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THE IMPACT OF UNCONDITIONAL CASH TRANSFERS ON NUTRITION: THE SOUTH AFRICAN CHILD SUPPORT GRANT*

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ABSTRACT

In light of research that has argued that the income elasticity of nutrition is low, the goal of a new generation of cash transfer programmes to boost the nutrition of poor families' children may seem surprising. This observation applies especially to South Africa's *unconditional* Child Support Grant (CSG), in which cash grants are made to families with no strings attached. However, in contrast to the market-generated income increases that identified low nutritional elasticities in the earlier studies, the income increases generated by the South African cash transfers are almost exclusively assigned to women. Taking advantage of a slow programme rollout that created exogenous variation in the extent of CSG treatment received by beneficiaries in the province of KwaZulu-Natal, this Working Paper utilizes the continuous treatment method of Hirano and Imbens (2004) to estimate the impact of these transfers on child nutrition as measured by child height-for-age. Large dosages of CSG treatment early in life are shown to significantly boost child height. Drawing on the best estimates in the literature, these estimated height gains in turn suggest large adult earnings increases for treated children and a discounted rate of return on CSG payments of between 160 per cent and 230 per cent.

Keywords: Nutrition, cash transfers, continuous treatment estimator, South Africa.

JEL Classification: I12, H53, C21, D13.

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1 INTRODUCTION

Despite improvements over the last two decades, child malnutrition remains a serious health problem in developing countries, and is the main contributor to child mortality (World Bank 2006). For those children who survive, early childhood malnutrition contributes to the inter-generational transmission of poverty. In a striking study of Ecuadorian children, Paxson and Schady (2005) show that by age five, children who were likely inadequately nourished have already fallen well behind the cognitive development of their better nourished peers. Assuming that these disparities persist, the malnourished children would likely do less well in school, accumulate less human capital and enjoy lower adult earnings than their peers. We would expect that their own children would in turn repeat this inequitable cycle.

In an effort to break this intergenerational transmission of poverty (poverty that 'lays its own eggs', in the words of an informant quoted in the Chronic Poverty Research Centre Report (2004)), some middle-income countries have adopted cash transfer programs designed to bolster the nutrition, health and education of the children of poor families. At first glance, reliance on cash transfers to achieve these goals may seem somewhat surprising in light of the debate about whether nutrition responds at all to income increases amongst poor families. For example, Behrman and Deolalikar (1987) find an income elasticity close to zero for a sample of families in south India. While other studies find a positive elasticity, the issue is far from solved.¹

There are, however, several critical differences between the new generation of cash transfer programmes and the market-generated income difference used to identify nutritional elasticities in the earlier literature. Mexico's *Progresa* programme, the best known of these cash transfer programmes, has two key design features that may mediate its nutritional impacts.² First, cash transfers are conditional on the household meeting certain required behaviours: older children must attend school; and younger children must visit clinics for regular medical check-ups and nutritional monitoring (where among other aspects they are given nutritional supplements).

In addition to these conditionalities, *Progresa* cash transfers are also assigned to women. Unlike market-driven income increases, which may have been generated by increases in returns to assets owned by men, these targeted cash transfers have been designed to bolster the bargaining power of women, with the idea of giving more weight to their preferences because they are presumed to be more child-centric.³

While much of the impact evaluation literature on *Progresa* has focussed on schooling outcomes, there is evidence that *Progresa* has boosted child nutritional status (Behrman and Hoddinott 2005). However, because *Progresa* transfers were conditional (and included in-kind nutritional supplements), it is not clear whether these findings indicate non-zero income elasticities of nutrition, or simply the impact of transfer conditionality.

Unpacking the reasons behind this response is of more than academic interest. Aid agencies have noted that the heavy administrative burdens implied by transfer conditionality limit the ability of lower income African economies to implement programmes modelled on *Progresa*. Given that it is precisely these economies where malnutrition is most severe, understanding the importance of costly conditionality is important.⁴

This Working Paper aims to contribute to knowledge in this area by studying the impact of the South African Child Support Grant (CSG), which was first rolled out in 1998. Like *Progresa* and its sister programmes in Latin America, CSG cash transfers are targeted at women. Unlike

those programmes, CSG transfers are unconditional, and come with no strings attached, nor with any in-kind transfers.⁵ Analysis of this programme thus promises a more sharply focused examination of the income elasticity of nutrition, at least in the context of income increases targeted at women.

However, in comparison to the *Progresa* program, evaluation of the CSG presents a particular methodological challenge. By randomly selecting rural areas to receive the cash transfer treatment, *Progresa* quickly became a popular program among academic analysts. In contrast, the CSG was rolled out as a single, national programme, depriving analysts of purposefully randomized treatment and control groups. Alternative methods are thus needed to estimate the impact of the South African CSG.

