UNITED NATIONS UNIVERSITY
UNU-WIDER
World Institute for Development Economics Research

Working Paper No. 2011/23

# Public-Private Co-operation for Gas Provision in Poor Neighbourhoods of Buenos Aires

## Impact on Housing Improvements and Health

Cynthia Goytia[1], Ricardo Pasquini[2], and Pablo Sanguinetti[3]

April 2011

**Abstract**

This study examines the programme *Redes Solidarias*, a public-private initiative that connected to natural pipelined gas 4,000 households in the Great Buenos Aires Area during 2005. The main features of the institutional framework are described and the main results of an impact estimation analysis are reported. The mechanism of selection of neighbourhoods for the connection represents a 'natural experiment', which allows the estimation of the causal effects of the programme on several indicators, including housing improvements, health and happiness related variables. We perform this analysis using data from two surveys we collected on the neighbourhoods in 2006 and 2007. The programme was found to generate improvements on dwelling walls, and the …

Keywords: infrastructure provision, gas, impact evaluation
JEL classification: H43, I31, I38, O22



[1]Universidad Torcuato di Tella (UTDT), email: cgoytia@utdt.edu; [2]UTDT and CEF; email: rpasquini@gmail.com, [3]CAF and UTDT, email: psanguinetti@caf.com

This study has been prepared within the UNU-WIDER project on Development in an Urban World, directed by Jo Beall, Basudeb Guha-Khasnobis, and Ravi Kanbur.

UNU-WIDER gratefully acknowledges the financial contributions to the research programme by the governments of Denmark (Royal Ministry of Foreign Affairs), Finland (Ministry for Foreign Affairs), Sweden (Swedish International Development Cooperation Agency—Sida) and the United Kingdom (Department for International Development).

ISSN 1798-7237 ISBN 978-92-9230-386-0

installation of hot water in the bathroom. A significant reduction of cases of flu, fever and other respiratory diseases is also found. Finally, the programme is found to improve the satisfaction reported by people with respect to their dwellings.

**Acknowledgements**

We want to give special thanks to Gabriel Lanfranchi and Jerome Saniez from Fundación Pro Vivienda Social for collaborating in this research project. We also thank participants in the LACEA seminar and UNU-WIDER session in Buenos Aires (May 2009) for their comments.



UNU World Institute for Development Economics Research (UNU-WIDER)
Katajanokanlaituri 6 B, 00160 Helsinki, Finland

Typescript prepared by Lorraine Telfer-Taivainen at UNU-WIDER

# 1 Introduction

The improvement of infrastructure, among the interventions that aim at reducing poverty, is certainly one of the most relevant. For example, the attainment of almost all the MDG goals depends, at least in part, on the improvements in infrastructure services.The reason for this is the impact of the services on the quality of life and on the sanitary conditions of the population (Amis 2001). Despite this importance of housing characteristics and infrastructure as crucial factors to influence on the general wellbeing of its dwellers, little work has been done to assess the causal impact of infrastructure and housing improvement programmes on the formalization, health and welfare of the most poor.

In this study, we examine one particular aspect of housing infrastructure: the provision of natural gas pipelined services and its impact on the health and satisfaction of the dwellers that live in informal settlements. Specifically, we analyze a programme for network gas supply in the Greater Buenos Aires area and identify its impact on the formalization of the dwellings, households' happiness and health, particularly as regards respiratory diseases, flu, fever and gastrointestinal diseases.

The programme *Redes Solidarias* (solidarity networks) was implemented in the locality of Moreno in Great Buenos Aires Area (GBA), through a novel institutional logistic which included a strong participation of the community. An NGO, Fundación Pro Vivienda Social (FPVS), in co-operation with the licensee company for the distribution of natural gas service, the local municipality and neighbourhood organizations were involved in its implementation. It provided access to the gas network for low-income households living in the informal settlements of a relatively poor neighbourhood of the area, named 'Cuartel V'. The area involved has 2.5 square kilometres, 200 blocks where 4,100 families live; approximately 17,000 people.

In order to identify the causal impact caused by the intervention, we took advantage of a geographical discontinuity in the allocation of the programme. Because of technical constraints, the programme had to be implemented in a group of neighbourhoods that were closer to the existent pipeline and leave other similar neighbourhoods to a future stage. The allocation mechanism can be considered exogenous and allow the evaluation, avoiding possible self-selection biases. Several outcomes are examined: (i) dwelling formalization, (ii) health, and (iii) satisfaction indicators. We test the hypothesis that access to a gas programme induces dwelling improvements, such as an improved quality of wall or floor construction, which related to a forced housing formalization process, and other related outcomes such as the connection to a water network inside the dwelling. In terms of health indicators, we examine the occurrence of flu, fever, and other respiratory and gastrointestinal diseases.

