we may have somewhat greater reason to trust the Guatemala data more than the El Salvador data, from the argument just given above, there results may lead us to suspect that effects of water access on house values may be biased upward in our El Salvador sample.

In tables 8-9, the first line in each block shows average home prices, with table 8 showing results for cities in El Salvador, and table 9 for Guatemala, respectively. The next line in the block shows the calculated relative house price increase when a previously unconnected house relying on a particular non-tap water source, obtains a tap water connection. These calculations are based on the estimated dummy coefficient of this particular non-tap source. The final line in the block is derived by simply taking the average house prices in the first row, and adding the percentage increase in the second row. We then arrive at "predicted values" of houses that previously relied on a particular water source, but are now connected to the water system: these values we call "predicted house values".[5] Such values can be viewed as realized in the (hypothetical) event that the respective households were connected to the tap water system, on the basis of our estimated hedonic function. Figures in italics indicate that averages have been computed using 5 or less observations.

We also calculate the corresponding average monthly gain from a water connection, by transforming the figures in tables 8-9 into monthly income equivalents for the respective households. In tables 10-11 we present two sets of such calculations (with same remark as for tables 8-9 applying, regarding figures in italics). The first are direct monthly income gain estimates, based on an assumed discount rate of 15 %, which may seem high but is consistent with local private lending rates. On this basis we calculate the corresponding monthly values as 1/12 of respective annualized values. Willingness to pay for a tap connection calculated in this way for cities in El Salvador, provided in table 10, varies substantially between cities and initial water sources. It is generally higher in San Miguel than in the two other cities, reflecting the generally higher home prices and incomes in San Miguel (with the exception of household relying on truck supply in Santa Ana, where values are higher). Monthly values here vary from a low of 18 USD for private well users in Sonsonate, to a high of 127 USD for

[5] Standard errors are also shown in the table.

public well users in Santa Ana and San Miguel (all PPP adjusted). These values represent fractions of total household income varying from a low of 0.9 % (for private well users in Sonsonate) to a high of 7 % (for public well users in San Miguel).

In the Guatemalan cities, with figures given in table 11, equivalent numbers are substantially lower, reflecting both the lower relative impacts on house prices, and lower general house values. An exception from this pattern is Mixco, where figures are comparable to those in El Salvador. Apart from Mixco, income equivalents in Guatemalan cities vary from a low of only 3 USD per month for truck water users in Chinautla (representing 0.6 % of average household income), to a high of 39 USD for public tap users in Guatemala City (representing 2.7 % of household income). In Mixco where gains are greater, the largest gains from a tap water connection are for households with access to public well, who are estimated to gain 126 USD per month on the average, leading to a relative household income increase by 11 %.[6]

The results derived above can also be used to find the impact of complete tap water coverage on overall average incomes among the population of currently unconnected households. We present in tables 12-13 the income effects of providing tap connection to all currently unconnected households (using previous assumptions about how changes in home prices can be translated into income effects), for the cities in El Salvador and Guatemala respectively. Although this is not directly displayed in the tables, the provision of full tap coverage would shift the income distribution of unconnected households to the right. The reason for this is that unconnected households generally belong to the lowest-income groups in the cities in question. The tables present results on how average incomes of the currently unconnected would move in each of the cities. In the El Salvador cities, reported in table 12, average incomes would increase by between 2.4 % (San Miguel) and 3.0 % (Sonsonate). In

[6] We have to be cautious here since the latter numbers are averages over 3 observations only.

Guatemala, providing full tap coverage increases the incomes of unconnected households only moderately (by 0.8 – 1.4 %), except in Mixco where the average increase is 2.8 %, similar to that in El Salvador.

To these results one should clearly add the reservation made above, that there may be upward biases in the estimated water access coefficients, in particular for the El Salvador cities, and an equivalent upward bias in the estimated house value effects. We have no clear indication of the magnitude of any possible bias. Note however that the coefficients for "public tap indicator" and "private well indicator" are twice as great in El Salvador as in Guatemala; this may indicate some possible range of bias, although it is of course not conclusive.

