

Childcare provision, its use and nutritional outcomes. Crowding out and impacts of a community nursery programme¹

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Abstract

In this paper, to study *Hogares Comunitarios*, a large childcare and food nutrition programme in Colombia, we use a behavioural model of child nutrition. We consider the programme as one of the inputs in the production function of nutritional status together with female labour supply and food intake at home which is unobservable. We obtain an estimating equation whose parameters we can interpret in the light of the model. In particular, we can test whether the programme fully crowds out food consumed at home, as well as we can estimate a lower bound of the productivity of the programme. We reject that the programme fully crowds out food consumed at home and we estimate that the productivity of the programme is large. Dealing with the endogeneity of treatment is crucial, as the children with otherwise worse nutritional status tend to select into the programme. We also validate our evaluation strategy by considering the effect of the programme on pre-intervention variables as well as the sensitivity of our main results to our assumptions

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1. Introduction

Malnutrition amongst children is a very prevalent phenomenon in developing countries. According to Onis *et al.* (2000) approximately one third of children below the age of five are stunted in growth. There is now strong evidence that inadequate nutrition in early years has long term consequences as it affects adversely educational attainment (Behrman 1996, Strauss and Thomas 1998, Glewwe *et al.* 2001, Alderman *et al.* 2001, Maluccio *et al.* 2006), which reduces productivity later on in life (Strauss and Thomas 1998, Schultz 2005, and Maluccio *et al.* 2006). A recent review by Walker *et al.* 2007 identifies stunting, inadequate cognitive stimulation, iodine deficiency, and iron deficiency anaemia as the four key risk factors where intervention is urgently needed to help children in developing countries to reach their full development potential.

Governments in developing countries have implemented many different policies to tackle the problem of child malnutrition, including the provision of nutritional supplementation, price subsidies, cash transfers, and childcare programmes. And yet, there is no definitive evidence on which programmes are most effective, what impacts they have and how they work.

The formation of human capital is a complex and incremental process whose outcome depends on a variety of investment decisions taken at different points in time. The efficiency of a policy intervention aimed at fostering human capital accumulation is likely to be determined by the way in which the specific policy interacts with the existing process and with other inputs. These interactions are important both because of the possible substitutability/complementarity of the policy and existing inputs and because the policy might affect other investment decisions and therefore the level of other inputs.

To determine whether a given policy crowds out (or not) private inputs involves estimating how much they decrease due to the policy. However, private inputs might not be observable to the econometrician, possibly because it is very costly to collect information on them. This is usually the case with food intakes because it is very time consuming to collect detailed information on them. This limits the ability to test whether nutrition policies crowd out private food intake.

In this paper, we develop and estimate a behavioural model of child nutrition that allows us to test whether a childcare and food nutrition program crowds out other inputs, even when food intake at home is not directly observed by the econometrician. The production function of child nutrition depends on food intake at home, participation in the childcare and food programme, and mother's labour supply. As in Rosenzweig and Schultz (1983), we assume that the inputs of the production function, including the use of the programme, are chosen by the household decision maker taking into account their cost and their productivity. The econometrician does not observe all the variables that affect inputs' productivity and, therefore, affect inputs choices.

The availability of a programme such as the one we consider has a direct effect on children nutritional status (if it is used) and an indirect one, as it may change other inputs and the resources available to a household. From this consideration, it follows that testing whether or not a program improves child nutrition is not enough to reject crowding out because the programme can increase overall household resources through its impact on female labour supply. To test for crowding out, one needs to keep fixed other inputs that can affect child's nutritional status and might change due to the participation in the programme. In our case, we need to keep female labour supply fixed.

Our contribution is twofold. First, we provide a theoretical model that implies a well specified empirical strategy. With the help of our model, we spell out the assumptions that our empirical strategy requires, we establish what variables should be included in our regressions, what variables are valid instruments, and how to interpret the coefficients we estimate. The model delivers an estimating equation that allows us to test for crowding out even if some private inputs are not observable to the econometrician. We note that other inputs affected by the policy need to be kept constant to test for crowding out. Second, we learn about the effect of the childcare programme that we study. In particular, we can estimate a lower bound of the effect of the programme on children nutritional status.

The focus of this paper is a childcare and nutrition programme in Colombia, *Hogares Comunitarios* (HC), that was established by the Colombian government in 1986 and that provides childcare and food to children less than 7 years of age. The programme expanded rapidly since its introduction and is now the largest welfare programme in the country: there are approximately 80,000 HC centres across Colombia and more than one million children attend a HC centre. The cost of the programme, which is financed by a 3% tax on the wage bill, is approximately 250 million US\$, or almost 0.2% of Colombian GDP. Programmes similar to HC are also being implemented in Bolivia,

Guatemala, Mexico, and Peru. Despite its size, with the exception of an internal report, (Sabato et al. 1997) the HC programme has never been formally evaluated. We estimate our model on a data set which was collected to evaluate the impact of a conditional cash transfer (CCT) programme in Colombia. We use the ‘control towns’, where the CCT was still not in place to estimate the impact of HC.

Although the results we present are informative about the impact of the HC programme in the rural areas included in our estimation sample, the main focus of this paper is a methodological one. We want to stress how the ‘impact’ results should be interpreted within the theoretical model we propose. The theoretical framework guides us both because it allows us to spell out the conditions under which our approach is valid and because it gives a structural interpretation to the ‘impact’ results we find. This lesson is valid in a variety of contexts. In a companion paper, (Attanasio, DiMaro and Vera-Hernandez, 2009), we focus on the heterogeneous impact of the HC programme studying not only rural areas but also urban ones.

Our paper is related to at least four different strands of the literature. First, from a methodological point of view, our paper shares the concerns of Rosenzweig and Wolpin (2000), who stress the necessity of justifying an instrumental variable approach within the framework of a well defined model. Along the same lines, Todd and Wolpin (2003) emphasize the problems that emerge when some inputs are not observable by the econometrician. Second, our paper is related to the literature on crowding out of feeding programs (Jacoby 2002), and nutritional supplements (Islam and Hoddinott, 2009), as well as crowding out of private transfers (Albarran and Attanasio, 2003). Third, it also speaks to the literature on impact evaluation of nutrition interventions, including childcare and child nutrition programmes (Martorell *et al.* 1995; Maluccio *et al.* 2006, Rivera *et al.* 2004, Behrman and Hoddinott, 2005; Gertler 2004). Behrman, Cheng and Todd (2003) and Ruel *et al.* (2000) are particularly important as they study programmes that are very similar to HC but in Bolivia and Guatemala. Finally, the results we present are also relevant in the context of the recent literature that highlights the importance of early child development (see for instance Currie 2001, Heckman and Masterov, 2005 and Grantham-McGregor *et al.* 2007). It is argued that early childhood is the most cost effective period in a person’s life to invest (Carneiro. and Heckman, 2005a; Heckman and Masterov 2005; Engle *et al.* 2007). Evaluations of the Head Start programme in the US have shown that large-scale pre-school programs can have impacts on later educational attainment (Currie and Thomas 1995 and 1999; Garces, Thomas, and Currie 2002).

The rest of the paper is organized as follows. In Section 2, we describe the operation of the programme. In Section 3, we present our model. Section 4 describes the data we use for our empirical results and Section 5 contains the main results. In section 6 we discuss the credibility of our identification strategy and provide some evidence to support it. Section 7 concludes. The definitions of control variables and the full set of results are relegated to the Appendix.

2. The *Hogares Comunitarios* programme

In the late 1970s, the Colombian government legislated a new nutrition intervention targeted towards poor families. The programme, called *Hogares Comunitarios de Bienestar Familiar*, was legislated in 1979 as the development of previous initiatives that focussed on community participation and initiatives to target nutrition and child development.