The access to basic infrastructure services has a direct effect on the economic equation of households since such services represent a significant portion of the monthly expenses of families. The main reason is that families living in these settlements have to spend relatively high prices to purchase low-quality substitutes of these services (Estache et al. 2002). Therefore, a strategy of efficient provision of infrastructure services may have a very high social return.

The literature examining infrastructure interventions also shows that these produce direct and indirect effects on the physical and mental health of the population, as well as on their welfare (Shaw 2004). For example, the goal of the programme Piso Firme de México was to replace earthen floors with cement in low-income dwellings. This intervention had significant effects on children, since their health improved and so did their cognitive development. Adults were happier and their mental health also improved, and there was no alteration of the indicators of household income for the dwellings that were part of the programme (Cattaneo et al. 2007).

In relation to health outcomes, some articles in the literature have shown that the use of certain alternative fuels, the lack of heating or hot water, the existence of moisture and insufficient home ventilation are risk factors for respiratory health in household members (Dasgupta et al. 2004; Duflo et al. 2008). The medical literature in particular, remarks that the quality of the fuel and the kind of devices used to cook and provide heating inside the dwelling may affect the respiratory health of its inhabitants, especially that of children (Triche et al. 2002). In dwellings with building deficiencies and bad ventilation, the frequent use of fuel to cook in the same room that the household members use to sleep is a risk factor that increases the possibilities of suffering respiratory diseases (D'Souza 1997). The presence within the dwelling of particles in the air generated by domestic combustion processes that use solid fuels, such as biomass or fuelwood, is associated with the prevalence of respiratory diseases and allergies (EPA 2006; WHO 2002). Similarly, in order to have acceptable levels in air quality within the dwelling it is necessary to maintain proper ventilation. However, proper ventilation levels within low-income households mean an extra loss or gain of temperature, which causes additional costs to maintain an appropriate temperature, a cost that those households cannot face (Engvall et al. 2003; D'Souza 1997; Cappelletty 1998).

The rest of the study is organized as follows. Section 2 describes the programme and its expected effects. Section 3 describes the conditions for a 'natural experiment' that may allow an evaluation to be carried out in order to analyze the impact of the programme and of other methodological steps. Section 4 shows the results, including the pre-intervention and post-intervention analysis of the data. The study ends with the main conclusions.

## 2 Conceptual framework: the gas programme and its expected effects

Households living in informal neighbourhoods of the metropolitan region of Buenos Aires lack of access to infrastructure services and formal tenure. These characteristics are similar to this type of neighbourhoods in many other Latin American cities. In Buenos Aires, the utilities concession contracts that regulate the provision of pipelined gas service states that the network expansion must be financed by the customers. Hence, the engine idea of the programme was to induce households to finance their connection to the gas network with savings generated from the substitution of tube gas consumption for the new lower-cost network gas. A financing mechanism was offered to households that charged a monthly amount approximately equal to the monthly tube gas expenses that households paid before the provision of the network service. The NGO made also an individual microcredit available, which allowed families to finance other related improvements inside the dwellings.

A key dimension of the programme was the induced participation and interaction of the community which helped to build social capital and trust among them. With that purpose, the

programme fostered the involvement of local social organizations to contribute in its promotion. An essential related requirement set that over 70 per cent of the households in each block should express their interest in receiving the service, so that the respective block could be incorporated to the gas network. This guaranteed the commercial firm to achieve the necessary economies of scale that would help in the profitability of the scheme. For achieving this requirement, many neighbours inclusion-related activities took place, leading to a significant level of social capital raised between all families living in the block and the neighbourhood.

## 2.1 Infrastructure improvements

One of the key aspects of the gas programme is that it has induced a process of formalization in the dwellings. We must recall that these have been progressively constructed over time, without professional help, and according to the amount of the households' savings. One of the major limitations that restricted the incorporation of households as public service customers was the need for housing formalization, since in many of the cases they did not meet the minimal habitability requirements (e.g. dimensions, ventilation) set by municipal ordinances for the authorization of services. In particular, a gas service connection within a dwelling has to comply with quite a number of safety-related measures, set by the authority that regulates the services. The informal tenure of the lot and the lack of finance to afford the improvements necessary for the connection, constituted another significant constrain. Therefore the families, in order to obtain the authorization of the gas company and to have access to gas connection, may have needed to undertake improvements in the infrastructure of their dwellings, including the construction and improvement of walls, floors or the pipelined water inside the house.

A second reason that might have induced improvements in dwellings infrastructure is related with the savings that were generated due to the programme. Families that were part of the programme saved a significant amount of money in relation to gas consumption. According to FVPS estimates, the cost of this service represents 1.9 per cent of the total household income of families connected to piped gas whereas, for the families that were not still part of the programme, the cost of gas bottles represents 5.2 per cent of the total household income. This effect is even more important for those households that develop an activity in their dwelling. These savings might have been used in the improvements.