Our estimates may also have implications for efficient resource allocation in the household water sector. Provision of one additional connection is worthwhile from a social efficiency point of view if willingness to pay for the connection exceeds the social costs of the connection. These costs consist of the costs of the water provision per household, and the costs of the connection itself. In the Central American cities in question, long-run marginal cost of additional water provision is close to 0.50 (current) USD per m^3, translated to 1-1.50 USD in PPP terms. At current consumption rates for tap households in the region (around 25 m^3 per month higher than for non-tap households), provision costs are then approximately 25-40 (PPP) USD per month per household. To this number one must add connection costs, which may vary widely. For connections to be socially beneficial, these costs must be more than outweighed by households' willingness to pay, which is the sum of the WTP figures (for access to a tap water connection) derived here, plus the water bill payments made by connected households. No such calculations are made here; it however seems very plausible that benefits of additional connections exceed costs in many, perhaps most, cases, in particular in El Salvador.

5. Concluding remarks

We have in this paper attempted to derive economic values of tap water services in Central American cities, and the role of such services in affecting real income levels, based on an extensive data set for households in three cities in El Salvador, and marginal "barrios" in four cities in Guatemala. Significant fractions of the households surveyed were without tap service at the time of the survey; indeed, a criterion for selecting a city for our analysis is that the available data from this city contain substantial fractions of both tap and non-tap households. In our data we observe wide disparities in average household water consumption and water price levels, between those households that enjoy tap water access and those that do not. We estimate average consumer surplus from current tap water access for each of the cities, based on econometric "hedonic price" analysis of housing prices and their relationship with water access. The value of housing property is in most cases found to be significantly affected by whether or not the house is connected to the water system. Among non-tap households in El Salvador, access to a public well (public tap) is found to reduce house value by 45 % (36 %), ceteris paribus. Access to a private tap or well or to truck services is found not to significantly reduce house values in El Salvador. In Guatemalan city "barrios", access to private and public tap is found to reduce house values by 24 % and 20 %, respectively.

When correcting for other available variables, a tap water connection is on average found to add 10-80 % to the sales value of the house in El Salvador (everything else equal), depending on the non-tap source, and a slightly lower range, 10-40 %, in the Guatemalan marginal barrios. Assuming an annual discount rate of 15 %, the average addition to a household's welfare from having a tap water connection is mostly in the range 20 – 130 USD per month (PPP adjusted) in the cities in El Salvador (and highest in San Miguel); and in a lower range, mostly 5 – 40 USD per month, in the marginal barrios in Guatemala City, Villa Nueva and Chinautla, and 5 – 130 USD in Mixco.

Letting the income concept include net benefits from water consumption, average incomes are higher by about 60 % among households with tap water access relative to those without such access. When initially unconnected households obtain tap water access (with quality and terms as for connected households), their real incomes thereby rise by between 1 and 11 % differing between cities and with generally higher values in El Salvador. This real income increase eliminates around 3 % of the initial difference in average real incomes between the groups. We take this as evidence that tap water access may serve as an instrument for eliminating welfare differences across households in Central American cities.

We have added a qualification, however, that there may be upward biases in particular in the El Salvador estimations due to our inability to correct for the effects of all relevant neighbourhood characteristics on house values. We argue that this is less of a problem in Guatemala where all houses in our sample are located in marginal "barrios". A general problem with the hedonic price method for amenity valuation is the general inability to correct for all relevant background variables that may affect house prices; this is a particularly serious problem when the neighbourhoods from which the data are collected, are very heterogeneous, a problem that here applies mainly to the El Salvador data. Clearly, future work, applying this method, must seek to improve the data bases in these dimensions, through more careful and detailed data on house characteristics and location. We intend to contribute to such work in the future.