At the beginning of the programme, which started between 1984 and 1986 and is run by the *Instituto Colombiano de Bienestar Familiar (ICBF)*, the ICBF regional office targeted poor neighbourhoods and localities and encouraged eligible parents with children aged 0 to 6 to form ‘parents associations’. Households belonging to the so called SISBEN levels 1 to 3 can participate.² After a few meetings with programme officials, the parents association was registered with the programme and elected a *madre comunitaria* (or community mother). This mother had to satisfy some criteria, such as having basic education and a large enough house and would be certified by the regional office of the ICBF. The *madre comunitaria* would then receive in her house the children aged 0 to 6 of the parents belonging to the associations. Each family would pay a small monthly fee (roughly the equivalent of four US dollars), which would be used to pay a small salary to the *madre comunitaria*. Each *madre comunitaria* would receive up to 15 children. The average number of children is around 12. The parents association would then receive funds from the government to purchase food. The food would be delivered weekly at the house of the *madre comunitaria* who would keep it in her fridge. The menu varies regionally and is established by a nutritionist in the regional office of ICBF. In addition to the food included in the regional menu, the children would also be given a nutritional beverage called *bienestarina*. Children are fed three times daily: lunch and two snacks. According to ICBF, the

² In Colombia most welfare programs are targeted through the SISBEN indicator. This indicator is computed using a number of different indicators of economic well-being. SISBEN is constructed on the basis of an index that is the first principal component of a number of variables related to poverty. Depending on the value of the index, each household is assigned to one of six levels. Information on the variables used in the construction of SISBEN is collected periodically. For most welfare programs, only households belonging to level 1 and 2 are deemed eligible. FA households are in SISBEN 1.

food received by the children (including the beverage) would provide them with 70% of the recommended daily amount of calories.

Therefore, in exchange for the small monthly fee, the parents would obtain child care and food for the children. The programme objectives included the improvement of the nutritional status of poor children as well as the provision of child care that could stimulate labour force participation of women and the generation of additional income.

The program, whose cost is financed with a 3% tax on the wage bill, expanded very rapidly in Colombia. It is now the largest welfare programme in the country: there are roughly 80,000 HC centres across the country and more than a million children that attend one. The cost of the programme is approximately 250 million US\$, or almost 0.2% of GDP.

As we discuss below, the location of the *HC* plays an important role in our identification strategy. After the start of the programme and its rapid growth, the turnover among the *madre comunitarias* was substantial. According to officials of the ICBF, between 10 and 15% of the existing *HC* are relocated in each year, in that a *madre comunitaria* ceases to be such and a new *one* starts to operate it. Moreover, if a household moves to a certain neighbourhood, it can normally register its children in an existing *HC*. It seems that over time, the *HC* have evolved into relatively mobile and informal nurseries and have lost some of the tight connection with the original parents association. In rural and very dispersed areas, an apparently common problem is the difficulty to set up a new *HC* because the ICBF does not start a new centre unless there is a sufficient number of children who want to attend. This ‘integer’ constraint seems to be binding in many communities.

Although the *HC* programme is the largest welfare programme in Colombia, it has barely been studied. Besides some early internal studies, which considered mainly the operation of the program, the only attempt at measuring the effect of the programme was Siabato *et al* (1997), a study commissioned by the program’s administration, that used a relatively large survey designed for the explicit purpose of evaluating the *HC* programme. However, that study only measured children who were attending a *HC* centre. No measurements were taken of children not attending the programme. While the study provides a wealth of useful statistics and observations about the children and the *madres comunitarias*, the basic (and implicit) evaluation strategy is to compare the anthropometric measures of *HC* children with those of children of *similar socio-economic background* (observed in other surveys). The most striking observation was that participant children’s standardized height was worse than in children with ‘similar socio-economic background’.

3. Theoretical Model

In this section, we consider the HC programme within a behavioural model of child nutrition. Our main objective is to obtain a regression function that will allow us to learn about the productivity of the HC programme as well as to consider the interactions of the programme with other inputs chosen by the households. We are particularly interested in testing for full crowding out of the programme. As in Rosenzweig and Schultz (1983), we consider that the inputs of such a production function, including the use of the programme, are chosen by the household decision maker taking into account their cost and their productivity. An important difficulty we face is that one important input (food consumed at home) is not observable.

Let's consider a household that maximizes a utility function that depends on child nutritional status, H , on household consumption other than child food consumed at home, x and on female leisure, $1-L$ and, possibly, some unobserved factors e . Total household consumption, C , is given by children food, priced at p , and other consumption x . Therefore we have $C=x+pF$. The maximization problem is given by the following:

$$\begin{aligned}
 & \underset{x,F,M,A}{\text{Max}} U(H,x,L,e) \\
 & \text{s.t.} \\
 (1) \quad & H = H(A,F,L,u) \\
 & pF + x + zA = w(L - DA - M(1 - A)) + Y \\
 & 0 \leq L \leq 1, A \in \{0,1\}.
 \end{aligned}$$

where A is participation in the HC programme and can take the values 0 or 1, u is a vector of observable and unobservable variables that affect nutritional status H , p is the price of child food, z the fee to attend a HC . D is the distance (in time) from the HC , T is the total amount of time available to a mother, and M is the amount of time the mother needs to spend with a child if the child does not attend a HC . Notice that the child's food consumption does not affect utility directly but only through its effect on the child's nutritional status H . The household chooses x , F , L , and A taking w , p , Y , T , D , u , e and z as given. Here we consider A as a discrete variable.³

The first of the constraints assumes that H is a function of the child's intake of food at home F , attendance to a HC , female labour supply L , and other observable and unobservable variables u .

³ We could consider A a continuous choice: the results we have below would be very similar if we also had some sort of non-convex costs: implicitly we are considering here fixed costs that induce a 0/1 choice.

Observable variables could include, for example, mother's height or mother's education. The dependence of H on L is justified by some evidence on the impact of maternal care on the growth and development of young children.⁴

The second constraint in problem (1) is the budget constraint. On the left-hand-side we have expenditures: household consumption other than child food, child food and the fee for the *Hogar Comunitario*. On the right hand side we have mother's earnings and other income, Y , including male earnings that are not modelled.

Suppose first that food consumed at home by the child, F , was observable. Then we could solve the endogeneity problem discussed by Rosenzweig and Schultz (1983), by estimating the production function $H(\cdot)$ in (1) using w , D , and z as instruments for F , L and A . The identification assumption that the instruments do not enter the production function directly and are not correlated with the unobserved component u does therefore, in principle, hold. Under this assumption it is possible to identify the parameters of the production function, including the contribution of A to the child's nutritional status. This approach, however, is very demanding in terms of data because one needs to observe F , child specific food consumption at home. This would not be available in most household surveys, including ours.

In what follows, we outline our strategy that does not require observing food consumed at home by the child. Given that A is a discrete variable, of the two alternative values, households will chose the one yielding higher utility, taking into account the optimal choice of the other variables. In particular:

$$(2) \quad A = \begin{cases} 1 & \text{if } U^*_{|A=1} \geq U^*_{|A=0} \\ 0 & \text{otherwise} \end{cases}$$

where

$$U^*_{|A=1} = \underset{x,F,M}{\text{Max}} U(x, H, L, e) \quad U^*_{|A=0} = \underset{x,F,M}{\text{Max}} U(x, H, L, e)$$

$$\begin{array}{ll} \text{s.t.} & \text{s.t.} \\ H = H(1, F, L, u) & H = H(0, F, L, u) \\ pF + x + z = w(L - D) + Y & pF + x = w(L - M) + Y \end{array}$$

Conditional on the optimal level of A (that is 0 or 1), the set of first order conditions are the following:

⁴ For US evidence see, for instance, Karoly et al. (1998) and the references therein. A more recent paper is Baker and Mulligan (2008). For some evidence from a developing country see Fagusoro et al. (2004).

$$\begin{aligned}
(3) \quad x : & \quad U_{x^i} = \mu^i \\
F : & \quad U_H H_{F^i} - p\mu^i = 0 \\
L : & \quad U_{L^i} + U_H H_{L^i} = -w\mu^i \\
pf : & \quad H = H(i, F^i, L^i, e) \\
bc : & \quad pF^i + x^i + zi = w(L - Di - M(1-i)) + Y \\
& \quad i = 0 \text{ or } 1
\end{aligned}$$

One can use the f.o.c. for F and L in (3) to eliminate the multiplier associated with the budget constraint and obtain the following relation:

$$(4) \quad wU_H H_F = -p(U_L + U_H H_L),$$

that does not depend on x if the utility function is additively separable in x . Under this assumption food at home F can be expressed as a function of H , L , i , p and w , (but not on x , D , or z). That is:

$$(5) \quad F = \mathbf{F}(A, L, H, p, w).$$

According to equation (5), food consumption at home will depend on, A , the attendance to HC. This is the crowding out effect. Food consumption also depends on female labour supply, L , because it will affect household disposable income. If we substitute (5) into the production function, and linearize it, we obtain:

$$(6) \quad H_h = \pi' q_h + \gamma A_h + \alpha L_h + v_h,$$

where the parameter γ does not reflect only the productivity of the HC programme but also the crowding out effect contained in equation (5). If food consumed at home is fully crowded out by the HC programme then γ will be zero. Clearly, γ will be smaller than the productivity of the HC programme.