One method would be to follow the current literature and use matching methods to evaluate CSG support as a binary treatment. Statistical problems aside, this approach would overlook the fact that the extent of CSG treatment (the 'dosage') varies significantly across the treated population. During the nutritionally critical first 36 months of life (which will be the focus of the analysis here), some children received CSG support nearly 100 per cent of the time, while others received only a month or two of support. The nutritional impact of the latter is likely negligible, while the impact of the former could be substantial. The analysis here will thus use variation in the extent of treatment to identify the impact of the CSG.

While the continuous treatment estimator of Hirano and Imbens (2004) opens the door to analysis of the extent of treatment among the treated, it still requires strong orthogonality assumptions. The critical statistical identification assumption is that the extent of treatment is unrelated to unobserved factors that themselves can affect child health and nutrition.

While this assumption may seem hard to sustain for a voluntary programme that had a single national eligibility date, we show how information on effective program rollout can be used to derive a caregiver 'eagerness' measure that allows analysts to control for otherwise unobservable, and confounding, characteristics. Conditional on 'eagerness' and other covariates, we argue that exposure to the CSG depends (randomly) on the interaction between the child's birth date and the effective programme rollout for the child's locational and temporal cohort.

Exploiting this eagerness variable, our analysis of the impacts of early-life CSG as a continuous treatment case uncovers economically and statistically significant effects for large dosages of CSG support. These estimates show that effects are insignificant for children who received CSG support for less than 50 per cent of their 36 month window. These results are robust to the inclusion of cohort and cluster variables meant to control for differences in the supply of health-related public goods and other time and locational differences.

Finally, in an effort to get an understanding of the possible economic value of these nutritional gains, we project forward in time using best estimates from the literature concerning the impact of adult height on wages. Adaptation of these estimates to the South African reality suggests that the present value of early CSG support is 1.5 to 2 times as large as the direct cost of that support. These findings in no way imply that there are not further gains from CSG support later in childhood. Indeed, they suggest that such further gains are quite likely. However, within the confines of this study, we have not been able to estimate their magnitude.

The remainder of this Working Paper is organized as follows. Section 2 provides background description of the South Africa Child Support Grant. Section 3 presents descriptive

statistics on the programme, discussing key measures and identification strategies that are available. Section 4 presents the methods and results from using continuous treatment effects. Section 5 attempts to infer the lifetime economic value of the nutritional impact identified in Section 4, and Section 6 concludes the paper.

2 THE SOUTH AFRICAN CHILD SUPPORT GRANT

The South African system of state welfare transfers changed little in terms of its basic structure up to the 1990s. The system remained dominated by means-tested, non-contributory old age pensions and disability pensions, with discrimination between different racially defined population groups in terms of access to the grants and the levels of benefits. Substantial progress was, however, made during the early 1990s in removing racial discrimination from these two programmes. This greater equalization resulted in increased access and real benefit levels for Africans and reduced real levels of benefits for white pensioners. Fiscal costs expanded significantly.

Despite its apartheid past, South Africa now possesses a substantial system of state provided, cash social assistance with wide coverage of the population, most notably of the formerly disenfranchised African majority. This important role of cash social assistance is fairly exceptional compared to most other middle-income countries (see Lund 1993, Lund 2001, Van der Berg 1997, Case and Deaton 1997).

The reforms of the early 1990s did not extend to the third most important component of state transfer payments, namely, State Maintenance Grants (SMGs). These grants, payable in the form of parent and child grants, were means-tested benefits payable to a natural parent who could not, for a number of reasons, rely on the support of the second parent. If the second parent was alive, it was necessary to apply for a private maintenance order through the courts; and only if this failed (or the amount awarded was very low) was the child eligible for the grant. This bureaucratic hurdle, in conjunction with very low awareness of the grant, was effective in excluding many eligible children from accessing the grant.

In 1990, only 0.2 per cent of African children were in receipt of the SMG, while 1.5 per cent of white children, 4.0 per cent of Indian children and 4.8 per cent of Coloured children received benefits (Kruger 1998). It became apparent in the mid-1990's that providing equal access to the SMG would have severe fiscal implications given poverty levels and household structures. Simulations based on household survey data predicted a more than twenty-fold increase in expenditures (Haarman and Haarman 1998).

In December of 1995, the new democratic government of South Africa established the Lund Committee to evaluate the existing system of state support and to explore new alternative policy options targeting children and families. In 1998, the Child Support Grant (CSG) replaced the existing SMG. The benefit was initially limited to children under seven years of age (unlike the SMG, which covered children up to age 18). In proposing the CSG, the Lund Committee emphasized that the grant must 'follow the child', meaning that the benefit should be independent of the child's family structure.