The availability of hot water in the bathroom might have also been a consequence of the new possibilities that the gas connection offered. In particular, the connection might make it possible to have hot water inside the house at a lower cost, bringing an incentive for the building of water installation for dwellings in neighbourhoods where a low proportion of the households have running water in their dwellings. Due to the substitution of tube gas consumption with the new low-cost network gas , the savings in fuel expenses allowed for new resources which might have been used for the financing (in some cases with microcredit) of the internal water installation in the dwelling.

## 2.2 Disease reduction and satisfaction

The gas programme may have an impact on health in several ways. The gas connection allows families to enjoy several improvements in their standard of living: heating and a better regulation of temperature in rooms, hot water in the kitchen and in the bathroom, personal

and food hygiene, less time and better quality of food cooking. All this is reinforced by the improvements on infrastructure that were already mentioned. For example, the incorporation of finishing in walls and floors may have also helped to keep their houses at the right temperature.

All these factors have clear implications on the probability of getting certain diseases, in particular respiratory and gastrointestinal ones. As it was already mentioned, the substitution of solid fuels to cook or provide heating has a beneficial effect on health thanks to a minor carbon dioxide concentration. Therefore, a reduction in respiratory diseases and allergies is expected. Diseases from the upper respiratory tract have also been associated to defective housing. The improvements in food hygiene and cooking quality are also expected to reduce gastrointestinal diseases.

Finally, the programme and its associated improvements in the standard of living may well be related to a perceived satisfaction of the families with respect to their homes.

## 3 Methodology

A 'natural experiment' brings up the possibility of evaluating the impact of the gas programme in Moreno. This section describes the characteristics of the programme that allowed the application of an impact evaluation methodology, and then presents the econometric models that were estimated to measure the effects.

### 3.1 Identification strategy

With the aim of isolating the causality effect of the gas programme from other changes that occurred in the region, the evaluation consists in estimating a counter-factual scenario to reconstruct the hypothetical situation of what would have happened with those households if they had not been beneficiaries of the programme. Following this idea, the difference between what would have happened and what effectively happened would be the impact of the gas programme. Although it is impossible to observe the hypothetical situation, it is possible to approximate it by establishing a comparison group (control group), composed of households which have not received the programme, which should be as similar as possible to the group that benefited from the intervention (treatment group).

The allocation mechanism of the gas programme allowed the possibility of establishing a treatment and a control group, from a group of neighbourhoods with similar characteristics. Due to technical reasons related to the geographical location of the main gas pipe, the gas distribution company decided to extend the network to a group of neighbourhoods on a first stage.[1] A treatment group was defined as the group of neighbourhoods which were effectively connected on August 2005, while the control group was defined by boundary

1 The additional cost of installation that might be necessary to face for the expansion of the network, if crossing trough an inter-municipal road, was considered. In particular, the temporary closing of roads and the effects that this would have on the traffic of the region was evaluated. It was decided to start with the first stage of the gas network expansion programme in the area that was closer to the trunk network. The second stage of the programme, currently on work, has expanded the network to the other group of neighbourhoods.

neighbourhoods, which were going to be connected on future stage. The mechanism used to select neighbourhoods can be considered exogenous and therefore allow the evaluation, avoiding possible self-selection biases.

### 3.2 Characteristics of the groups prior to the intervention

In order to corroborate the degree of similarities of the selected groups (treatment and control), we analyzed the information that was available from a time prior to the intervention. Data from the area is provided by the National Population Household and Housing Census (2001). The data is publicly available in census-range level statistics, and allowed the comparison of both groups on several socioeconomic and infrastructure related variables and tested their differences. In the case of the area under analysis, the data represents approximately 17,000 individuals in the treatment group (4,170 dwellings) and 15,100 individuals in the control group (3,800 dwellings).

### 3.3 The issue of partial compliance

Although the programme was targeted to all families living in the region, not all of them wanted to join in. Hence, if the families that entered the programme were the only ones assigned to the treatment group for the analysis, the results would potentially reflect self-selection bias, since the decision of each household to join in could be considered an endogenous component (i.e. self-selection). We dealt with this potential endogeneity in the following way: first, the treatment group was created by a random selection of a sample of households from the region where the programme was offered, no matter whether they had joined in the programme or not. For the control group, there was, again, a random selection of households from the region where the programme was not offered. Thus, this estimation is based in the *intention-to-treat* sample.

Second, we measure the impact of the programme per se, by estimating the effect of the programme on only those who effectively entered the programme, and instrument this potentially endogenous variable with the *intention-to-treat* variable. Finally, we can compare the results arising from both specifications (i.e., the intention to treat estimation and the instrumental variables (IV) estimations) and checks how consistent are the estimated effects.

