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*Full Length Research Paper*

# Environmental returns to education: an application to waste management in quilmes county of Argentine

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**This paper presents estimations about the nascent field of environmental returns to education. It focuses on household solid waste and analyzes the case of the urban district of Quilmes, Argentina.Models were estimated using Two-Stage Probit Least Squares. The results suggest that education would appear to be relevant to explaining knowledge in terms of understanding environmental implications of waste management once agents have been provided with some background information. However, a higher level of education was not significant when explaining the availability of information about the subject. On the other hand, there is evidence of a significant incidence of knowledge – both in terms of availability of information, and understanding – about the likelihood that the public is willing to cooperate (voluntarily) in a recycling program. Therefore, there are positive and significant environmental returns to education through understanding regarding the probability that a person is willing to separate his or her own waste once the agent acquires baseline information about the topic.**

**Keywords:** Environment; Waste Management; Two-Stage Probit Least Squares; Estimation; Return to education; Understanding; Information; Attitudes; Willingness to cooperate

## INTRODUCTION

Studies addressing the issue of environmental returns of education seek to examine how the level of formal education attained by people impacts on their attitudes, knowledge, valuations and behaviors regarding environment, isolating it from the effect that may have other relevant variables.

Several studies have explained pro-environmental behavior as a function of behavioral intentions which would, in turn, could be affected by factors such as values and/or knowledge (e.g. Heberlein, 1989, Schulitz and Oskamp, 1996, Mansaray and Abijoye, 1998, Thøgersen and Ölander, 2002, Clark et al., 2003, Arkesteijn and Oerlemans, 2005). In this respect, particularly in the field of knowledge, some studies argue that well-informed citizens who know about environmental problems are better aware of the possible damage and might have stronger pro-environmental attitudes and behaviors (Danielson et al., 1995, Callan and Thomas, 2007, Heimlich, 2010).

In the field of waste management, in particular, some research found that knowledge is a significant factor that positively influences recycling (Gamba and Oskamp, 1994, Simmons and Widmar, 1990, Jenkins et al., 2003). Consequently, policy measures aimed at generating a better understanding of these issues could help improve waste management (Tadesse, 2009). So, assuming that people's willingness to cooperate in recycling programs reflects their environmental values, it can be expected that their respective knowledge of the issue affects the valuation they give to the question.

Thus, the factors that shape knowledge – including a formal education – may influence the public's willingness to participate in recycling programs. Now, some questions arise: Does a formal education affect the generation of knowledge related to the environment? Does a formal education directly influence people's values concerning the environment? Does a formal education indirectly influence the environmental values of a population, mediated by the acquisition of knowledge? Inversely, are those who have a higher quantitative valuation of pro-environmental practices more stimulated to learn more about the subject and, consequently, do they want to acquire more knowledge?

The aim of this study is to examine whether formal education has significantly influenced the formation of environmental knowledge and pro-environmental values

of individuals, focusing on household solid waste in the district of Quilmes, Argentina, as a case for empirical analysis.

To this end, environmental returns to education in terms of knowledge and valuation are estimated based on data from a survey conducted in Quilmes, an urban district with a high population density in a developing country –Argentina.

## Theoretical background

In the sixties Schultz (1961) and Becker (1964) refined the analysis of the link between wealth and work, a topic that had been examined from the time of Adam Smith in 1776. They mentioned the existence of a direct and positive link between investment in human capital and workers' earnings. Investment in education would increase productivity and lead to positive rates of returns to education.

This conception led to the Human Capital revolution which, along with the increased availability of data, stimulated the emergence of studies that began to analyze the wage differentials by educational level. The first empirical studies on the topic (for example, Hanoch, 1967) corroborated that a higher level of education generates higher returns in terms of wages.

Additionally, the Mincer (1974) model has been a pragmatic way to incorporate the factors considered important into a simple econometric framework, applicable to most of the available databases. In the following years, the literature tackled some issues to explain the levels evidenced in the returns to education and their dynamics, as well as ways to improve their measurement.