This approach represented a move from a family-based benefit to a child-focused one. Legally, however, the grant must be paid over to an adult and it is the intention that the person to whom the grant is paid is the 'primary care giver' of the child for whom the benefit is

intended. In cases where the applicant is not the biological parent of the child, a sworn affidavit from the parents or guardians is required to confirm that the applicant is indeed the primary care giver. In practice, the designation of the primary care giver as the grant recipient has effectively targeted women. In the data used here, 98 per cent of designated primary care givers are female.

When the Child Support Grant (CSG) was introduced, it was intended to cover the poorest 30 per cent of children and was means-tested, i.e., the child had to be residing in a household with a household income below a certain threshold. The threshold was set at R800 (approximately US\$ 110) for children living in urban areas and at R1100 (US\$ 150) for those living in rural areas or in informal settlements. In 1999, due to a low take-up rate, the Department of Welfare altered the income test from a household based measure to one that considered only the income of the primary caregiver plus that of his/her spouse (net of other state transfers).

The means test has remained unchanged in nominal terms since 1998, despite the fact that the Consumer Price Index rose 40 per cent between April 1998 and September 2004. Despite this increasingly stringent means test, about half of age-eligible children were in receipt of the grant by this latter date.⁶

The government has increased the age limit for eligibility in recent years. In April 2003, the age limit was raised to nine years old and a year later this was increased to 11 years. In April 2005, the age limit was raised to 14. The amount granted has also changed since 1998 and the increases have outstripped inflation. While the initial monthly benefit was R100 in 1998, it is currently R180. During the time of the survey that we discuss, the monthly benefit was R170, which equates to approximately US\$ 25 using the market exchange rate (or, using PPP, US\$ 50).

3 THE KWAZULU-NATAL DATA AND THE MEASUREMENT OF NUTRITION

The data for this study come from the KwaZulu-Natal Income Dynamics Study (KIDS).⁷ The KwaZulu-Natal province is home to approximately 20 per cent of South Africa's population of 40 million and was formed in 1994 by combining the former Zulu homeland with the old Natal province.

Although KwaZulu-Natal is not the poorest province in South Africa, it arguably has the highest incidence of deprivation in terms of access to services and perceived well-being (Klasen 1997, Leibbrandt and Woolard 1999). KwaZulu-Natal is also home to most of South Africa's ethnically Indian people, who constitute 12 per cent of the province's population. Africans comprise about 85 per cent of the province's population, with people of European descent (largely British) comprising most of the remainder.

As explained in greater detail by May, Agüero, Carter, and Timaeus (2005), respondents to the KIDS study were first interviewed in 1993 as part of a nationwide living standards survey. In 1998, the KIDS study re-interviewed households from the 1993 survey that were located in the KwaZulu-Natal province. A third round of surveys was undertaken in 2004. While the 1993 survey constructed households based on the residents of randomly selected dwellings, the 1998 and 2004 studies focused on re-interviewing designated 'core people' from the 1993

surveys. A household member was designated as a 'core person' if s/he satisfied any of the following criteria:

- A self-declared head of household (from 1993).
- Spouse/partner of self-declared head of household (from 1993).
- Lived in a three generation household and all of the following were true: the child, child-in-law, or niece/nephew of the self-declared head, who was at least 30 years old, have at least one child living in the household.
- Spouse/partner of person satisfying criterion.

Thus all heads of households and spouses of heads are automatically included and in some three-generation households, adult children of household heads are included. The 2004 survey was able to interview at least one core person from 71 per cent of the original 1993 households. In addition, children of core people who had had their own children and established new, separate residences were also interviewed in 2004.

The analysis to follow will consider children resident with core people as well as grandchildren of core people now living separately. Note that children who are resident with core people include grandchildren of the cores whose parents have not established independent residences.

3.1 USING HEIGHT-FOR-AGE Z-SCORES TO MEASURE THE NUTRITIONAL IMPACT OF THE CSG

The CSG programme issues monthly payments to the caregivers of eligible children. Evaluating the impact of such payment flows requires an indicator whose *ex post* measurable value reflects the cumulative effects of those flows. School attainment or amount learned are the kind of after-the-fact observable stock measures whose values reflect earlier inflows of educational inputs. Similarly, a child's height-for-age z-score can serve as an *ex post* indicator of nutritional inputs, especially for inputs received during the first three years of life.⁸

Stunting, or height that is short relative to standards established for healthy populations, is an indicator of long-term malnutrition. Stunting is an indicator of past growth failure. It is associated with a number of long-term factors, including chronic insufficient protein and energy intake, frequent infection, sustained inappropriate feeding practices and poverty. In children under three years of age, the effects of these long-term factors may not be reversible (UNICEF 1998, p. 21-23).