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Tables

Table 1. Distributions of households by type of water supply

City	Number of households	Number of metered tap households (share, %)	Number of non-metered tap households (share, %)	Number of non-tap households (share, %)
El Salvador				
Santa Ana	645	153 (24)	349 (54)	143 (22)
Sonsonate	670	143 (21)	302 (45)	225 (34)
San Miguel	545	111 (20)	239 (44)	195 (36)
Guatemala (marginal barrios)				
Guatemala City	358		125 (35)	233 (65)
Villa Nueva	945		739 (78)	206 (22)
Chinautla	201		133 (66)	68 (34)
Mixco	652		522 (80)	130 (20)
Total	4,016	407 (10)	2,409 (60)	1,200 (30)

Table 2. Average household water consumption (in cubic meters per month)

City	Metered tap households	Non-metered tap households, imputed	Non-tap households
El Salvador			
Santa Ana	30.5	31.2	8.5
Sonsonate	31.1	31.1	5.1
San Miguel	30.1	33.2	11.4
Guatemala (marginal barrios)			
Guatemala City		28.9	5.2
Villa Nueva		30.4	7.1
Chinautla		31.0	3.1
Mixco		34.2	8.3

Table 3. Pecuniary and time costs of water service, across cities[(a)]

City	PPP conversion factor[(b)]	Marginal tap price, metered house-holds	Average tap price, metered households	Imputed average tap price, non-metered households	Average water price, nontap households	Hauling times, h/mo, non-tap households
El Salvador						
Santa Ana	1.55	0.32	0.26	0.34	2.08	2.95
Sonsonate	1.55	0.33	0.26	0.31	2.76	8.15
San Miguel	1.55	0.32	0.26	0.36	0.61	3.72
Guatemala (marginal barrios)						
Guatemala City	2.56			0.22	5.73	24.22
Villa Nueva	2.56			0.44	5.27	15.09
Chinautla	2.56			0.36	3.23	8.48
Mixco	2.56			0.28	5.68	11.59

(a) Pecuniary costs in USD per m^3 at PPP rates.
(b) Purchasing Power Parity.

Table 4. Average water consumption by type of source for non-tap households[(a), (b)]

City	Private well	Public well	Private tap	Public tap	Trucks
El Salvador					
Santa Ana	10.69 (12)	6.97 (33)	3.11 (45)	3.02 (16)	8.61 (39)
Sonsonate	7.07 (33)	3.74 (4)	2.36 (74)	4.07 (134)	
San Miguel	12.32 (128)	12.65 (20)	4.13 (47)	3.53 (38)	16.94 (2)
Guatemala (marginal barrios)					
Guatemala City	1.74 (8)	2.26 (10)	2.75 (62)	3.33 (45)	6.73 (126)
Villa Nueva	1.51 (2)	1.32 (1)	4.03 (45)	6.00 (53)	8.77 (105)
Chinautla			3.64 (43)	4.50 (9)	2.84 (3)
Mixco	0.57 (1)	1.72 (18)	4.20 (22)		8.98 (106)

(a) Average household water consumption is measured in cubic meters per month.
(b) Number of households are shown in parentheses.

Table 5. Average home values, by water service mode and city in the sample[(a), (b)]

City	Metered tap households	Non-metered tap households	Non-tap households
El Salvador			
Santa Ana	25,698 (78)	25,706 (164)	13,432 (66)
Sonsonate	41,577 (72)	41,297 (134)	10,195 (112)
San Miguel	50,684 (58)	50,467 (130)	27,730 (107)
Guatemala (marginal barrios)			
Guatemala City		12,071 (82)	6,474 (138)
Villa Nueva		12,247 (558)	7,844 (144)
Chinautla		6,833 (87)	6,159 (36)
Mixco		36,508 (360)	22,573 (79)

(a) Home values are measured in USD, PPP converted.
(b) Number of households are shown in parentheses.

Table 6. Descriptive statistics for tap and non-tap households, by country

Variable	El Salvador		Guatemala (marginal barrios)	
	Tap households	Non-tap households	Tap households	Non-tap households
House value (USD)	38,126	17,425	19,276	10,496
Size of residence (m^2)	118	89	79	52
Size of lot (m^2)	233	229	102	81
Income (USD/month)	3,435	2,105	1,838	1,542
Floor main material :				
Brick stone or ceramic tiles (0/1)	0.91	0.54	0.26	0.08
Cement slab/cement blocks (0/1)	0.05	0.13	0.38	0.28
Dirt (0/1)	0.04	0.33	0.37	0.64
Owner with title (0/1)	0.61	0.43	0.29	0.11
Electricity service (0/1)	0.99	0.89	0.97	0.85
Street material :				
Concrete (Asphalt Cement or similar) (0/1)	0.66	0.11	0.53	0.22
Dirt (0/1)	0.34	0.89	0.47	0.78