Within that line of study, from the nineties, a conceptual framework was developed to examine the social returns to education in a new line of research. This was made on the basis of studies like that of Wolfe and Zuvekas (1997) who established a guideline to assess non-monetary returns, questioning the emphasis on the link between education, productivity and the monetary returns of individuals. They argued that other aspects of social development had been left aside and the individual was being treated as a mere tool for economic growth.

In this regard, experts from various disciplines suggest that estimates of returns to education that only take into account income levels understate total returns (Moretti, 2006). Accordingly, different studies have analyzed the impact of education on several areas: on crime (e.g. Farrington et al., 1996); on democratization, voter turnout and political stability (e.g. McMahon, 2001, Tenn, 2007); on health (e.g. Wolfe and Zuvekas, 1997, Feinstein, 2002) and so on. It is in this way that the recent literature concerning environmental returns to education also arises as a category belonging to the study of the social returns to education.

In this context, it is worth highlighting the work of McMahon (1999), who developed a literature review on social returns to education showing the specific advances existing on the subject of environmental returns.

Applied work on environmental returns to education is scarce. However, some studies focusing on other themes have provided evidence or theoretical arguments about the incidence of education on some aspects of the environment. In general, such studies show a trend that higher levels of education tend to increase the protection and concern for the environment (e.g., Samdahl and Robertson, 1989, Witzke and Urfei, 2001, Israel and Levinson, 2004). Additionally, in the field of waste management, there exists evidence of the influence of formal education on people's behaviors and attitudes (e.g., Hong et al., 1993, Hong, 1999, Kipperberg, 2007, Troschinetz and Mihelcic, 2009).

Nevertheless, work aimed at obtaining environmental returns to education in the field of domestic solid waste management are difficult to find, especially when limiting the universe to the issue of returns in terms of knowledge and valuation of the environment and the link between both factors. Research in this field can provide a basis to examine the impact formal education has on environmental quality.

## Social context and the local problem of domestic solid waste

The study area is the city of Quilmes, an urban district in the province of Buenos Aires, Argentina. It has one of the highest population densities in the country and, consequently, urban environmental problems are usually significant. Hence, policy design to manage them is a substantive issue for decision makers.

In particular, the decision of having made a cut at the district level is based on the fact that waste management in Argentina is (legally) jurisdictionally bounded to this scope. The focus on the district of Quilmes was based on the fact that its relatively heterogeneous socio-economic composition makes it possible to discriminate the influence that other factors can have on the knowledge and valuations of the effect of formal education. Also, the district of Quilmes is, to some extent, illustrative because its generalized methods of waste management are similar to those found in many urban districts around the world, especially at present in developing countries.

Quilmes has no systematic production of compost as a by-product of organic waste or an overall policy oriented to the separation and recycling of inorganic products. Landfills are the regular destinations of indiscriminately compacted waste produced by households. These practices have high environmental costs, often polluting the air, soil and aquatic ecosystems. Moreover, the waste generated by households is discarded, losing the opportunity to reinstate them in the productive system as

resources and involving the unnecessary extraction of new resources for production (van den Bergh, 2008). All this implies an environmental degradation that affects the current and future generation's trough, the increasing problems for health and the unsustainable use of biological resources.

Furthermore, as in other cases, solid waste disposal has become increasingly costly in recent decades, mainly due to land scarcity and new environmental regulations (Fullerton & Kinnaman, 1995).

Therefore, waste management produced by households is important in environmental terms and because it consumes a high percentage of the local government's budget.

However, some exceptions to this type of waste management exist. For example, when trash bags are left on the streets pending collection, stray dogs tear them up in search of food, producing pests such as cockroaches and rats. To avoid this situation many decide to burn their trash or throw it in streams.