The reason why it is important to control for female labour supply in equation (6) is intuitive. There are two channels through which the HC programme could improve child's nutritional status: crowding out is not full, and family disposable income increases because female labour supply increases. If one wants to test for full crowding out, the latter channel must be controlled for and hence female labour supply should be included in the regression. Notice that female labour supply appears in the regression not only because of its direct presence in the production function, but very importantly for the above argument, because of equation (5). Because these two effects might have

opposite directions, the sign of α is difficult to predict *a priori*, and the two effects might even offset each other.

The theoretical model is useful to study the specification and identification of the regression function (6). First, the price of food and wages, which in our notation are part of the q vector, must be included in the regression function, because they affect food consumption at home (see equation 5) which was substituted into the production function to obtain (6). As a consequence w and p cannot be used as instruments to identify the parameters of interest. Second, as it is clear from equation (5), if the utility function is additively separable in x , F does not depend on either D , or z . Hence, D and z can be excluded from the regression function (6) and can potentially be used as instruments to identify the parameters in (6).

If one wants to estimate the parameters of equation (6) by instrumental variables, because L and A are endogenous, identification requires at least two instruments that generate independent variation in A and L . In our context, this is facilitated by discrete nature of A . To see why it is useful to consider that the instruments affect female labour supply and attendance both directly and indirectly, that is, $L=L(A(D,z),D,z)$. First consider the case of two households one living very close and another one living more far away from the HC centre. Still, z is small enough so that both households attend the HC programme. This would imply that the household that live more far away would have smaller female labour supply because it has to spend more time travelling to the HC centre. Second, consider two households that live sufficiently close to a HC centre, but one must pay a higher fee than another one. If they both attend a HC centre, the one that pays the higher fee will have larger female labour supply to achieve higher disposable income. The above discussion shows the instruments can potentially influence both directly and indirectly the input choices.

The final question we pose is under what conditions one can obtain a ‘standard’ IV regression where one regresses nutritional status H on some control variables and A , instrumenting the latter with the cost and availability data:

$$(7) \quad H_h = \pi' q_h + \gamma A_h + v_h$$

The main difference between equation (6) and (7) is that (7) does not depend on female labour supply. One possibility to obtain an equation similar to (7) from the model we have sketched would be to use the f.o.c.’s for L and F to solve them as a function of A, p, w, D , and z and substitute into the production function to obtain:

$$(8) \quad H = H[A, G_F(A, P, w, D, z), G_L(A, P, w, D, z), \epsilon].$$

Notice that, in general, not only w but also D and z would enter equation (7). We would therefore lose the possibility of using these variables as instruments for A and the parameters of equation (7) would not be identifiable. However, under certain restrictions on the utility function U and/or the production function $H(\cdot)$, the variables D and z would not enter equation (8). This would be the case, for instance, if α in equation (6) is zero, in which case equation (6) collapses to the standard IV specification, that is, equation (7). This might happen either because of the direct effect of L in the production function and the indirect one through F (equation 5) offset each other, or because the utility function is additively separable and linear in L and that L does not enter the production function $H(\cdot)$. If any of these two conditions hold, then it is straightforward to prove that the coefficient α in equation (6) is indeed zero.

In the more general case in which these functional form assumptions are violated, if we do not condition on L , the requirement that D and z do not enter in equation (7) will not be valid and D and Z could not be used as instruments. In these circumstances, only equation (6) can be consistently estimated. This shows that the presence of female labour supply in (6) is not only important to test for full crowding out as discussed above but potentially also for the identification of the estimating equation. Notice that the bias induced in the ‘standard IV specification’ if labour supply was omitted arises even when D and z are distributed completely randomly across households. It is induced by the fact that, even among participants, differences in distance or fee might induce changes in labour supply behaviour and food intakes, which in turn, directly or indirectly, have an effect on nutritional status.⁵ The extent to which these biases are important in practice depends, apart from the form of the utility function, on other factors such as the type of variation in D and z . For instance, if among participants variations in D are not large, the bias should not be too important. This is likely in our setting. Table 4.3 below shows that the 75th percentile of distance, *among participants*, is only 15 minutes. Consequently, participants live close enough to HC centres so that travel distance might not be an important variable that affects the amount of labour supplied.

⁵ This type of argument is made in a number of different contexts by Rosenzweig and Wolpin (2000).

4. The data

The data we use in this paper were collected to evaluate *Familias en Acción*, a new welfare programme perceived as an alternative to *HC*. For this reason, the sample we use is concentrated in a certain type of community. In this section we first describe the nature of the data set and then present some descriptive statistics of the sample.

4.1. *The Familias en Acción programme and the evaluation database.*

Between 2001 and 2002, the Colombian government started a conditional cash transfer programme in towns with less than 100,000 inhabitants, modelled after the PROGRESA programme in Mexico and financed with a loan from the World Bank and the Inter American Development Bank. This program, called *Familias en Acción* (FA from now on) has an education, and a health component and is directed to the poorest families living in the municipalities targeted by the program. As in the case of PROGRESA, the targeting of the programme is first done at the community level and then, within the chosen communities, at the individual level. The targeted communities were chosen on the basis of several criteria. First, they had to be relatively small towns (less than 100,000 inhabitants and no departmental capitals). Moreover, given that *FA* is a conditional cash transfer program, a town could be included only if it had enough education and health infrastructure. Finally, for security reasons in delivering the payments, the presence of a bank in the municipality was also a condition for qualifying.⁶ At the individual level, the programme was targeted to households with children aged 0 to 17 belonging to the lowest level of the so called SISBEN index (see footnote in section 2).

The nutrition component of *FA* consists of a cash subsidy that is given to the mother of children aged 0 to 6 living in beneficiary households. The subsidy is about 15 US dollars per month and is conditional on certain behaviours. Clearly such a programme is very different from *HC* and, indeed, is widely perceived as a substitute for it. While *HC* provides childcare, in-kind transfers and up to a certain extent nutritional insurance, *FA* relies on monetary transfers conditional on visits to health care professionals. Moreover, in the targeted municipalities, households entitled to the nutrition component of *FA* have to choose between that programme and *HC*, in that they cannot send their children to an *HC* if they register for *FA*.

⁶ An additional condition (that turned out to be binding in some situations) was that the mayoral office had to process some documents and have a list of potential beneficiaries ready.

When the *FA* programme started, the government commissioned a large scale evaluation of its impact. A large data collection project was undertaken in 122 municipalities, 57 of which were targeted by the programme. The remaining 65 were chosen as ‘comparison town’. While the assignment of the programme to municipalities was not random, the comparison towns were chosen so be as similar as possible to the random sample of 57 ‘treatment’ municipality. In practice, most of the comparison towns satisfy most of the conditions imposed by the programme with the exception of the bank presence.⁷ The first wave of data was collected in the summer of 2002. The same households were interviewed twice more: the second wave was collected between July and November 2003, while the third took place between December 2005 and March 2006. Attrition rates were reasonable low (6% between the first and second wave and an additional 10% in the third wave).

The households included in the survey had to satisfy the eligibility rules of *Familias en Acción*, that is they had to be registered as SISBEN 1 as of December 1999 and have children aged 0 to 17. This implies that our sample is representative of the poorest households in small towns. In addition to a very large number of questions covering consumption, income, school attendance, labour supply and a variety of other variables, every child aged 0 to 6 was weighed and measured. The questionnaire included a number of questions about current and past attendance of each child to a *HC*. In particular, for each child, we know whether he or she is currently attending a *HC*, and, for each year of the child’s life, how many months he or she had attended a *HC*. Finally, and importantly for our identification strategy, if a child is attending a *HC* centre, we know the distance from the household to the *HC* centre. If the child is not attending a *HC* centre, we know the distance to the nearest *HC*. For each child that has ever attended a *HC* centre, we also ask for the fee that they currently pay or that they used to pay when they attended. We also know at what ages they attended a *HC* centre.