Put differently, children under three years of age are particularly vulnerable to nutritional shortfalls, and the impacts of poor nutrition during the first three years of life are likely to leave a permanent mark on the child's z-score. We should thus be able to *ex post* evaluate the nutritional impact of the CSG by looking at the impact of CSG payments received during the child's 'window of nutritional vulnerability' during the first three years of age.

While z-scores offer a promising way to examine the impact of income transfers on nutrition, there are two important differences between z-scores and the household food use or individual food ingestion measures used in much of the nutritional elasticity literature. First, behavioural changes potentially induced by income increases (e.g., the purchase of more food)

may not increase height if the child's body is unable to process or effectively use additional nutrients. Thus, a failure to find a response of HAZ (an acronym for the Height-for-Age z-score) to an income increase could either reflect the lack of a behavioural response (i.e., the household purchased no more food), or the inability of individuals to physically transform increased nutritional inputs into improved nutritional status.⁹

A second difference between a HAZ and food use or intake measures of nutrition concerns the likely extent of measurement error. HAZ simply requires measurement of child height and age. In contrast, measurement error is an important factor when measuring food consumption because in most cases the data are collected retrospectively and the most informed person about food purchases is not always present to answer the survey questions (Strauss and Thomas 1998).¹⁰ Failure to find significant nutritional elasticities in studies that employ food use or intake measures could thus be a problem of noisy data.

While HAZ measures are not free of such errors (Behrman and Deolalikar 1988), the data used here come from a survey where measures of height were taken at least twice and should, therefore, be reliable. As described in the appendix, a child's height was taken twice and the enumerators needed to compare both measures in order to make sure that the difference never exceeded 0.5cm. In Table 1 we show that the mean absolute difference of the two measures is 0.015. The median difference is zero for all cases and only two children have measures that differ more than 0.5cm. These results support the idea that measuring nutrition using HAZ is subject to a minimal level of measurement errors.

Before turning to the analysis, one final comment is warranted. While the analysis here will attempt to measure the impact of CSG support received during the critical first three years of the child's life, this analytical choice does not mean that CSG support outside this three-year window is unimportant. Indeed, it might be quite critical. However, it is the likely irreversibility of early nutritional effects that implies greater likelihood that we can with greater confidence and accuracy measure the impact of the CSG using only information on early treatment.

TABLE 1

Differences in Height Measures, by Age and Gender

Year of birth	Boys	Girls	Total
1997	.023	.008	.016
1998	.011	.031	.021
1999	.015	.019	.017
2000	.018	.013	.015
2001	.011	.013	.012
2002	.014	.011	.013
2003	.016	.011	.013
Total	.015	.016	.015

Absolute difference in centimeters.

3.2 DESCRIPTIVE STATISTICS

Table 2 presents descriptive statistics regarding children, their caregivers and the child support grant using the KIDS data. Reported in Table 2 are data on all age-eligible children. Children are grouped according to whether or not they received CSG support during the critical three-year year window from birth to 36 months of age. Had the CSG programme been experimentally rolled out, as was Mexico's *Progresa* programme (see Behrman and

Hoddinott 2005), then evaluation of treatment effects by comparing the treated and the not-treated would be relatively simple. However, the South African CSG was not implemented with an experimental design. As shown in the table, non-treated children can be grouped into three categories: those who received the child support grant only after they were three years old (321 children); those who had applied for CSG support but had their applications rejected or had not yet received benefits by the time of the survey (154 children); and those for whom CSG applications were never made (886 children).

The latter group of non-applicants is clearly suspect as an adequate control group given that the CSG is a means-tested programme. As can be seen, household expenditures per capita are 40 per cent higher on average for this group compared to the other groupings in the table.

TABLE 2

Descriptive Statistics by CSG Treatment Status

	Treated in 3-year window			Not treated		
	Coverage			Beneficiaries	Applicants	Non-applicants
	All	Low	High			
Treatment						
Exposure (% life)	51	34	69	24	0	0
Window (% life under 3)	40	18	61	0	0	0
Child Characteristics						
HAZ 2004	-0.84	-0.93	-0.75	-0.91	-1.08	-0.83
Age in 2004	2.5	2.4	2.7	6.2	6.1	6.9
Caregiver Characteristics						
Per-capita household expenditure*	330	321	340	335	323	461
Application delay (days)	329	456	194	1369	1448	-
Eagerness (% deviation average delay)	29	0.2	60	-3	-39.9	-
Female (%)	94.5	95.5	93.6	96.2	96.0	91.8
Age	38	39	37	41	48	46
Unemployed (%)	50.1	48.8	52.5	42.7	25.3	29.8
Education (yrs.)	7.7	7.4	7.9	6.7	5.3	6.3
Number of observations	245	123	122	321	154	886

* Rand per month.