## METHODS

The following assumptions have been adopted to quantify the environmental returns to education in terms of knowledge and valuation:

- All individuals produce about the same volume of waste; or alternatively, differences in the volumes generated are not significant in terms of how much time, effort and additional space the practice of waste separation would involve.
- The roles at home are flexible so that the respondent could clean and separate his or her own residuals, even if he or she does not currently take care of his or her own waste.
- Formal education is homogeneous for the same level of education.
- Once the environmental benefits of a source separation government program to recycle for environmental purposes have been highlighted, it is assumed that those who declare their willingness to cooperate with a project of this kind will do so for environmental reasons.

Under these assumptions, the potential effects of education on environmental knowledge and valuation in the field of waste management were included in the following model:

$$\begin{cases} kn = \alpha_0 + \alpha_1 dc + \alpha_2 ag + \alpha_3 ns + \alpha_4 sx + \alpha_5 s + \alpha_6 dg + \alpha_7 re + \varepsilon_1 \\ dc = \beta_0 + \beta_1 kn + \beta_2 ag + \beta_3 sx + \beta_4 tr + \beta_5 s + \beta_6 dg + \beta_7 re + \varepsilon_2 \end{cases}$$

**where the variables are defined as:**

kn A continuous variable representing a knowledge score

dc A dichotomous variable indicating whether respondents stated that they agree to participate in a government recycling program by separating their waste into two bags, assuming (as do Oliveira and Rosa, 2003, Troschinetz and Mihelcic, 2009), that sorting and separating household waste for recycling are pro-environmental behaviors

ag A categorical variable indicating the age of the person in years

ns An ordinal variable indicating the stated frequency of reading newspapers

sx A dummy variable indicating gender

s A dummy variable representing the level of formal education

dg The declared economic status measured by an indicator of the durable goods in the home

re A dummy variable indicating work or past work in the recycling activity

tr An ordinal variable indicating the extent to which respondents say they trust that the local government of Quilmes properly implements a waste management policy

$\varepsilon_1$ and $\varepsilon_2$ The error terms.

In this model, $\alpha_5$, in (1), measures the returns to education in terms of knowledge and $\beta_5$, in (2), represents the returns to education in terms of valuation. It is expected that the estimates for these coefficients are significant and positive.

Moreover, the shape of this model suggests that there exist exogenous variables (ag, ns, sx, dg, re and tr) representing factors influencing cognitive scores and/or waste-related valuation.

Also, this model shows that a continuous variable (kn) and a dichotomous variable (dc) are hypothesized to simultaneously determine each other. Therefore, some factors may influence valuation through knowledge while other variables can be indirect determinants of knowledge mediated by valuation.

Additionally, this simultaneous equation model in which potential endogeneity exists implies that

$Cov(dc, \varepsilon_1) \neq 0$ and $Cov(kn, \varepsilon_2) \neq 0$.

Consequently, as explanatory variables are related to the error terms in the population model of the data generating process, the standard estimators of the relevant model parameters are biased and inconsistent. This problem of reciprocal causation is resolved using Two-Stage Probit Least Squares (2SPLS) to estimate the model, following Maddala (1983).

So, for the first stage, the following model is fitted:

$$\begin{cases} kn = \Pi_1' X + v_1 & (3) \\ dc = \Pi_2' X + v_2 & (4) \end{cases}$$

where $X$ is a matrix of all the exogenous variables in (1) and (2); $\Pi_1$ and $\Pi_2$ are vectors of parameters to be estimated; and $v_1$ and $v_2$ are the error terms.

From this reduced-form, equation (3) is estimated via OLS and (4) via Probit. Then, the predicted values from each equation are obtained to be used in the second stage where the original endogenous variables in (1) and (2) are replaced by their fitted values and, respectively, estimated via OLS and Probit. Finally, the correction of the standard errors are necessary because such estimations will be based on $\widehat{dc}$ and $\widehat{kn}$ from the first stage and not on the appropriate $dc$ and $kn$. So, the Maddala (1983) correction will be implemented on the variance-covariance matrices of the second stage.