As we are interested in evaluating the impact of the *HC* programme and we want to avoid contaminations by the new programme (*FA*), in what follows we focus on the towns where *FA* was

⁷ The municipalities were classified in 25 strata according to geographical region, population size living in the urban part of the municipality, the value of synthetic index for quality of life (QLI) as well as education and health infrastructure. Two treatment municipalities were randomly selected within each stratum among the municipalities participating in *Familias en Acción*. For each treatment municipality, a control municipality was chosen as the most similar to the treatment municipality in terms of population size, population living in the urban part of the municipality, and QLI among the set of municipalities not participating in *Familias en Acción* belonging to the same stratum than the treatment municipality.

not implemented. In the first and second wave, there are 65 municipalities where FA was not implemented. Between the second and third wave of data, the FA programme started in 13 municipalities that were part of the comparison group in the first and second wave. So, only 52 municipalities are used in the third wave of data. As a consequence the third wave includes considerably less children than the first two.

The fee paid for attending a *HC* centre and municipality wages as reported by the town major were collected in the second and third wave of data but not in the first one. For the first wave, we use the values collected in the second wave. We do not think that this is a major problem as the first and second wave were collected only 12 months apart. The distance to the health centre and school was collected for the whole sample in the second and third wave, but only for users of these services in the first wave. To prevent issues of sample selection, for the first wave of data, we use distance to the health centre, and school collected in the second wave of data. However, in the first wave, we do not use 384 children whose household moved between the first and second wave of data as the distance to the nearest school and health centre might have changed. Note however that we obtain very similar results if we include these 384 children and use, for the first wave, the distance to the nearest school and health centre measured in the second wave.

4.2. *Descriptive Statistics.*

Here we provide some basic information about our sample. More descriptive statistics are provided in Table A1 of the Appendix. The towns in our sample are reasonably small: the average (median) population in 2001 was 25k (20k) and even the town at the 75th% percentile had less than 30k inhabitants. However, the area over which these municipalities extend is at times substantial: the average size in square kilometres is 674. Typically, there is a substantial fraction of the population that lives in the so called ‘cabecera municipal’ (the main town -the average is 14k) while the rest is dispersed in the country side.

The population of our sample is very poor. The average family size is 7. Average consumption is about 114 US dollars per month, which includes our estimates for consumption of food produced or acquired as remuneration of work.⁸ The average share of food consumption in total consumption

⁸ The data base contains information on the quantities of 98 types of food consumed and on prices of each of these commodities at the town level. According to the 2003 Quality Life Survey, the average consumption in Colombia is \$432, excluding consumption in kind.

is 73%. The education level of household heads and spouses is very low: in our sample, 15% of the children have a mother with no education.

Following the literature, we do not use height directly, but we construct the so-called z-scores for these variables standardizing them by age and sex according to the World Health Organization/Centre for Disease and Control (WHO/CDC) reference population. In particular, the z-score for height per age is obtained from the height of a child, subtracting the median height of the WHO/CDC reference population of the same age and gender and dividing by the standard deviation of height of the WHO/CDC reference population of the same age and gender. Acceptable values of the z-scores range from -6 to 6. Chronic malnourishment in children is typically defined in terms of height per age. A child is defined as ‘chronically malnourished’ if his or her z-score for height per age is less than -2, that is if his or her height is less than 2 standard deviations from the median height for children of the same age and gender in the WHO/CDC reference population.

The children in our sample have a deficit in height. The average height per age z-score is -1.25 (while it should be zero in a healthy sample). Moreover, 23.7% of children are chronically malnourished. However, they do not have a deficit of weight for the height nor problem of obesity.⁹ This is why we focus our paper on the impact of the programme on child height which is an indicator of long run nutritional status.

In Table 4.1 we report the percentage of children who attend a *HC*. Two features are worth stressing. First, attendance rates have an inverted U shape, being highest at age 3. They are particularly low for very young children. Second, attendance rates do not achieve 50% which suggests either important supply constraints or that the population is not extremely popular.

Age	0	1	2	3	4	5	6
Boys	4	16	44	44	34	20	8
Girls	3	20	39	46	36	16	7

⁹ The percentage of children acutely malnourished –their weight is too low for their height- is only 1.2%. The percentage of obese children is 1.9%.

	Age: 0-1	Age:2-4	Age:5-6
Available caregiver at home	63%	39%	16%
No <i>Hogar</i> or too far away	15%	25%	13%
Cannot afford fee	4%	8%	3%
Does not like food	1%	4%	3%
Other	17%	24%	65%

For each child that does not attend an *HC* we ask the main reason for not attending. In Table 4.2, we report the percentages reporting a specific reason, for different age groups. The most popular reason for not attending is the availability of child care at home. As to be expected, this is particularly relevant for the youngest children. For the oldest children, the importance of the ‘other’ reasons is explained by the fact that a significant proportion of these children are in school. Interestingly for our analysis, the distance from the nearest *HC* and the fee that has to be paid to attend a *HC* centre appear as important reasons for not attending a *HC*.

In the theoretical model we presented in Section 3, the distance from the nearest *HC* and the cost of *HC* are the two cost variables that can play an important role in identifying the impact of the program on children’s nutritional status. We measure the former as the distance in minutes of travel¹⁰ to the nearest *HC* and the latter as the median monthly fee paid in the municipality to attend a *HC* centre. It is therefore important to check what type of variation we have in our sample for these variables. In Table 4.3, we report the mean and three percentiles (25th, 50th and 75th) for these two variables. In the left-hand panel we consider the statistics computed over the whole sample, while on the right hand panel, we restrict our attention to the sample of participants to *HC*. For the distance, we distinguish in each panel between rural and urban households (while reporting also the statistics for the pooled sample). By urban, we mean households residing in the town centre.

¹⁰ Distance is commonly measured in time in Colombia. In the third wave of the survey we asked respondents how they travel (or would travel) to the nearest *HC*. 87% of the respondents stated by walking.

As can be seen there is a substantial amount of variation in distances, especially in rural areas. In urban areas, however, the variation is much more limited. As expected, participants tend to live close to HC centres and live in municipalities with lower fees. For both variables, the differences are statistically significant. We return to the importance of these variables as determinants of participation below. Finally, notice that, among participants, the variability in distance is much more reduced: for this sub-sample, the difference between the 75th and 25th percentile is only 12 minutes, compared to 25 for the whole sample. In the last paragraph of Section 3 we mentioned that small variations in distance among participants is unlikely to induce changes in labour supply behaviour, *conditional on participation*, reducing the possible biases discussed in that section.

Table 4.3

Distribution of Distance to the nearest HC and average fee in the municipality

	Entire sample			Median monthly fee. Col. pesos	Participants in the HC program			Median monthly fee. Col pesos
	Travel distance in minutes				Travel distance in minutes			
	All	Rural	Urban		All	Rural	Urban	
25 th percentile	5	5	3	1651	3	3	3	1000
Median	10	20	5	3000	5	5	5	3000
Mean	21	34	9	3821	10	13	8	3056
75 th percentile	25	60	10	5254	15	15	10	4000

5. Empirical results.

In this section, we start by presenting the first stage regressions for the endogenous variables in our model. In particular, we study how our endogenous variables - participation in the HC programme and female labour supply – correlate with our ‘instruments’ - the distance from the household to the nearest HC and the median fee in the municipality where the household lives. We check that these variables are indeed correlated with participation into the programme, after controlling for the other

determinants we consider in our model. Obviously we cannot test directly whether the instruments are valid in the sense of being uncorrelated with the unobserved terms of the production function. In section 6, however, we provide some evidence about this assumption.

We then move on to empirical specifications inspired by equation (6) in Section 3. As we discussed there, the parameters of these equations can be given a structural interpretation, if the identifying assumptions we make hold. In particular, we need to assume that the variation in distances and fees are taken by the household as exogenous to the problem of investing in children nutrition and do not enter directly in the production of human capital. As distance could correlate with location and therefore many other environmental variables, in our specifications we control for a large number of location variables, such as the distance from the town centre or the distance from the nearest health centre and nearest school.