Table 7. Estimation results for the hedonic price relationship[(a)]

Variable	El Salvador cities		Guatemala marginal barrios	
	Coefficient[(b)] (Std error)	Prob>t	Coefficient (Std error)	Prob>t
Constant	6.5371*** (0.3708)	0.000	7.6550*** (0.3822)	0.000
Santa Ana dummy[(c)]	-0.5503*** (0.0753)	0.000	-	-
Sonsonate dummy	-0.3499*** (0.0756)	0.000	-	-
Guatemala City dummy[(d)]	-	-	-0.8154*** (0.0987)	0.000
Villa Nueva dummy	-	-	-0.7154*** (0.0800)	0.000
Chinautla dummy	-	-	-0.9856*** (0.1177)	0.000
Size of residence (log)	0.2638*** (0.0479)	0.000	0.1267*** (0.0448)	0.005
Size of lot (log)	0.2483*** (0.0447)	0.000	0.3882*** (0.0666)	0.000
Income (log)	0.1461*** (0.0358)	0.000	0.0548* (0.0325)	0.092
Owner with title	0.0868 (0.0606)	0.153	0.0723 (0.0701)	0.302
Electricity dummy	0.3053* (0.1601)	0.057	0.1168 (0.1144)	0.308
Private tap indicator	-0.1247 (0.1393)	0.371	-0.2709** (0.1156)	0.019
Public tap indicator	-0.4459*** (0.1198)	0.000	-0.2182 (0.1352)	0.107
Public well indicator	-0.6001*** (0.1742)	0.001	-0.3195 (0.3153)	0.311
Private well indicator	-0.1285 (0.1073)	0.231	-	-
Truck indicator	-0.2147 (0.2048)	0.295	-0.1056 (0.0732)	0.150
Street material: dirt road[(e)]	-0.2050*** (0.0682)	0.003	-0.4244*** (0.0525)	0.000
Floor material: cement slab or blocks[(f)]	-0.4694*** (0.1162)	0.000	-0.3921*** (0.0714)	0.000
Floor material: dirt	-0.5177*** (0.1032)	0.000	-0.6912*** (0.0802)	0.000
Number of observations	899		1,316	
Multiple R-squared (adjusted)	0.40		0.46	

(a) Connected households are taken as reference group.
(b) ***, **, * indicate significance at the 1, 5 and 10 % level respectively.
(c) San Miguel is reference city for El Salvador.
(d) Mixco is reference city for Guatemala.
(e) Asphalt or concrete cement is the reference category for street material.
(f) Brick, stone or ceramic tiles is the reference category for main floor material.

Table 8. Imputed home prices for non-tap households obtaining a connection to the tap water system. Cities in El Salvador[(a)]

Households with access to:		Santa Ana[(b)]	Sonsonate	San Miguel
Private tap	Number of households	17	19	9
	Current house value	13,881	15,280	20,259
	Change in house value %	13	13	13
	Predicted house value (standard error)	15,724 (2,191)	17,309 (2,412)	22,950 (3,198)
Public tap	Number of households	8	73	7
	Current house value	5,244	8,837	16,236
	Change in house value %	56	56	56
	Predicted house value (standard error)	8,191 (981)	13,802 (1,653)	25,359 (3,038)
Public well	Number of households	16	*2*	8
	Current house value	12,370	*6,196*	12,347
	Change in house value %	82	*82*	82
	Predicted house value (standard error)	22,541 (3,927)	*11,291* *(1,967)*	22,501 (3,920)
Private well	Number of households	*5*	15	75
	Current house value	*10,798*	10,775	31,218
	Change in house value	*14*	14	14
	Predicted house value (standard error)	*12,280* *(1,318)*	12,253 (1,315)	35,499 (3,810)
Truck supply	Number of households	18	0	*1*
	Current house value	19,325	-	*8,851*
	Change in house value %	24	-	*24*
	Predicted house value (standard error)	23,953 (4,906)	-	*10,971* *(2,247)*

(a) Capitalized values in USD, PPP adjusted.
(b) Figures in italics indicate that averages have been computed from 5 or less observations.