### 3.4 Data

Two surveys were carried out in the neighbourhoods by specialized staff on November 2006 and 2007. They collected information about households' demographical structure, socioeconomic status, expenses and income, housing and infrastructure characteristics — detailing the construction materials of the dwelling—health related indicators, and subjective indicators of satisfaction with the housing and the quality of life.

The first survey, carried out in 2006, was delivered to a total of 450 households. 250 households were randomly selected from the group of neighbourhoods where the gas network expansion programme was offered, including both the households that became clients of the service as well as those that were not. In order to make a representative sample of the control group, 200 households in the neighbourhoods that have not yet been benefited from the intervention were surveyed. They were selected at random among those households that

declared their intention to access the gas service.[2] Both samples were prepared using administrative records kept by FPVS.

### 3.5 Econometric model

As suggested in the previous section, some of the expected effects of the programme are related to: i) improvements in the infrastructure of the dwelling, ii) reduction in the occurrence of diseases between family members, and iii) happiness with respect to the dwelling. We obtained a measure of the effects of the programme on these potential outcomes (Y) by estimating econometric models of the variables related to each of these outcomes. Regarding material finishing and other infrastructure improvements we considered: (1) walls with cement plastering; (2) hot water installation; (3) ceramic revetment on the floor. The second group of variables accounts for diseases that family members had within a period of two months before the survey: (1) flu or fever; (2) other respiratory diseases; (3) gastrointestinal diseases. Finally, we evaluated the effects of the programme on the individuals' satisfaction in relation to their households. We will use as satisfaction indicator the score (0-10) given by the individuals according to the level of satisfaction they felt with their respective dwellings.

Several variables were incorporated as control on the estimations: socioeconomic variables (family per capita income, age of household head, education level of household head, overcrowding, number of children under ten years old, tenancy-related variables (formal owner of the house and the plot) and others that are not related (at least, theoretically speaking) to the expected results of the intervention. Following the discussion on Section 2, the water quality is an important factor related to the occurrence of gastrointestinal diseases. Therefore, we add a dummy variable for the existence of water connection. Another important question is, as explained in the following section, the existence of pretreatment differences in the access to water connection between the treatment and the control group. As a consequence, we cannot omit this variable for a proper identification of the causality of the programme. In the case of flu, fever and respiratory diseases models, the use of heating origins dummy variables that were also incorporated.

Summing up, the intention-to-treat specification of the econometric model is defined as follows:

$$Y = \alpha + \gamma\, sample\_dummy + \beta\, X + \varepsilon \quad (1)$$

Where Y is one of the potential outcome variables (a dummy variable for all infrastructure and health related variables, and a variable that ranges from 1 to 10 for the level of satisfaction), $\gamma$ is the parameter of interest, which captures the effect of the programme; *sample_dummy* is the dummy variable with value 1 for observations in the treatment group (i.e. households in the region where the programme was offered regardless of their participation, also called *intention-to-treat* variable) and 0 for observations in the control

2 As is usual in this kind of surveys, there was quite a lot of difficulty in obtaining answers from households in the control group that did not had interest in joining the programme on a future stage. Although this fact implies a certain self-selection bias in the programme's estimated results, this bias would tend to underestimate the real effect of the programme on the treated, and therefore does not represent a serious problem for the purpose of measuring if there was an impact on the treated.

group (i.e. households in the region where the programme was not offered); X is the vector of control variables, and ε is the error term.

The estimated models are robust Probit models in the cases of infrastructure and health related variables, and an Ordinal Probit for the happiness indicator. For all these models we compute average marginal effects and elasticities.

Finally, by instrumental variables for specification in order to see the effect of the programme on those who entered it, we used a *treatment-dummy* (i.e. with value 1 for those who entered the programme, and 0 to indicate the opposite) and the *intention-to-treat* variable as its instrument.

## 4 Results

### 4.1 Characteristics of the groups before the intervention (2001)

Table 1 presents the pretreatment information from the 2001 Census. The aim of this comparison is to confirm that the main characteristics of the treatment and control groups are similar and, if differences emerge, to properly define the post-intervention comparison. Table 1 presents a summary of the results of tests of difference of means calculated on each variable. As can be seen, socioeconomic, housing, and infrastructure service variables are reasonably well balanced for some groups, displaying no differences in most indicators, and small differences were significant differences emerge. For example, in terms of socioeconomic characteristics, there are no significant differences as regards household welfare, as measured by the Unsatisfied Basic Needs (UBN) indicators (including the housing, sanitary, education, and subsistence characteristics).[3] Again, there are no significant differences in the head of household education level.