The sample we use includes several children from the same household, and several different households from the same municipality. Moreover the same children and households might be observed at different waves. This means that observations cannot be taken as independent and identically distributed. The error terms of different observations might be correlated because they refer to the same individual in different waves, or individuals of the same household, or individuals that live in the same town. In order to draw valid inferences, the standard errors for all the results we present are clustered at the municipality level, which allows for arbitrary intra-cluster dependence and arbitrary heteroskedasticity (see Pepper 2002).

5.1. *First Stage Regressions.*

The endogenous variables in equations (6) are the ‘treatment’ or programme (A) and female labour supply (L). For A we consider two alternatives: current attendance to a HC centre and ‘exposure’ to a HC. We define the latter as the number of months in which the child has attended a HC between ages 0 and 6 divided by the child’s age in months, that is, as the fraction of his or her life spent in a HC. This indicator considers the intensity of treatment as in Angrist and Imbens (1995). For female labour supply (L) we consider both the number of hours that a mother worked in the day previous to the interview and an indicator variable that takes the value one whether the woman has worked in the week previous to the interview.

As instruments we consider two set of variables that affect the availability and cost of the *HC* and that can be assumed as exogenous to the household: the distance from the household to the nearest *HC* nursery,¹¹ and the fee charged to attend a *HC* nursery. Identification is based on the exclusion restrictions, which in this context state that our cost instruments are uncorrelated with unobserved inputs that enter the production function H .

To be more precise, for each child, regardless of whether he or she attends a *HC*, we consider the distance to the nearest *HC* from the child's household residence in minutes and its square. We use both the distance in the current wave as well as the distance in the first wave of data. Past distance is correlated with exposure as well as with current attendance, due to probably some inertia in the participation decision. As for the cost of attending, in each town, we compute the median fee paid to participate in a *HC* nursery.¹² Again, we consider both the level and the square of this variable.

Table 5.1 reports the regression of the endogenous variables over the instruments (the first stage regression). The first two columns refer to our two definitions of programme participation, while the last two refer to our two definitions of labour supply. The results for programme participation are consistent with those in Table 4.2 on the self-reported reasons for not attending a *HC* nursery: "being too far away" was the second most important reason not to attend, and "cannot afford the fee" the third. We find that the distance from the household to the *HC* nursery is a very important determinant of both attendance and exposure. The average fee paid in the municipality is also an important determinant of our two definitions of treatment. The F-statistics for distance are high enough to rule out a problem of weak instruments. The F-statistic for the average fee is also strongly

¹¹ Distance to college has been used as an instrument for schooling by Card (1993), Kling (2001), and Cameron and Taber (2004).

¹² The average fee paid is computed using the fee that participants currently pay as well as the fee that used to be paid by children that were enrolled in the past. This question is only available for the second and third wave of data. Exchange rate of 2600 peso to the US dollar. Average per capita household consumption in our sample is 83427 Colombian pesos.

Table 5.1**First stage regression results. OLS regressions**

	Exposure HC	Attend HC	# of hours worked	Worked Previous Week
Distance in the current wave	-0.16 (0.030)	-0.33 (0.07)	-0.49 (0.73)	-0.26 (0.10)
(Distance in the current wave) ²	0.07 (0.02)	0.13 (0.04)	0.08 (0.43)	0.13 (0.06)
Distance in the first wave	-0.15 (0.04)	-0.18 (0.08)	-0.5 (0.72)	-0.06 (0.09)
(Distance in first wave) ²	0.062 (0.024)	0.08 (0.04)	0.30 (0.46)	-0.0002 (0.058)
Median fee	-0.025 (0.008)	-0.026 (0.014)	-0.16 (0.06)	-0.031 (0.012)
(Median fee) ²	0.001 (0.000)	0.001 (0.001)	0.01 (0.003)	0.002 (0.001)
F-statistic for distance [P-Value]	16.55 [0.000]	12.36 [0.000]	1.62 [0.18]	2.81 [0.04]
F-statistic for Fee [P-Value]	10.49 [0.000]	5.68 [0.007]	15.25 [0.000]	10.26 [0.000]
N1	2538	2538	2338	2347
N2	2395	2395	2385	2386
N3	966	966	941	941

The regressions include a number of other controls. Complete results are reported in the Appendix.

Standard errors in parentheses are clustered at the town level. P-values are reported in square brackets

Distance is in minutes and divided by 100. Fee is in Colombian pesos and divided by 1000.

Number of hours worked are daily.

statistically significant for exposure. For attendance, the fee and its square term are statistically significant different from zero at the 1% level, although this F-statistic (5.68) is the lowest.

The last two columns of Table 5.1 shows the results for the first stage regression of the labour supply variables that are included in equation (6). As mentioned above, we define as labour supply

either the total number of hours worked by the mother in the previous day or a binary variable that takes value 1 if the mother worked for paid in the last week and 0 otherwise. The results show that the Fee paid to attend a HC centre in the municipality is a very important predictor of mothers' labour supply variables.

Notice that the sample size of the third wave is much smaller than in the first and second one. This is because of two main reasons. The first one is that *FA* programme started in 13 municipalities between the second and the third wave, and hence we do not use them in the third wave. Second, as the original households have grown older, the number of households whose children are in the age group that qualifies for HC has decreased.

5.2. *Second Stage Results.*

Table 5.2 reports the estimates of equation (6), which relate child height to participation in the HC programme and female labour supply, as well as other controls. As discussed above, we use distance and the median fee in the municipality as instruments. Consistently with our theoretical model, we condition on average female wages in the village, and a price index for food.¹³ We also include a large set of covariates at the individual, household, and village level. In particular we control for distance from the household to the nearest school, nearest health centre, town hall, as well as town level variables. The reason for our un-parsimonious specification of this respect is our worry that our instruments could capture some unobserved feature of the environment where the households live and have a direct effect on the outcome of interest. We discuss our identification assumptions further in section 6.

The estimates associated with participation in the HC programme (exposure and attendance) are positive and statistically different from zero at the 5% level. The IV estimate of γ is large. The coefficient on Attendance is about 0.59 standard deviations on the Z-score. This effect corresponds to 2.86 centimetres for a boy (2.90 for a girl) aged 72 months.¹⁴

The coefficients associated to female labour supply are never significant at the 5% in the specifications reported in Table 5.2. This might be an indication of the fact that the conditions under

¹³ In Table 5.2, we only report the coefficient on the variables associated with participation in the HC. The full results of the regressions are given in the Appendix.

¹⁴ The standard deviation of height in the reference population for a boy aged 72 months is 4.8573 cms. and 4.917 for a girl.

which the ‘standard’ IV specification is valid hold. These include the fact that female labour supply does not enter the production function for human capital $H()$. Or it could indicate that the coefficient α just happens to be, given the specific parameters that affect it, close to zero. Perhaps not surprisingly, setting to zero the coefficient on labour supply in equation (6) does not change substantially the results we obtain.

Table 5.2

Height per Age over Participation and Female Labour Supply (Equation 6).

Instrumental Variable Estimates

	Exposure & N. Hours	Exposure & Participation	Attendance & N. Hours	Attendance & Participation
Exposure	0.996 (0.440)	1.016 (0.448)		
Attendance			0.589 (0.294)	0.590 (0.296)
Number of hours worked by the mother in the day previous to the interview	-0.028 (0.067)		-0.02 (0.073)	
Dummy variable if mother worked in the week previous to the interview		-0.103 (0.307)		-0.048 (0.317)
N1	2338	2347	2338	2347
N2	2385	2386	2385	2386
N3	941	941	941	941

The regressions include a number of other controls. Complete results are reported in the Appendix.

Standard errors in parentheses are clustered at the town level.

Distance is in minutes and divided by 100. Fee is in Colombian pesos and divided by 1000.

It is interesting to compare the IV estimates of equation (6) reported in Table 5.2 with the estimates one would obtain by OLS, that is ignoring the fact that attendance to a HC is a choice. The results obtained with such a result are reported in Table 5.3. Unlike the IV estimates, the coefficient on the HC variables are negative and, if participation is measured using attendance, statistically different from zero at 5%.

Table 5.3

Height per Age over Participation and Female Labour Supply (Equation 6).