It was selected a model to test the existence of a significant link between knowledge, valuation and formal education level in a simple way, discarding other effects that may also be playing a relevant role -however, according to the model design and the precautions taken, those additional potential effects were included as explanatory variables, or are involved in the error term. It could be argued that this kind of model uses a methodological individualism to proceed. This kind of analysis may be overlooking certain phenomena inherent to the social context. In this sense, it would be relevant to supplement this study with rigorous qualitative analysis that refers to collective phenomena (as collective action dilemmas, for example).

## Data and variables

The data used in this study are taken from the Quilmes Solid Waste Survey (QSWS) conducted jointly by the University of Buenos Aires of and two public agencies between April and May of 2010. The participation of the University of Buenos Aires, institution from where this study was drawn, allowed to generate reliable data from the design stage of the survey and consistent with the objectives of this work.

The design of the 490-case sample took into account the population composition based on the National Census of Population and Housing of 2001, covering a representative share of the population of 16 years of age or older living in the district.

Well-trained enumerators using a structured questionnaire conducted face-to-face interviews with the individuals. It is necessary to clarify the characteristics of some of the variables proposed in this study for the analysis of returns to education:

## Knowledge variables

To assess knowledge (kn) two cognitive levels were considered based on two categories of knowledge constructed from previous theorical work. Two questions were used to assign a score ranging from zero to two for each question.

One of the questions used is an example of what was categorized as 'availability of information', which involves their having basic, concrete, memoristic or rote knowledge. This category is consistent with the kind of knowledge that Fogarty and Stoehr (1995) calls 'factual thinking' and 'gather', with the category of Anderson and Krathwohl (2001) of 'remember' and with the simplest level of knowledge proposed by Bloom et. al. (1956). To construct the indicator of knowledge in this category, the scores assigned to an example question in the QSWS were used as a frame for a first experimental approximation and a soft measure to examine whether recycling and/or the reuse of materials was associated with environmental care. It was assumed that those who spontaneously associate recycling and/or the reuse of discarded household materials with environmental care know more about environmental care compared to those who associate environmental care exclusively with the cleanup.

The other question ($kn_u$) represents an example of deeper knowledge or 'understanding', which includes the possibility of developing a more complex, abstract and consistent reasoning, in addition to moving from concrete examples to generalizations and vice versa. This category is in line with the interpretation of understanding of Boix Mansilla and Gardner (1999). It also includes the knowledge levels of 'critical thinking', 'the creative thinking process' and 'apply' that Fogarty and Stoehr (1995) proposed; it summarizes the levels 'understand', 'apply', 'analyze', 'evaluate' and 'create' that Anderson and Krathwohl (2001) present and covers Bloom's (1956) more complex levels: 'evaluation', 'comprehension', 'synthesis', 'analysis' and 'application'. In this case, the knowledge indicator was configured as a frame for a first experimental approximation and a soft measure by the scores assigned by the QSWS to the ability to make consistent arguments about the benefits of recycling —consistently explain that it reduces pollution and natural resource extraction (letting the respondents answer spontaneously) - and, in turn, to exemplify the analysis.

These are two different dimensions of knowledge where availability of information does not imply greater knowledge on a deeper level or understanding. Also, these are soft measures whose conceptual content was defined by expert intersubjective agreement. Future research should focus on translating the soft measures of knowledge into detailed metrics.

## Valuation variables

To conduct a quantitative approach to the environmental

valuation of individuals have for recycling waste programs, an indicator was defined based on their willingness to collaborate in terms of time-effort. A dichotomous variable (dc) was used to quantify the valuations of individuals about the provision of environmental services for waste recycling. It reflects the respondent's willingness to cooperate with the separation of waste, implying an effort in terms of time, a physical effort and the use of space at home.