However, the other two groups of non-treated children appear more promising as a comparator group, around which one could build an analysis. Household expenditures are quite similar between these non-treated groups and treated children. Indeed, other studies (see for example Angrist 1998) have used rejected applicants as a relevant control group.¹¹

The descriptive statistics in Table 2 hint at what such a comparison might reveal. Child z-scores are higher for treated children (-0.84) versus the beneficiary and applicant groups of non-treated children (-0.91 and -1.08, respectively). However, a closer look at the data reveals that fewer than 10 of the 154 non-beneficiary applicants are actually rejected applicants. The others are still in process and are perhaps better described as tardy applicants.

As reported in Table 2, caregivers for this group of children delayed application, on average, by nearly 1,500 days after the child became eligible. Note that this figure is nearly four

times higher than the average delay for beneficiary children. A similar observation applies to beneficiary children who did not receive CSG support during the first three years of their lives.

While the height-for-age z-scores (HAZ) for applicant and non-treated beneficiary children are lower than those for treated children, it is unclear whether this difference is the result of the CSG treatment received by the latter, or whether the long delay in application by the non-beneficiary applicant signals something about the caregivers of the former group (e.g., their preferences, family organization or childrearing skills). This observation questions, of course, the adequacy of these individuals as a control group for the purposes of impact analysis. However, it also hints at a possible resolution of the problem using the information on application delay.

3.2.1 CSG Rollout and Caregiver Eagerness

There are at least two forces at work shaping the application delay for any child. The first factor is the characteristics of the child's caregiver and the family environment. The second is the effective rollout of the programme in the child's community relative to the child's birth or eligibility date.

While the CSG programme was announced nationally in mid-1998, it took time for information on the programme to filter down to all communities. The average delay in application was initially high, dropping off to a lower level as the programme became better known (Case, Hosegood, and Lund 2003). While the programme was not purposefully rolled out differently across communities (unlike the Brazilian *Bolsa Escola* programme discussed by Arends-Kuenning, Fava, Kassouf, and de Almeida (2005)), we might anticipate that the programme uptake might have been quicker in urban and less-isolated rural areas.

These observations suggest that a better indicator of latent caregiver characteristics might be not the gross delay in CSG application, but the deviation from the average delay for children in the same age and locational cohort. Figure 1 displays the results of such an analysis. The horizontal axis displays the date that the child became eligible for the CSG grant (measured as the number of days since the 1998 creation of the programme). An eligibility date of zero means that the child was already born (and under age seven) when the programme was announced. An eligibility date of 1,500 means that the child was born 1,500 days after the programme was created. Projected onto the figure are the actual data points.

The vertical axis in Figure 1 shows the delay in application. The non-parametric fit (displayed as a solid line) shows that, as expected, average application delay dropped off sharply as the eligibility date increased. For children immediately eligible for the programme when it was announced, it took an average 1,500 days (roughly four years) before caregivers applied for the grant. By the time of the survey in 2004, newly born children were on average being enrolled in the programme in less than a year.

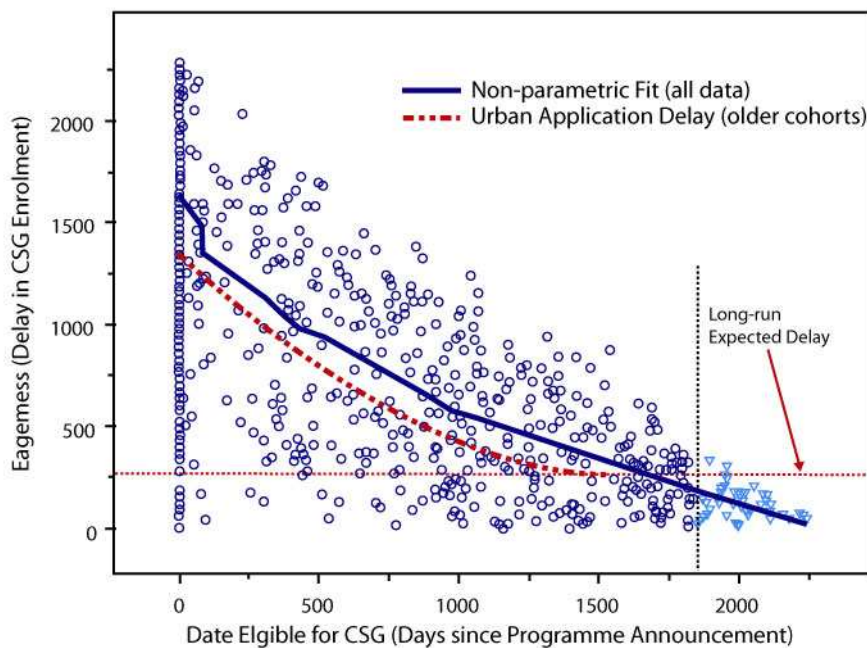
However, this very short application delay of the youngest children likely understates the eventual application delay as there were younger children yet to be enrolled at the date of the survey. To control for this problem, a quadratic OLS fit of the application delay was performed using only data on children born two years or more before the survey date (those data points to the left of the vertical line in Figure 1).