Table 9. Imputed home prices for non-tap households obtaining a connection to the tap water system. Marginal barrios in Guatemala[(a)]

Households with access to:		Guatemala city[(b)]	Villa Nueva	Chinautla	Mixco
Private tap	Number of households	18	20	23	8
	Current house value	5,336	4,796	5,904	22,042
	Change in house value %	31	31	31	31
	Predicted house value (standard error)	6,996 (809)	6,289 (727)	7,741 (895)	28,900 (3,342)
Public tap	Number of households	15	26	*5*	0
	Current house value	12,724	4,341	*5,153*	-
	Change in house value %	24	24	*24*	-
	Predicted house value (standard error)	15,826 (2,140)	5,399 (730)	*6,409* *(867)*	-
Public well	Number of households	*5*	0	0	*3*
	Current house value	*3,153*	-	-	*26,831*
	Change in house value %	*38*	-	-	*38*
	Predicted house value (standard error)	*4,341* *(1,369)*	-	-	*36,933* *(11,646)*
Truck supply	Number of households	72	69	*2*	55
	Current house value	6,535	11,130	*2,075*	22,659
	Change in house value %	11	11	*11*	11
	Predicted house value (standard error)	7,263 (532)	12,370 (906)	*2,306* *(169)*	25,183 (1,844)

(a) Capitalized values in USD, PPP adjusted.
(b) Figures in italics indicate that averages have been computed from 5 or less observations.

Table 10. Average estimated effects on home prices of obtaining a connection to the tap water system, for previously non-connected households. Cities in El Salvador.

Households with access to:		Santa Ana[(a)]	Sonsonate	San Miguel
Private tap	Monthly income equivalent (USD)	23	25	34
	As a share of monthly income (%)	1.8	1.3	1.2
Public tap	Monthly income equivalent (USD)	37	62	114
	As a share of monthly income (%)	2.9	4.1	6.3
Public well	Monthly income equivalent (USD)	127	*64*	127
	As a share of monthly income (%)	3.0	*4.6*	7.0
Private well	Monthly income equivalent (USD)	*19*	18	54
	As a share of monthly income (%)	*1.2*	0.9	2.0
Truck supply	Monthly income equivalent (USD)	58	-	*26*
	As a share of monthly income (%)	2.2	-	*2.2*

(a) Figures in italics indicate that averages have been computed from 5 or less observations.

Table 11. Average estimated effects on home prices of being connected, for previously non-connected households. Marginal barrios in Guatemala.

Households with access to:		Guatemala city[(a)]	Villa Nueva	Chinautla	Mixco
Private tap	Monthly income equivalent (USD)	21	19	23	86
	As a share of monthly income (%)	1.5	1.2	1.5	5.3
Public tap	Monthly income equivalent (USD)	39	13	*16*	-
	As a share of monthly income (%)	2.7	0.8	*1.1*	-
Public well	Monthly income equivalent (USD)	*15*	-	-	*126*
	As a share of monthly income (%)	*1.5*	-	-	*11.2*
Truck supply	Monthly income equivalent (USD)	9	15	*3*	32
	As a share of monthly income (%)	0.7	0.8	*0.6*	2.1

(a) Figures in italics indicate that averages have been computed from 5 or less observations.

Table 12. Average estimated effects on real income of obtaining a connection to the tap water system, for previously non-connected households. Cities in El Salvador[(a)]

Income concept		Santa Ana	Sonsonate	San Miguel
Initial income	Mean	2,402	1,661	2,566
Real income after tap connection	Mean	2,462	1,711	2,627
	% change	2.5	3.0	2.4

(a) Income values in USD, PPP adjusted.

Table 13. Average estimated effects on real income of obtaining a connection to the tap water system, for previously non-connected households. Marginal barrios in Guatemala[(a)]

Income concept		Guatemala city	Villa Nueva	Chinautla	Mixco
Current income	Mean	1,385	1,868	1,432	1,508
Income after tap connection	Mean	1,400	1,883	1,452	1,550
	% change	1.1	0.8	1.4	2.8

(a) Income values in USD, PPP adjusted.