OLS Estimates

	Exposure & N. Hours	Exposure & Participation	Attendance & N. Hours	Attendance & Participation
Exposure	-0.022 (0.088)	-0.025 (0.088)		
Attendance			-0.103 (0.046)	-0.104 (0.046)
Number of hours worked by the mother in the day previous to the interview	0.01 (0.005)		0.011 (0.005)	
Dummy variable if mother worked in the week previous to the interview		0.068 (0.040)		0.075 (0.040)
N1	2338	2347	2338	2347
N2	2385	2386	2385	2386
N3	941	941	941	941

The regressions include a number of other controls. Complete results are reported in the Appendix.

Standard errors in parentheses are clustered at the town level.

Distance is in minutes and divided by 100. Fee is in Colombian pesos and divided by 1000.

The fact that the OLS estimates are negative is an interesting result in its own right. OLS estimates, effectively compare (conditional on a number of control variables) children who attend a *HC* to children who do not. The fact that children attending *HCs* are not better off (and are possibly worse off) than children that do not from a similar background is consistent with the evidence from the internal study done by Siabato *et al.* (1997) previously mentioned, which found that children attending *HC* were shorter than children of ‘similar socio-economic background’. The negative bias of the OLS estimates relative to the IV ones is consistent with self-selection into the programme by those individuals with poor nutritional status. Indeed, the program guidelines explicitly say that children must suffer from “economic vulnerability” in order to be eligible.¹⁵ This might indicate that

¹⁵ http://www.icbf.gov.co/Tramites/primer_infancia.html#I

the programme is well targeted, in that the households most in need seem to self-select as *HC* customers.

5.3. *Female employment.*

A potentially attractive feature of a nutrition programme associated with the provision of child care is that it might allow the child's mother to work and, therefore, earn income. It is therefore tempting to try to establish the effect that the program has on female labour supply and employment. However, our theoretical model makes it clear that, in our context, it is difficult to frame the question in the language of impact evaluation. In the case of children nutrition status we defined one goal of the exercise we undertake as the estimation of the productivity of *HC* in the production of human capital. If we define as the outcome of interest female labour supply, it is not clear what the treatment is and how to interpret the relationship between female employment and children attendance to a *HC*. From a theoretical point of view this difficulty is reflected in an identification problem: it would not be possible to exclude any of the variables used as instruments (distance and fee) from an equation that relates female labour supply to *HC* attendance, as they are linked through the budget and time constraint. For instance, if two women take her children to the *HC* centre, the one that has to travel smaller distance have more time available to work. So, even conditional on participating in the *HC* programme, the distance travelled could affect female labour supply.

On the other hand, in the light of our model, the reduced form results that we reported in Table 5.1 have a straightforward interpretation. If the distance from the nearest *HC* and the cost of *HC* in a town reflect the availability of *HC*, the last two columns of Table 5.1 indicate that there is a strong relationship between female employment (either at the extensive or at the intensive margins) and *HC*. In particular, mothers who live closer to a *HC* or in towns where *HC* are cheaper, are more likely to work.

6. Is the identification strategy credible?

The credibility of the results we present relies on the plausibility of our instruments as exogenous variables that determine participation into *HC* but are not related directly to nutritional outcomes. In this section, we present some evidence that justifies our identification strategy.

There are two reasons why the distance from the nearest *HC* centre could be considered endogenous to the outcome of interest: (i) individual households who care about their children needs or need more help could locate closer to a *HC* centre; (ii) the unobserved determinants of nutritional status are systematically different between households that live close to a *HC* centre and those who live far. We analyze each of these issues in turn.

6.1 Do households move to be closer to a *HC* centre?

Given the evolution of the *HC* programme, we believe that the distance from the household to the nearest *HC* is a good instrument. First, conversations with programme officials indicated that, especially in isolated rural areas, which make up a substantial proportion of our sample, there might be severe supply restrictions induced by the need of a minimum number of children for ICBF to register a new *HC*. Moreover, after the first few years of the program, the turn over of *madres comunitarias*, induced by a variety of factors, contributed to substantially weaken the link between the original parent association and the location of the *HC*.¹⁶ It seems that many of the current clients of *HC* are households that move to a given neighborhood and access an existing *HC*. Second, we can provide evidence that households do not move with the purpose to be closer to a *HC*. Those households that moved location between two consecutive waves but were found and interviewed were asked the reason for changing address. Although ‘moving closer to a *HC*’ was explicitly listed as a possible reason to move, only one of the 596 households that moved chose it as an answer.¹⁷ Moreover, comparing the distance from the nearest *HC* for the movers and those who did not move, (which is done in Table 6.1 both conditionally on the distance to the nearest school and

¹⁶ It is possible that the quality of the new *HC* available in a place is related to the density of children in need of a *HC*. This would be reflected in heterogeneity of impacts, which we investigate below.

¹⁷ Responses to the reasons to move are “to find a better equipped house” (32%), “for work related reasons” (14%), to be closer to a relative (8%), to be closer to a school (3%), violence related (2.68%), to be closer to the town centre (0.5%), and to be closer to a *HC* centre (0.17%), and other reasons (39%).

health centre and unconditionally), we do not find any statistically significant difference. Notice that the additional covariates considered in the second column of Table 6.1 are also included in our model and in the main results reported in Table 5.2.

	Without additional covariates	With distance to other facilities as covariates
Moved (1 if household moved address, 0 otherwise)	-2.20 (1.86)	0.453 (1.511)

Sample size is 3095. Standard errors shown in parenthesis are clustered at the town level.

Finally, among the households who moved, we compare those who have children less than 7 to those who do not, as the latter are not eligible to participate. Once again the distance to the nearest HC is not statistically different for the two groups. All these pieces of evidence indicate that households do not seem to move to be closer to a HC centre, which could be partly explained because of the high turnover of *madres comunitarias* that we described in section 2.

6.2 Is distance to a HC centre correlated with unobserved determinants of nutritional status?

Our identification strategy relies on the assumption that the unobserved determinants of nutritional status are not systematically different, conditional on the set of variables we control for in our main specification, between households that live close to a HC and households that live far. We believe that this is true because households do not seem to move to be closer to a HC and because we control for the location of the household in the municipality because we introduce in our specifications several variables related to that: the distance from the household to the nearest health centre, nearest school, and the town hall, all of which are probably more important attraction points than a HC centre.

To provide a sense of the plausibility of our identification assumption, we estimate a specification similar to those reported in Tables 5.2 and 5.3, but using as an outcome a variable which is unlikely

to be affected by the intervention: children’s birth weight. The idea is that a child cannot be affected by the *HC* before starts going there. If we were to find that our instrumental variable procedure indicates an effect of the programme similar to that we estimate for height per age one would suspect that the instruments we are using are correlated with unobservable determinants of nutritional status and are therefore invalid. It is likely that the unobserved determinants of height per age are shared with the determinants of birth weight. Therefore a correlation between these factors with the instruments we use would induce a similar bias both in the specification for height and that for birth weight. For instance, it could be that children from households that live closer to a *HC* are healthier or wealthier (and therefore heavier at birth and taller at later ages) for some reason other than the exposure or participation into *HC*.

Rather than report all for specifications in Tables 5.2 and 5.3, we focus on those where the female labour supply variable is measured by a participation dummy. We obtain very similar results when we use the number of hours (available in the Appendix). The first two columns of Table 6.2 report the results obtained by our Instrumental Variable procedure when using current attendance and exposure as our measures of ‘treatment’. The third and fourth column of Table 6.2 estimate the same specification by OLS, as it was done in Table 5.3 for height per age.

	IV		OLS	
Exposure	0.151 [0.234]	-	0.011 (0.026)	-
Attendance	-	0.108 (0.139)		-0.013 (0.019)
Dummy variable if mother worked in the week previous to the interview	0.039 (0.156)	0.024 (0.163)	-0.007 (0.016)	-0.006 (0.016)
Sample Size	1402	1402	1402	1402

Standard errors clustered at the municipality level. The regression includes the same controls as in Tables 5.2 and 5.3. Complete results are available in the Appendix.

None of the coefficients in Table 6.2 is significantly different from zero. In the case of attendance, the OLS point estimates are negative, perhaps another symptom of the negative selection process.

6.3 Sensitivity analysis

In this section, we assess the robustness of our results to deviations from the identifying assumption that the instruments are not correlated with the error term of the outcome equation (6).¹⁸ In particular, we want to assess the bias arising from different degrees of correlation between the instruments we use and the error term.