The difference in the mean values of the variables corresponding to household appliances—refrigerator with freezer, and computer—which we use as another approach to household income since the census gives no information about this, is not significant.

In the case of the proportion of households with an unemployed head is of 10 per cent; the mean value is 0.24 and 0.17 in the treatment and control group, respectively. Although a small difference, this suggests greater employment precariousness in the treatment group. As a function of this difference, the incorporation of the variable of per capita income in the regressions shown below might be necessary[4]. Finally, the demographic variable of children

3 According to the National Statistics Institute (INDEC), a UBN is a quality of life indicator. People living in households in some of the following conditions is considered to have UBN: more than three people per room, an inappropriate type of dwelling, lack of bathroom with a water tank, children of school age (6 to 13 years old) who do not go to school, or when an adult who does not have secondary education, is the only income provider among four household members.

4 Nevertheless, there are no significant differences in the per capita income between the households in the treatment and control samples during the year 2006, as it will be shown.

Table 1: Evaluation of the differences between the treatment and control groups for selected variables, 2001 CENSUS

| Variable | Diagnosis* | Mean, % |
|---|---|---|
| *Socioeconomic characteristics* | | |
| Born in Argentina | Higher in treatment group | 96 in treatment group, 95 in control group |
| Incomplete primary school | No difference between groups | 42 |
| Rate of children aged less than 14 years | No difference between groups | 37 |
| Rate of households with UBN | No difference between groups | 27 |
| *Other goods/labour status* | | |
| Computer | No difference between groups | 5 |
| Fridge with freezer compartment | No difference between groups | 40 |
| Unemployed head of household | Higher in treatment group | 24 |
| *Characteristics of the dwellings* | | |
| Overcrowding in rooms | Higher in treatment group | 11 in treatment group, 9 in control group |
| Dwelling and landowners | Higher in treatment group | 69 in treatment group, 65 in control group |
| Rate of precarious housing units | No difference between groups | 9 |
| Dwelling with UBN | No difference between groups | 10 |
| Rate of dwellings with ceramic floor tiles | Higher in control group | 30 in treatment group, 32 in control group |
| Rate of dwellings with plasterwork walls | No difference between groups | 57 |
| *Infrastructure services* | | |
| Connection to a water network | Higher in treatment group | 22 in treatment group, 6 in control group |
| Gas cylinder or bottle gas | No difference between groups | 90 |

Note: The complete output of the difference in means tests is available in Goytia (2008). *A difference between groups is reported when there is a rejection of the equality of means null at 1 per cent error level.

Source: See text.

under 14 years old, and the proportion of Argentines, displays differences that seem not quite relevant—0.372 and 0.363 in the first case and 0.958 and 0.947 in the second, for the treatment and control groups, respectively.

In terms of housing and living conditions variables in general, there seem not to be important differences with one exception: the connection to water. The variable measuring overcrowding—associated with the number of people per room in the dwelling—shows a slightly higher difference in the treatment group (11 per cent) in relation to the control group

(9 per cent). This variable can have a direct incidence on some diseases especially on respiratory ones, and in consequence, it should be included as a control in diseases model regressions.[5] Another slight difference may also be seen in the proportion of households with formal tenure of the house and the plot, which is higher in the treatment group (68.5 per cent and 65.1 per cent respectively). This characteristic may influence directly some of the result variables analyzed later. In particular, the literature on this subject has shown how informality affects the investment to improve the houses, as noted by Besley (1995), Brasselle et al. (2002), Field (2005). In particular, this situation would affect the incentives to improve housing and would also have an impact on the estimated health and satisfaction outcomes.

There are also no differences in the variable of plaster walls, which is one of the possible outcomes of the programmes outcomes that we examine. This data is relevant since this is one of the variables that could be affected by the intervention and could become one of the channels through which housing formalization may affect the household health. Instead, the difference in the variable of floor quality is significant (1 per cent), being higher in the control group.

Last, but not least, differences are found in the proportion of dwelling with access to the water network (22 per cent and 6 per cent respectively)[6]. The difference in this indicator is largely explained by the existence of a neighbourhood within the control group, Alem, which is part of the treatment group where a water and sanitation precarious community network is located. In order to control the impact that the aforementioned differences could have on the variable of access to water network, we have decided to include this variable as a control in the regressions. At the same time, as a robustness check, the observations from Alem are excluded.[7] Nevertheless, the census data also show that there are no differences in the variable of water of a good bacteriological quality. Such variable is built by adding the households that get water from a well. This water is placed at a considerable depth and has to be extracted with a motor pump.