It was assumed that individuals have certain preferences that allow them to consistently sort a set of goods and services, including a good that represents a level of environmental quality ($A_i$) and a basket of market goods and services (x). Therefore, a utility function can be defined as an ordinal representation of preferences (Hanley et al., 1997):

$$U(x, T_l, T_r, A), \quad x=(x_1, x_2, ..., x_n)$$

(5.2.1)

$$U_A \equiv \frac{dU}{dA} > 0 ,$$

$$U_{x_i} \equiv \frac{\partial U}{\partial x_i} > 0 , \quad U_{x_i x_i} \equiv \frac{\partial^2 U}{\partial x_i^2} < 0 , \text{ for all i, } x=(x_1, x_2, ..., x_n),$$

$$U_{T_l} \equiv \frac{dU}{dT_l} > 0 , \quad U_{T_r} \equiv \frac{dU}{dT_r} < 0$$

where $T_l$ is the time available for leisure. In addition, as the separation of waste at
source implies a cost for households in terms of time as well as effort (Morris and Holthausen, 1994), a time-effort variable spent on the task of recycling ($T_r$) has been added to this utility function, as Hong (1999) proposed.

So, given an initial allocation, if there is an improvement in environmental quality, keeping x fixed, there would be a consumer surplus from a new endowment which implies a maximum of willingness to pay so that the individual obtains the original utility level.

In addition, it is considered that a budget constraint implies that the individual spends no more than his or her available income on the consumption of market goods. However, as recycling requires a nontrivial effort in terms of time and Argentine districts offer no monetary incentives linked to waste, costs in terms of time are dominant and must be incorporated into the constraints of households (Kipperberg, 2007). The time spent on waste management is an alternative measure of willingness to pay and probably a better standard than money to measure interest in the subject (Sterner and Bartelings, 1999).

Hence, a constraint can be defined where the available time ($T_a$), after selecting the time spent at work ($T_W$) is:

$$T_a = 16\text{-}T_w = T_l + T_r$$

(5.2.2)

so that each individual must choose how much time to devote to leisure ($T_l$) and how much to tasks related to recycling ($T_r$), where more time and effort devoted to recycling implies an opportunity cost with respect to leisure. Indeed, because the separation of waste is a task that the individual must do at home and is directly linked to and in constant interaction with the tasks performed at home, it can be reasonably assumed that they choose between leisure and recycling, once defined how many hours to dedicate to the labor market.

Now, the usual technique of contingent valuation can be applied to assign valuations but instead of a monetary standard, a time-effort standard can be used.

To do so, a hypothetical market was proposed to all respondents for the recycling of certain solid waste materials produced by households, where the payment mechanism was the cleanup and disposal of 'dry' materials in separate bags. To achieve reliable measures of valuation the environmental advantages that this cooperation would generate was briefly described. Thus, the willingness to cooperate in terms of time-effort was measured as the result of an underlying utility problem for each individual.

## RESULTS

The model that includes reciprocal causation between knowledge and valuation in the field of solid waste was solved using Two-Stage Probit Least Squares, following the command CDSIMEQ developed by Keshk (2003). The results of the estimates are shown in Table 1 and interpreted as significant at the 5-percent level (with |t|>2 o |z|>2, as appropriate). Models A and B in it consider $kn_i$ or $kn_u$, respectively, as dependent variables in the second equation of the system.

From the selected estimation technique, after controlling for the possibility of simultaneity, the results seem to indicate that there does not appear to be a significant incidence of the variable representing the willingness to separate waste, (iv)dc on knowledge ($kn_i$ in Model A and $kn_u$ in Model B). In contrast, there is evidence of a significant incidence of knowledge – both in terms of availability of information, (iv)$kn_i$ and understanding, (iv)$kn_u$ – about willingness to separate waste, dc (Models A and B). [1]

Now, in relation to the incidence of education, having reached at least the secondary education, level s was not significant in explaining the availability of information, $kn_i$ (Model A). However, education was relevant in terms of understanding, $kn_u$ (Model B) – based on the basic information provided.