Re-writing equation (6) in matrix form, we have:

$$(9) \quad H = S * \beta + U,$$

Where $S = [q | L | \bar{A}]$ has dimension $n \times k$; H , A and U have of dimension $n \times 1$, n is the number of observations, q are $k-2$ exogenous covariates and $\beta' = [\pi' | \alpha | \gamma]$ has dimension $1 \times k$. The IV estimator can be written as:

$$(10) \quad \hat{\beta}_{IV} - \beta = [S' P_w S]^{-1} [S' W (W' W)^{-1} W' U],$$

where $W = [q | z | \bar{A}]$ is the matrix of instruments, z is $n \times 1$ vector that contains the median fee in the municipality to attend a HC centre, and \bar{A} is another $n \times 1$ vector containing predicted attendance or exposure to HC using a Probit model and the four distance variables included in Table 5.1. This is a useful way of collapsing the four distance variables into one instrument.¹⁹ Notice that the last component $W' U$ includes the correlation between the predicted instrument \bar{A} and the error term U . As a first exercise, using (10), one can compute different values for γ under different assumptions about $corr(\bar{A}, U)$ and $corr(z, U)$. As is often the case, the bounds we obtain by varying the relevant correlation are extremely wide and not very informative, including both positive and negative values.

However, following Ashley (2009), one can carry out a more informative sensitivity analysis using information on the difference between OLS and IV estimates. In particular, one can solve for β in the formula for the OLS estimator, and substitute it in (10). Some straightforward algebra yields:

$$(11) \quad [S' P_w S]^{-1} [S' W (W' W)^{-1} W' U] = \hat{\beta}_{2SLS} - \hat{\beta}_{OLS} + [S' S]^{-1} [S' U]$$

¹⁸ Imbens (2003) and Altonji, Elder and Taber (2005) assess the robustness of their conclusions to the violation of the conditional independence assumption. Their benchmark assumption is the opposite of ours, that there is no correlation between the treatment variable and the error term of the outcome equation.

¹⁹ See Wooldridge (2002) page 623 for the attractive properties of this procedure

Under the maintained assumption that the exogenous variables q are uncorrelated with the error term U , for given values of $\text{corr}(A,U)$ and $\text{corr}(L,U)$, one can solve for $\text{corr}(\bar{A},U)$ and $\text{corr}(z,U)$ that are implicit in equation (11). These correlations can then be used to compute the implied estimate of the bias of the IV estimator, and the implied value of γ using equation (10). We report the results of this procedure in Figure A and B for attendance and exposure respectively, using values of $\text{corr}(A,U)$ and $\text{corr}(L,U)$ that ranges from -0.30 to 0.30, in increments of 0.01. For the sake of brevity, we use whether the mother worked or not in the previous week as labour supply variable.

When there is a single endogenous variable, the exercise is particularly simple. In our case, however, we need to deal with the fact that our main equation (6) contains two endogenous variables. For this reason, and to get more informative results, we make a number of assumptions when we generate Figures A and B. In particular, we assume: (1) that the correlation between participation in HC and the error term is negative, (2) that the correlation between female labour supply and the error term is positive, and (3) that the correlation between the predicted instrument, \bar{A} , and the error term is positive which implies that the correlation between distance and the error term is negative.²⁰

The first assumption, that the correlation between participation in HC and the error term is negative, can be justified using different pieces of evidence. First, according to the official guidelines, the programme is targeted towards children that suffer economic vulnerability. Second, a Probit regression, available upon request, shows that, even within our sample, children from poorer backgrounds (for instance with less educated mothers) are more likely to attend a HC centre. Third, the OLS point estimates reported in Tables 5.3 are negative and statistically different from zero. We find it easier to believe that this negative coefficient is due to children with poor nutritional status selecting into the programme rather than the programme having a negative impact on children's height. Fourth in a similar programme in Bolivia, the poorest children were also the ones that were more likely to participate (Behrman *et al.* 2004).

The second assumption, that female labour supply and the error term are positively correlated, can be justified because unobserved ability increases female labour supply and children nutritional status.

The third assumption, that the correlation between the predicted instrument, \bar{A} , and the error term is positive, is the least favourable for our findings in the sense that large positive correlations would imply that the actual γ is negative though we estimate a positive one.

²⁰ Notice that the predicted instrument decreases with distance. A positive correlation between distance and the error term would yield even larger estimates of γ .

In Figure A, we plot the value of γ for the combinations of different correlations that verify the assumptions above. Of the grid that we have used ($corr(A,U)$ and $corr(L,U)$ that ranges from -0.30 to 0.30, in increments of 0.01) there are 812 points that verify the three assumptions above. Only 77 of them have negative value of γ . The negative values of γ only occur when $-0.03 \leq corr(A,u) \leq 0$. In Figure B, we plot the same graph for γ but if HC participation is measured as Exposure. The results are even more robust in this case. The implied γ is negative for only 4 out of the 742 points in the grid that verify our assumptions above. These 4 negative values of γ occur when $corr(A,U)=0$ and $corr(L,U)$ ranges from 0 to 0.04.

7. Conclusions

In this paper we have studied one of the largest welfare programmes in Colombia. *Hogares Comunitarios*, a community nursery programme, that costs about 250 million US\$ per year and, although it has been running since the mid 1980s, had never been systematically evaluated.²¹ The fact that the programme is very widespread and has been operating for so long makes the use of a standard quasi-experimental evaluation approach problematic. Eligible children who do not attend a *HC* are clearly a selected sample that cannot be directly compared to those who attend a *HC*. We approach this problem modelling explicitly the process of participation. We see the *HC*'s within a model of Human Capital production as one of many possible inputs that poor households might choose to use. Given the features of the programme and other options available to them, it seems that the *HC* programme is chosen by the poorest households.

We use the model we have sketched in Section 3 to make two points. First, one could interpret the 'evaluation' of a programme such as HC as an attempt to estimate the marginal product of the programme in the production function for human capital. If that is the case, one needs to take into account of other inputs and their interaction with HC, both in terms of actual productivity and, especially, in terms of possible crowding out. There are at least two inputs that are relevant for what we do: food intakes at home and female labour supply. Estimating the productivity of a specific input, such as the programme, can be difficult for the usual issues that one encounter in estimating

²¹ Recently, the Colombian government commissioned an impact evaluation of HC. The results of this evaluation, which is mainly based on matching methods, are not publicly available yet.

production functions. These problems are compounded by the fact that some important inputs are, in our case, unobserved. In the framework we propose we show that, with some assumptions, we can identify the overall impact of HC keeping some inputs (such as labour supply) constant. Moreover, we can test the hypothesis that the programme induces full crowding out of food in.

The second point we make is that a standard IV approach, in which an outcome is regressed on the treatment and a number of control variables, using as an instrument variables that reflect the availability and cost of the treatment, could yield misleading results even when the cost variables are 'legitimate' instruments, in the sense that they can be legitimately excluded from the production function. The reason is the possible failure to control for other inputs of the production function.

Using an empirical specification that is consistent with our model. we find that, unlike the OLS estimates, our results show important impacts of the program. The OLS results, which indicate small or even negative effects in our sample, are consistent with the little descriptive evidence that was available on the programme and that stressed that the nutritional status of children attending a *HC* is not dissimilar (and possibly worse) from children of similar socio-economic background not attending it. Our results show that the negative or zero estimates of the OLS results are explained by the selection into the programme of the poorest children. In particular, a 72 months old boy (girl) that has attended a HC during half of his life will be 2.43 (2.46) centimetres taller than if he (she) had not attended a HC at all. The program, therefore, seems to be well targeted and to help maintain the nutritional status of the poorest children.

Behrman, Cheng and Todd (2004) (BCT), using data from a similar program in Bolivia and matching techniques which are substantially equivalent to OLS obtain results similar to ours. Participating children, conditional on observable variables, exhibit a nutritional status that is not dissimilar or even worse than non participating children. Participation into a HC is an investment *choice*, which is probably made considering its likely consequences and the possible alternatives. This consideration and the theoretical framework we use should advice some caution in the interpretation of the BCT results. Unobservable variables that determine participation might be correlated to outcomes. Revealingly, BCT also show that, conditional on participation, length of exposure to the Bolivian program seems to have positive effects on nutritional status.