5 Nonetheless, notice that the omission of this variable would tend to underestimate the impact of the programme.

6 It is important to clarify that the classification of the census for such a variable does not distinguish the kind of network to which each and every house is connected. The variable measures the way in which the dwelling receives the water, without making any difference between the quality and the type of network. The households in these neighbourhoods receive water from pipes coming from community networks without any purifying plant intervening, or it may come from a connection to a public tap made by the neighbours, or from their land.

7 These results are not included here, but are available upon request.

Table 2: Evaluation of the differences between the treatment and control groups for selected variables: post-treatment survey data (2006-07)

| Variable | Diagnosis | Mean |
|---|---|---|
| *Socioeconomic characteristics* | | |
| Number of household members | No difference between groups | 4.8 |
| Head of household age | No difference between groups | 47.5 |
| Complete primary school | No difference between groups | 0.62 |
| Complete secondary school | No difference between groups | 0.08 |
| Total household income per capita | No difference between groups | 247.5 |
| Number of children in the house aged 0-5 | Higher in Control Group | 0.31 in treatment and 0.58 in control group |
| Number of children in the house aged 0-10 | Higher in Control Group | 0.61 in treatment and 1.2 in control group |
| *Characteristics of the dwelling* | | |
| Age of the house | No difference between groups | 21.05 |
| Number of rooms | No difference between groups | 2.24 |
| People per room | No difference between groups | 2.37 |
| Water origin | | |
| Tube connection | No difference between groups | 0.14 |
| Well | No difference between groups | 0.75 |
| Other source outside the house | | 0.11 |
| *Basic needs* | | |
| Unsatisfied Basic Needs (UBN) | No difference between groups | |
| UBN people per room | No difference between groups | 0.18 |
| UBN house | No difference between groups | 0.09 |
| UBN sanitary conditions | No difference between groups | 0.02 |
| UBN education | No difference between groups | 0.01 |
| UBN survival | No difference between groups | 0.18 |

Note: The complete output of the difference in means tests is available in Goytia (2008). *A difference between groups is reported when there is a rejection of the equality of means null at 1 per cent error level.

Source: See text.

### 4.2 Characteristics of the groups after the intervention (2006-07)

Table 2 compares a selection of variables for the treatment and control groups using data obtained in the post-intervention surveys of 2006 and 2007. As in Table 1, the summary of mean difference tests between control and treatment groups is presented.

Most socioeconomic variables do not show any significant statistical differences, a result which is consistent with our hypothesis that the intervention had, by the time of the survey, no effect on socioeconomic variables. This is the case of the household head educational level, as regards the proportion of heads with complete primary or secondary school, which is similar on average (61 per cent and 8 per cent respectively). Household income per capita in both groups is also found similar between groups (247 pesos on average). Other demographical characteristics such as the number of members in the household are similar on average. The exception is the number of children, which seems to be slightly higher in the control group (0.58 children aged between 0-5 years old in the control group to 0.3 in the treatment). In addition, the components of UBN variables do not show differences between groups. The minimum standard of living conditions that are set by this indicator (e.g., basic sanitary conditions, overcrowding, minimum education level) remain similar between groups.

Summing up, many of the observable characteristics of treatment and control groups of households remain similar after the intervention. But this is not the case of many of the key variables that are related with the mentioned expected gas programme outcomes.

### 4.3 Impact of the programme on housing improvements

Table 3 reports a summary of the econometric results for the impact evaluation. The outcomes examined are listed together with the effect that can be attributed to the gas programme, the range of effects that was estimated according to the different specifications of the econometric models[8], and finally, a list of the control variables that were found statistically significant is detailed. Table 4 also adds a summary comparison of the results obtained from both the standard estimation of the model and the alternative incorporating instrumental variables.

In the case of infrastructure variables, results suggest that the gas programme caused an increase in the three variables that were analyzed—the proportion of dwellings with plasterwork walls, ceramic floor tiles, and hot water installations in the bathroom.

In the case of the availability of hot water in the bathroom, an increase of 22 per cent to 28 per cent in the proportion of households with this type of improvement is attributable to the programme.[9] Albeit the fact that the actual proportion of dwellings with this kind of connection is small, this effect is still statistically significant. In the case of the proportion of dwellings with plasterwork walls, an increase in a proportion from 12 per cent to 15 per cent is attributable to the gas programme, whereas an increase from 12 per cent to 16 per cent is found for the rate of dwellings with ceramic floor tiles. The instrumental variables (IV) estimation of the treatment effect, suggests similar conclusions, but with higher estimated

8 See Goytia (2008) for the complete regressions output.

9 According to the *intention to treat* effect.

coefficients. This finding is quite reasonable since the IV model estimates the effect of the treatment on those actually treated, while the *intention to treat* estimator incorporates households which have rejected the programme.[10] All the significant effects are confirmed under the IV model, with the exception of ceramic floor tiles which disappear when incorporating the tenure condition as a control. In other words, the difference that is observed between groups might be due to a higher proportion of households with formal tenure in the treatment group (instead of being a consequence of the programme).