Therefore, formal education has an indirect effect – through understanding (iv)$kn_u$ – on the probability that someone is willing to separate waste into two bags once

**Table 1.** *Two-Stage Probit Least Squares* regression analyses with knowledge (continuous variable) and valuation (dichotomous variable) as the dependent and potential endogenous variables.

| | **Model A** | | | | | | | | **Model B** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Reduced form** | | | | **Second Stage Regr.** | | | | **Reduced form** | | | | **Second Stage Regr.** | | | |
| | **Dep. V: *dc*** | | **Dep. v.: $kn_i$** | | **Dep. v: *dc*** | | **Dep. v.: $kn_i$** | | **Dep. v: *dc*** | | **Dep. v.: $kn_u$** | | **Dep. v: *dc*** | | **Dep. v.: $kn_u$** | |
| **Indep. v.** | **Coeff.** | **z** | **Coeff.** | **T** | **Coeff.** | **Z** | **Coeff.** | **T** | **Coeff.** | **z** | **Coeff.** | **t** | **Coeff.** | **z** | **Coeff.** | **t** |
| ag | 0.004 | 0.94 | 0.008 | 3.79 | -0.008 | -1.09 | 0.007 | **2.95** | 0.004 | 0.95 | 0.003 | 1.62 | 0.001 | 0.34 | 0.003 | 1.49 |
| ns | 0.090 | 1.36 | 0.072 | 2.01 | | | 0.047 | 1.11 | 0.089 | 1.35 | 0.015 | 0.58 | | | 0.016 | 0.51 |
| sx | -0.208 | -1.48 | -0.035 | -0.46 | -0.155 | -0.98 | 0.022 | 0.24 | -0.206 | -1.46 | 0.005 | 0.10 | -0.208 | -1.43 | 0.004 | 0.06 |
| dg | 0.116 | 1.76 | 0.068 | 2.00 | | | 0.037 | 0.82 | 0.116 | 1.76 | 0.120 | 4.92 | | | 0.121 | **3.82** |
| S | 0.374 | 2.16 | 0.061 | 0.63 | 0.291 | 1.34 | -0.041 | -0.31 | 0.374 | 2.15 | 0.202 | 2.95 | 0.177 | 0.75 | 0.205 | **2.20** |
| re | 0.632 | 2.05 | 0.355 | 2.43 | 0.102 | 0.26 | 0.183 | 0.84 | 0.633 | 2.06 | 0.202 | 1.93 | 0.409 | 1.31 | 0.206 | 1.36 |
| tr | 0.128 | 2.13 | 0.035 | 1.11 | 0.077 | 1.08 | | | 0.127 | 2.11 | -0.001 | -0.04 | 0.128 | **2.07** | | |
| ivdc* | | | | | | | 0.272 | 1.08 | | | | | | | -0.007 | -0.04 |
| $ivkn_i$** | | | | | 1.467 | **2.05** | | | | | | | | | | |
| $ivkn_u$*** | | | | | | | | | | | | | 1.093 | **2.00** | | |
| -cons | 0.090 | 0.31 | 0.831 | 5.30 | -1.119 | -1.45 | 0.807 | **4.77** | 0.089 | 0.30 | 0.144 | 1.28 | -0.033 | -0.10 | 0.145 | 1.22 |
| | Obs: 481 | | | | | | | | | | | | Obs: 480 | | | |
| | First stage regr: Prob>F=0.0003 , Prob>chi2=0.0028 | | | | | | | | First stage regr: Prob>F=0.0000 , Prob>chi2=0.0030 | | | | | | | |

* *ivdc* is instrumented *dc*. ***$ivkn_i$* is instrumented *$kn_i$* ****$ivkn_u$* is instrumented *$kn_u$*The signs of the estimates were plausible and consistent with what was intuitively expected (Variables (iv)dc, (iv)$kn_i$ and (iv)$kn_u$ are instrumented from the first stage of the estimation).

the agent acquires baseline information about the subject.