This two-year cut-off is consistent with the study by Case, Hosegood, and Lund (2003), which shows that by 2002 the CSG take-up rate for an age cohort levelled off at 40 per cent

within two years of birth (recall that the CSG programme was originally designed to serve 30 per cent of the population). Cohort enrolment rates are somewhat higher in the KIDS data. By the survey date in the second quarter of 2004, roughly 60 per cent of the cohorts born in 1998, 1999, 2000, and 2001 had applied for the CSG. The take-up rate for the 2002 cohort was slightly lower at 55 per cent.

These parametric estimates (which allowed the relationship to differ between urban and rural areas) indicate that the application delay levels off at about 255 days in both urban and rural areas. This long-run expected application delay is estimated to have been reached 1.5 years earlier in urban areas than in rural areas. Figure 1 illustrates the expected application delay for children in urban areas (the dashed line), as well as the horizontal long-run expected delay line. The expected delay in rural areas is nearly parallel to the urban line, but shifted to the right.

FIGURE 1

Standardized Eagerness

Using these estimates, an expected application delay was calculated for each child in the KIDS data set based on their date and location of birth.¹² An eagerness variable, defined as the per cent deviation in application for a child compared to the average delay expected for the child's age and locational cohort, was then calculated for each child. Positive eagerness values mean that there are extra-eager caregivers, while negative values indicate less-eager or tardy caregivers.

Table 2 reports information on these standardized eagerness measures. As can be seen, non-treated children come from less eager families than do treated children. The average treated child has an eagerness score of 29 per cent (i.e., they applied 29 per cent earlier than the average of their cohort). CSG beneficiaries who did not receive any CSG treatment during the first three years of life applied with the near normal delay, on average (-3 per cent

eagerness), whereas the applicant group that had not yet received any CSG payments by the survey date are shown to be tardy, with an average eagerness score of -40 per cent.

These eagerness figures thus suggest that the non-treated, potential control groups are different from the beneficiary group. They also suggest that the eagerness measure can be used as a control for latent caregiver and family characteristics.¹³ Using this idea, we will devise an identification strategy built on the notion that conditional on eagerness, the extent of CSG treatment should be random (related only to the accidents of birth time and location) and hence orthogonal to the expected effect of the treatment.

3.2.2 Changes in Health Services Infrastructure

Using programme rollout to generate variation in treatment does, however, mean that children born in later cohorts will be more likely to have more extensive treatment. While the period under investigation is relatively brief, this strategy does raise concerns that later cohorts may also enjoy better access to clinics and other health facilities, creating a spurious correlation between treatment and other nutrition-promoting interventions. While later econometric analysis will employ several methods to control for these other effects, an initial descriptive look at the possible magnitude of this problem is warranted.

The 2004 KIDS survey included a community questionnaire in which local leaders were asked their perceptions about the quality of local services in both 1999 and 2004. Table 3 is organized as a transition matrix, with 1999 perceptions defining the rows and 2004 perceptions the columns. It shows a preponderance of stasis (the bolded main diagonal of the matrix) or even deterioration in the perceived quality of local health services.

TABLE 3

Perception about Hospitals and Clinics Services: 1999, 2004

1999	2004				
	Very unhappy	Unhappy	Neutral	Happy	Very happy
Very happy (10 communities)	40.0	10.0	20.0	10.0	20.0
Unhappy (11 communities)	0.0	54.6	18.2	27.3	0.0
Neutral (6 communities)	33.3	33.3	16.7	16.7	0.0
Happy (23 communities)	34.8	43.5	4.4	17.4	0.0
Very happy (2 communities)	50.0	50.0	0.0	0.0	0.0

Source: 2004 KwaZulu-Natal Income Dynamics Study, Community Questionnaire.

While there are a few communities where services may have improved (the upper triangle of the transition matrix), these data suggest, if anything, that later cohorts of children may have had access to poorer quality health services. Given that these communities have been hit hard by increasing numbers of HIV/AIDS-related illnesses and deaths, this apparent deterioration in health services may be the result of a health care system that has been overwhelmed by these new demands.

The community questionnaire also asked about the main improvements in the community since 1999. Corroborating the evidence that health services have not been generally improving over the period of the CSG grant, only six per cent of communities identified hospitals and clinics as the most improved service since 1999, and another 4.7 per cent and 6.4 per cent listed them as the second and third most improved service. These numbers are much lower than for primary school (27.3 per cent, 21.5 per cent and 4.8 per cent, respectively) and for the supply of electricity (12.1 per cent, 20.0 per cent and 12.7 per cent, respectively). While these issues deserve further attention, at a descriptive level at least the evidence suggests, if anything, that complementary health care services have deteriorated for children in the later birth cohorts who have received higher levels of CSG support.