Table 3: Summary of econometric results: Intention to treat estimator*

| Dependent variable | Sign of the intention to treat coefficient | Estimated size of the effect** | Control variables and sign of the coefficient (between brackets)*** |
|---|---|---|---|
| *Dwelling infrastructure* | | | |
| Plasterwork walls | Positive | 12 to 15% | Income per capita (positive), Age of the head of household (positive) |
| Ceramic floor tiles | Positive | 12 to 16% | Income per capita (positive) |
| Hot water in the bathroom | Positive | 22 to 28% | Age of the head of household (positive), Head of household with complete secondary school (positive), Overcrowding in rooms (negative) |
| *Occurrence of diseases in people* | | | |
| Fever or flu | Positive | 18 to 45% | Income per capita (negative), Overcrowding in rooms (positive) |
| Respiratory diseases | Negative | 4 to 18% | Income per capita (negative), Age of the head of household (negative), Number of minors (negative) |
| Gastrointestinal diseases | Negative | 37 to 130% | |
| *Satisfaction* | | | |
| Satisfaction with the dwelling (0-10 scale) | Positive | 0.26 to 0.45 points | |

Note: *The complete output of regressions is available in Goytia (2008). **Range of elasticities obtained from the estimation of Probit models. ***Statistically significant variables (1 per cent error) that were found in the estimated models.

Source: See text.

The results on infrastructure seem consistent with our hypothesis that the formalization induced by participation in the programme fostered these kinds of improvements. Also, as

10 See the methodological section above.

explained above, results might arise because of the savings generated by the substitution of the energy source.

Regarding the effects of the programme on health indicators, the results show that the gas programme induced a decrease in both the occurrence of respiratory diseases, in particular flu and fever cases and, a result which is less robust, in the incidence of gastrointestinal diseases. The *intention to treat* estimator suggests a decrease of 18 per cent to 45 per cent in the cases of flu or fever cases, and a reduction of 4 per cent to 18 per cent in the cases of respiratory diseases. The IV estimator reports stronger effects with 55 per cent for the flu or fever cases and 43 per cent of respiratory diseases. As for the cases of gastrointestinal diseases, although the highest intention to treat coefficient was found, (the estimates indicate that there a reduction of between 37 to 100 per cent) the effect seems less robust across specifications since it disappears in the IV treatment estimation.

Table 4: Summary of the results on the instrumented treatment estimator

| | Range of treatment coefficient | Diagnostic |
|---|---|---|
| *Infrastructure improvements* | | |
| Plasterwork walls | 0.94 to 1.07 | Robust |
| Ceramic tiles in floors | 0.42 | The effect might dissappear when incorporating tenure controls. |
| Hot water in the bathroom | 0.46 to 0.64 | Robust |
| *Occurrence of diseases* | | |
| Cases of flu or fever | -0.55 | The effects are stronger when incorporating heating variables. |
| Respiratory diseases | -0.43 | The effects are stronger when incorporating heating variables. |
| Gastrointestinal diseases | - | Not robust. The effects do not appear in some specifications. |

Note: The complete output of regressions in available in Goytia (2008). *Range of significant coefficients at 1 per cent obtained from the specification of treatment model using the intention to treat variable as the instrument.
Source: See text.

Recall that the effects of the programme on diseases might be a consequence not only of the direct effect of the gas installation—e.g. by means of more heating, better cooking, and

improvement in the quality of the air—but also of the indirect results that were obtained due to the (measured) improvement in the conditions and infrastructure of the dwelling.

Finally, Table 3 shows that the study found a positive effect of the gas programme on the level of satisfaction, as informed by the people with respect to their dwellings. On a scale from 1 to 10, those households that belonged to the neighbourhood that benefited from the programme show a higher mark on average that ranged from 0.26 to 0.45. This implies that the gas programme, through the changes that it brought on the dwellings, may have improved the perception of the families as regards their level of satisfaction. The result holds even when controlling for the general level of reported satisfaction of each head of household, which in other words means that generally optimistic, or pessimistic, individuals were considered when evaluating the individual's perception with respect to their dwellings.

## 5 Conclusions

Like in most developing economies, informal neighbourhoods in the Metropolitan Region of Buenos Aires are affected by the lack of access to public services. The imbalances in the supply of such services cannot be solved by simply extending the traditional mechanisms. Informality and low quality in the infrastructure of the dwellings are some of the aspects that hinder the access to services. Access to credit as well as legal, logistic and technical problems must be solved. The programme *Redes Solidarias* tackled these issues by coordinating institutions, generating trust among neighbours and paving the way for families to become customers of the gas company.