At the same time, in both specifications (Models A and B), it seems that having reached the secondary education level, s, does not directly influence the willingness to separate waste for recycling, dc.

According to the above, from the estimated models evidence exists that the returns to education are not relevant when considering factors that shape knowledge in terms of the availability of information (Model A). However, they are significant in generating understanding (Model B). In turn, it could be seen that education has an indirect incidence on willingness to cooperate through understanding (Model B), once agents have been given some background information. So, it is pertinent to test the results that arise in this second – relevant – model (B), when the estimation is expressed (through PMC2E) after having discarded the exogenous explanatory variables that were not significant in the previous specification:

$$\begin{cases} \hat{kn}_u = \underset{(2,59)}{0,332} - \underset{(-0,08)}{0,0153}\,dc + \underset{(4,04)}{0,118}\,dg + \underset{(2,02)}{0,165}\,s_1 \\ \hat{dc} = \underset{(0,20)}{0,055} + \underset{(2,92)}{1,121}\,kn_u + \underset{(2,05)}{0,124}\,tr \end{cases}$$

$$\begin{cases} \hat{kn}_u = \underset{(2,59)}{0,332} - \underset{(-0,08)}{0,0153}\,dc + \underset{(4,04)}{0,118}\,dg + \underset{(2,02)}{0,165}\,s_1 \\ \hat{dc} = \underset{(0,20)}{0,055} + \underset{(2,92)}{1,121}\,kn_u + \underset{(2,05)}{0,124}\,tr \end{cases}$$

t and z values are expressed in brackets for the first and second equation, respectively. This re-specification of Model B suggests that the substantive results obtained previously hold.

On the one hand, understanding, $kn_u$, is positively and significantly influenced by the level of formal education, s, and, on the other, such knowledge positively and significantly affects the likelihood that people are willing to cooperate by separating their waste for recycling, dc. However, there is no evidence of simultaneity between the two equations because such willingness to cooperate does not significantly affect the deep knowledge of the population, $kn_u$. Corroborating this view, the covariance between the instrument ( $\hat{dc}$ ) and the residual of the estimated $kn_u$ in the second stage of the model was calculated, noting the exogeneity of the instrument (zero covariance).Some considerations can be made on these econometric applications. First, regarding

the variable dc, there may be a gap between the manifestation of willingness to cooperate and actual future behavior. Also, overlooking the ability of different individuals to respond to cognitive questions can generate an omitted variable bias. However, these potential problems and the possible lack of compliance of any assumption of the model would not be relevant to estimating the returns to education if they do not generate a systematic bias on the explanatory variables of the proposed model. In this sense, the possible bias caused by the ability should be studied further.

## DISCUSSION

The topic of environmental returns to education has recently taken shape as a category in the field of the social returns to education. As a contribution to the scarce literature of applied work focused on environmental returns to education, the results of this paper suggest that there are positive and significant environmental returns to education in understanding and valuating the environment. Thus, environmental returns must be taken into account when estimating total returns to education.

In particular, focusing on household solid waste in the district of Quilmes as a case for empirical analysis, the results of this work suggest that education would appear to be relevant to explaining knowledge in terms of understanding environmental implications of waste management once agents have been provided with some background information. However, a higher level of education was not significant when explaining the availability of information about the subject. Consequently, further work on these issues in schools could generate benefits in terms of environmental quality.

On the other hand, there is evidence of a significant incidence of knowledge – both in terms of availability of information, and understanding – about the likelihood that the public is willing to cooperate (voluntarily) in a recycling program. Therefore, there are positive and significant environmental returns to education through understanding regarding the probability that a person is willing to separate his or her own waste once the agent acquires baseline information about the topic.

Future research could deepen the measures of knowledge. It could also check for the possible presence of bias in the results generated by the existence of omitted variables like ability.

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