3.2.3 Binary Versus Continuous Treatment Measures

We are now in a position to consider alternative ways to study the impact of CSG payments on child health during the first three years of life. One approach would be to consider CSG support during the critical 36-month window as a binary treatment. Matching or scoring methods, which used eagerness as a key matching or control variable, could then be implemented.¹⁴

However, a weakness of this binary treatment approach is that it would classify all treated beneficiaries in the same way, despite the fact that some children have received CSG support for nearly 100 per cent of their life during their first 36 months, while others have received benefits for a small fraction of their lives. As the descriptive statistics in Table 2 show, the extent of treatment received by children varies substantially among the treated group.

Splitting the treated at about the median treatment level, we see that the low treatment group has coverage by CSG support for an average of 18 per cent of their early life whereas the average level of treatment coverage is 61 per cent for the high treatment group. One might expect that the cumulative impact of CSG support for the latter group should be larger, and indeed, the z-scores for this group are -0.75, as compared to -0.93 for the low treatment cohort. Treating these two groups as the same, as a binary approach would do, thus seems likely to understate the potential effect of full CSG treatment.¹⁵

Thus, as we develop in the next section, we propose to analyze the CSG as a continuous treatment programme, achieving identification of programme effects by exploiting variation of treatment amongst the subset of treated children. As with the binary analysis, the key identifying assumption will be that conditional on observables (including eagerness), variation in treatment status is the result of random factors related to child age and programme rollout.

4 CONTINUOUS TREATMENT ESTIMATES OF THE IMPACT OF THE CSG ON NUTRITION

It is common in the literature of programme evaluation to measure the treatment as a binary variable (see for example Blundell and Costa-Dias 2002, Imbens 2004, Heckman, Ichimura, and Todd 1998). Individuals or villages either received the treatment or not, regardless of the length of the doses. However, the lack of a randomized design of the CSG means that selection for treatment is not random and that the extent of treatment among the treated is not uniform. In this section we evaluate the impact of the CSG when the treatment is defined as a continuous variable using the recent developments by Hirano and Imbens (2004).¹⁶

4.1 ECONOMETRIC APPROACH

The intuition behind the Hirano and Imbens estimator is most easily explained with the empirical example used by these authors. In their study, Hirano and Imbens (2004) use their continuous treatment estimator to evaluate the impact of lottery winnings on labour supply of the ‘treated’ population of lottery winners. The treatment dosage (size of lottery winnings) is clearly randomly distributed amongst lottery winners, satisfying a general ‘unconfoundedness’ condition that treatment dosage is orthogonal to the outcomes of interest (e.g., leisure-seeking individuals were no more likely to receive large winnings than were those who wanted lottery winnings to start a new business and work more hours).

When this ‘unconfoundedness’ assumption is fulfilled, identification of treatment effects should be relatively straightforward and credible. However, in the empirical analysis of Hirano and Imbens (2004), the random distribution of treatment is disrupted by non-random survey response problems (their completed sample is biased towards winners of smaller lottery prizes). But their key contribution is to show how to integrate other covariates into the analysis when the observed treatment is not purely randomly distributed.

Formally, consider a random sample of individuals indexed by i where $i = 1, \dots, N$. Let $d \in D$ denote the dosage (in our case, the extent of CSG treatment during the child's first 36 months of life). For each i there is a set of potential outcomes, $Y_i(d)$, which capture i 's response to a dose. In our case, $Y_i(d)$ is the treated child's HAZ score. When the dose is binary then $D = \{0, 1\}$, but for the purpose of our paper we consider the continuous treatment case where D lies in the interval $[d_0, d_1]$. For each unit i we observe a set of covariates X_i , the level of the treatment received, $D_i \in [d_0, d_1]$, and the corresponding outcome $Y_i = Y_i(D_i)$.¹⁷

Let the average dose-response function at d be described by $\mu(d) = E[Y_i(d)]$. We are interested in estimating the average gain in height-for-age from receiving the CSG for a proportion d of the window compared to a smaller reference dose, \tilde{d} . Thus, our impact measure of interest is:

$$\theta(d) = \mu(d) - \mu(\tilde{d}) = E[Y_i(d)] - E[Y_i(\tilde{d})], d \in D \quad (1)$$

To keep the notation simple, we will drop the i subscript until the estimation section. The key assumption of the method suggested by Hirano and Imbens (2004) is a generalization of the ‘unconfoundedness’ assumption found in the binary treatment literature. The central idea is that after adjusting for differences in a set of covariates X , all biases in the comparison and treatment groups is removed. The authors capture this assumption as follows (p. 74):

Assumption 1 (Generalized Weak Unconfoundedness) $Y(d) \perp D \mid X \forall d \in D$

In other words, conditioning the extent of treatment on the covariates is random, unconfounded with any unobserved factors that might affect the extent of treatment (and outcomes). While this unconfoundedness assumption is obviously met in the case of the lottery winnings studied by Hirano and Imbens (2004), our key identification assumption here is that conditional on eagerness (and other observable characteristics), the extent of early life CSG treatment or dosage is random, depending only on the child's birth date and local programme rollout.