The evaluation of the impact of the programme reports effects on several dimensions of the households. Improvements in infrastructure have been found. Strong positive effects are found on the existence of walls with cement plasterwork and also on the installation of hot water in the bathrooms. In the case of ceramic floors, however, results suggest that the effects are less significant.

Some of these improvements in infrastructure may have been related to the process of formalization induced by the gas programme, in particular, the regulations on gas connections. Other improvements such as the installation of water inside the bathroom may have been a consequence of the new possibilities that the gas connection offered. The gas programme substituted the purchase of tube gas with a new lower cost network gas, generating new resources that allowed the financing —in some cases with microcredit— of internal installations and possibly several other infrastructure improvements.

The programme has also been found to generate strong reductions in the frequency of cases of flu, fever and other respiratory diseases. A less significant effect was found for gastrointestinal diseases. Reductions of at least 30 per cent in the probability of falling ill with flu or fever were found whereas at least a reduction of 14 per cent took place in the case of respiratory diseases. The gas connection allowed families to enjoy several improvements in their standard of living: heating and a better regulation of the temperature in rooms, hot water in the kitchen and in the bathroom, personal and food hygiene, less time and better quality of food cooking. All these improvements are theoretically related to a decrease in the risk factors to contract diseases and may explain the results. Moreover, the access to a gas

connection and its effect on health may have been reinforced by the infrastructure improvements already mentioned, so that infrastructure and health results might be related.

Finally, all these improvements might also be related to the effects found on the increase in the level of satisfaction of individuals with respect to the dwelling.

**References**


Amis, P. (2001). Rethinking UK Aid in Urban India: Reflections on an Impact Assessment Study of Slum Improvement Projects, *Environment and Urbanization*, 13(1): 101-13.

Besley, T. (1995). 'Property Rights And Investments Incentives: Theory and Evidence from Ghana', *Journal of Political Economy*, 103: 903-37.

Brasselle, A.-S., F. Gaspart, and J.-P. Platteau (2002). Land Tenure Security and Investment Incentives: Puzzling Evidence from Burkina Faso, *Journal of Development Economics*, 67(2): 373-418.

Cappelletty, D. (1998). 'Microbiology of Bacterial Respiratory Infections', *Pediatric Infectious Disease Journal*, 17: 55-61

Cattaneo, D.; Galiani, S.; Gertler, P.; Martinez, R. (2007). 'Housing, Health and Happiness', *World Bank Policy Research Working Paper*, No. 4214

Dasgupta S, M. Huq, M. Khaliquzzaman , K. Pandey, and D. Wheeler (2004). 'Who Suffers from Indoor Air Pollution? Evidence from Bangladesh,' *World Bank Policy Research Paper*, No. 3428.

D'Souza, R. (1997). 'Housing and Environmental Factors and Their Effects on the Health of Children in the Slums of Karachi, Pakistan', *Journal of Biosocial Science*, 29: 271-81.

Duflo, E., M. Greenstone, and R. Hanna (2008). *Indoor Air Pollution, Health and Economic wellbeing*, Abdul Latif Jameel Poverty Action Lab, Cambridge MA: MIT.

Engvall, K., C. Norrby, and D. Norback (2003). Ocular, Nasal, Dermal and Respiratory Symptoms in Relation to Heating, Ventilation, Energy Conservation, and Reconstruction of Older Multifamily Houses', *Indoor Air*, 13: 206-11.

Environmental Protection Agency (EPA) (2006). 'Health and Environmental Effects of Particulate Matter', US Environmental Protection Agency, available from: http://www.epa.gov/air/particles/actions.html

Estache, A., V. Foster, and Q. Wodon (2002). 'Accounting for Poverty in Infrastructure Reform: Learning from Latin America's Experience', *Studies in Development Series*, Washington DC: World Bank.

Field, E. (2005). 'Property Rights and Investment in Urban Slums', *Journal of the European Economic Association Papers and Proceedings*, 3(2-3): 279-90.

Goytia C., R. Pasquini, and P. Sanguinetti (2008). 'Public-Private Co-operation for Gas Provision in Poor Neighbourhoods of Buenos Aires: Institutional Framework and Impacts', mimeo.

Shaw, M. (2004). 'Housing and Public Health', *Annual Reviews of Public Health*, 25: 8.1-8.22.

Triche, E., K. Belanger, W. Beckett, M. Bracken, T. Holford, J. Gent, T. Jankum, J. McSharry, and B. Leaderer (2002). 'Infant Respiratory Symptoms Associated with Indoor Heating Sources', *American Journal of Respiratory and Critical Care Medicine*, 166: 1105-11.

World Health Organization (2002). 'Addressing the Links between Indoor Air Pollution, Household Energy and Human Health,' WHO-USAID, Washington, DC.