The evidence we provide is important as the Colombian government is considering the possibility of scrapping the *HC* programme in favour of conditional cash subsidies. What we have shown should give an element of caution in implementing these plans.

There is much work that still needs to be done. First, it should be stressed that our results cannot be extrapolated to different contexts. The large majority of *HC* in Colombia operates in large cities and urban areas: our results are from a sample of small towns with an important rural component. Second, as we have evidence on the effectiveness of the alternative programmes being considered, it would be interesting to compare them explicitly and model impact heterogeneity, especially in terms of child ages. It might be that the two programs, rather than being substitutes, are complements. It might be that the youngest children are best targeted by the conditional cash subsidies, while children aged 2 to 4 might benefit more from the *HC* programme. Third, there are many dimensions, such as the heterogeneity of impacts, that we have left unexplored.

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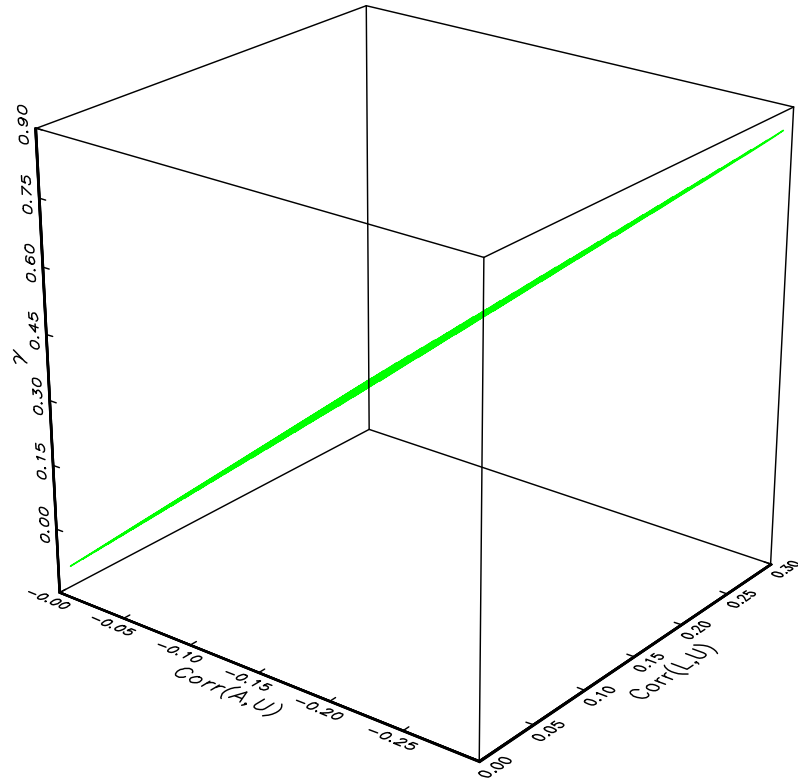
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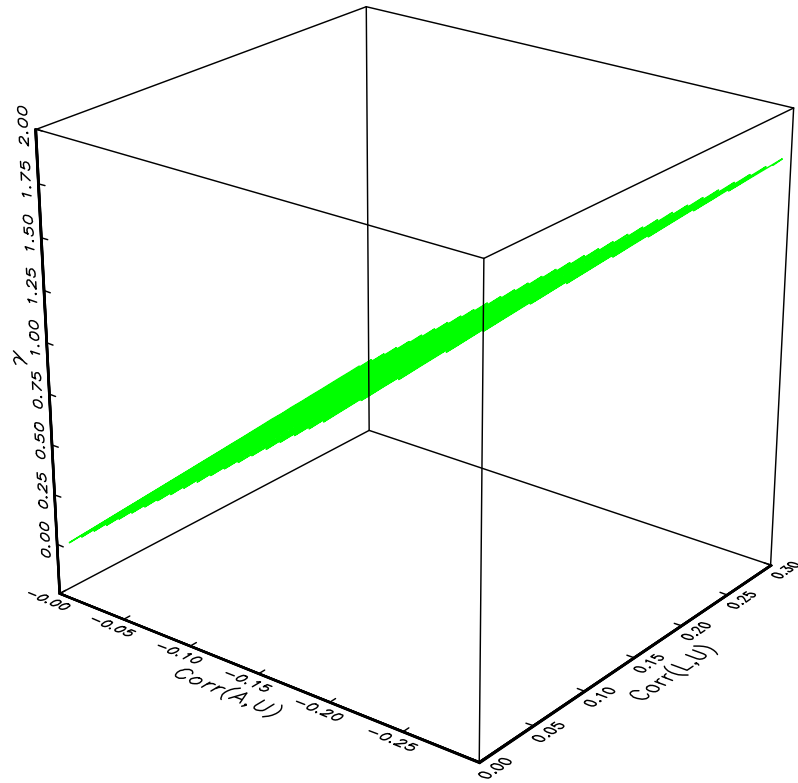
FIGURES

Figure A. Sensitivity of γ . HC participation measured as Attendance.



FIGURES

Figure B. Sensitivity of γ . HC participation measured as Exposure.



APPENDIX
Not for publication

Table A1. Variable definitions and descriptive statistics

Variable			
Name	Definition	Mean	Sd.
age_head	Household head's age in years divided by 100	0.39	0.11
age_mot	Mother's age in years divided by 100	0.32	0.07
age_m	Child age in months	48.83	23.27
altitude	Altitude in thousand meters	0.45	0.68
asis_hc	1 if the child is attending a HC centre, 0 otherwise	0.24	0.43
edu_h345	1 if household head has completed primary education or more, 0 otherwise	0.34	0.47
edu_m345	1 if mother has completed primary education or more, 0 otherwise	0.41	0.49
exposure	Number of months that the child has attended a HC centre divided by the age of the child in months	0.18	0.24
female	1 if child is female, 0 if child is male	0.49	0.50
haz	Child's height. Unit: z-scores	-1.25	1.10
hc_fee	Median fee to attend a HC nursery in the municipality. Colombian pesos divided by 1000.	3.82	3.18
height_mot	Mother's height in metres	1.54	0.06
hosp	1 if there is a hospital in the town, 0 otherwise	0.71	0.48
insur_mun	Proportion of children with formal health insurance in the municipality	0.62	0.22
ln_age_head	Logarithm of household head's age in years divided by 100	-0.96	0.26
ln_age_mot	Logarithm of mother's age in years divided by 100	-1.17	0.22
ln_order	Logarithm of order of kid in the household	1.15	0.53
order	Order of kid in the household	3.61	1.75
pipe	Percentage of households with pipe water in the municipality	0.85	0.14
price_index	Food price index	0.92	0.13
region_2	1 if household lives in the Eastern region, 0 otherwise	0.19	0.39
region_3	1 if household lives in the Central region, 0 otherwise	0.25	0.43
region_4	1 if household lives in the Pacific region, 0 otherwise	0.12	0.33
rural	1 if household lives in the rural part of the municipality, 0 otherwise	0.48	0.49
sewage	Percentage of households with sewage connection in the municipality	0.44	0.37
time_hc	Distance (minutes divided by 100) to the nearest HC	0.21	0.32
time_hc_b	same as time_hc but in the first wave of data	0.23	0.33
time_alc	Distance in minutes to the town hall, divided by 100	0.51	0.65
time_heal	Distance in minutes to the nearest health care provider, divided by 100	0.41	0.55
time_sch	Distance in minutes to nearest school, divided by 100	0.14	0.15
time_alc_mun	Average of <i>time_alc</i> in the municipality	0.52	0.38

time_hea_mun	Average of <i>time_bea</i> in the municipality	0.30	0.28
time_sch_mun	Average of <i>time_sch</i> in the municipality	0.10	0.05
time2	Time dummy for second wave of data	0.42	0.49
time3	Time dummy for third wave of data	0.17	0.37
wage_fr	Rural female wage in pesos as indicated by the town major divided by 1000 in Colombian pesos (December 2003)	0.91	0.35
wage_fu	Urban female wage in pesos as indicated by the town major divided by 1000 in Colombian pesos (December 2003)	0.98	0.34
work_hour	Number of hours worked by the mother the day previous to the interview	1.39	2.93
work_week	1 if mother worked the week previous to the interview, 0 otherwise	0.34	0.47