Unless childbirth decisions are postponed by more ardent caregivers (in anticipation of the CSG), this assumption should be satisfied. Such postponement is exceedingly unlikely,

however, as the programme was announced in mid-1998 and in principle was made available to all eligible children at that date. Put differently, anyone with immediate knowledge of the programme would have been positioned to benefit from it immediately and would have had no incentive to postpone childbearing.

Following Hirano and Imbens, the next step is to define the ‘generalized propensity score’ or GPS.

Definition 1 (Generalized Propensity Score) Let $r(d; x)$ be the conditional density of the treatment given the covariates:

$$r(d, x) = f_{D|X}(d, x) \quad (2)$$

Then the generalized propensity score is $R = r(D; X)$.

As in the standard (binary) propensity score, the GPS has the property that within strata with the same value of the conditional density $r(d, X)$, the probability that $D = d$ does not depend on the value of the covariates X . The authors use the GPS to show that, when using the weak ‘unconfoundedness’ assumption, the assignment to treatment is ‘unconfounded’ given the GPS. That is, for every d , we have $f_D(d | r(d, x), Y(d)) = f_D(d | r(d, X))$.¹⁸

The estimation of $\theta(d)$ requires computing two functions. First, let

$$\beta(d, r) = E[Y | D = d, R = r]$$

be the conditional expectation of the outcome as a function of the treatment level D and the GPS R (note that both variables are scalars.) The dose response function at a particular level of the treatment is the average of the conditional expectation over the GPS at the particular level of treatment. This is given by $\mu(d) = E[\beta(d, r(d, X))] = E[Y(d)]$. Once $\mu(d)$ is computed, we can obtain our estimate for $\theta(d)$ as defined above.¹⁹

Other authors, such as Robins, Hernán, and Brumback (2000), have proposed a very similar approach assuming a parametric form for the $Y(d)$ process and therefore, for the form of $\mu(d)$. That method is called the ‘marginal structural model’ (MSM.) The parameters in the MSM are estimated using a weighting scheme based on the GPS. By assuming a parametric assumption for $\beta(d, r)$ instead of $\mu(d)$, Hirano and Imbens (2004) do not need to define a weighting scheme (see p. 76).

4.2 IMPACT ESTIMATION

To estimate $\theta(d)$ for all $d \in D$, we use a two-stage approach as follows. In the first stage we assume a normal distribution for the treatment given the covariates:

$$D_i | X_i \sim N(\psi' X_i, \sigma^2)$$

where the parameters ψ and σ^2 are estimated by maximum likelihood. This allows us to estimate the GPS as:

$$\hat{R}_i = \frac{1}{\sqrt{2\pi\hat{\sigma}^2}} \exp\left(-\frac{1}{2\hat{\sigma}^2} (D_i - \hat{\psi}' X_i)^2\right)$$

In the second stage, we use a flexible function for $\beta(d, r)$. As suggested by Hirano and Imbens (2004) we use a quadratic approximation:

$$\beta(D_i, R_i) = E[Y_i | D_i, R_i] = \alpha_0 + \alpha_1 D_i + \alpha_2 D_i^2 + \alpha_3 R_i + \alpha_4 R_i^2 + \alpha_5 D_i R_i$$

The set of parameters $\alpha = (\alpha_0, \dots, \alpha_5)$ can be estimated using ordinary least squares. Given the estimated parameters, we can compute the average potential outcome at the treatment level d

$$\hat{\mu}(d) = E[\hat{Y}(d)] = \frac{1}{N} \sum_{i=1}^N (\hat{\alpha}_0 + \hat{\alpha}_1 \cdot d_i + \hat{\alpha}_2 \cdot d_i^2 + \hat{\alpha}_3 \cdot \hat{r}(d, X_i) + \hat{\alpha}_4 \cdot \hat{r}(d, X_i)^2 + \hat{\alpha}_5 \cdot d_i \cdot \hat{r}(d, X_i))$$

We can compute $\hat{\mu}(d)$ for all levels of d . To estimate $\hat{\theta}(d)$, the gains in Y from receiving a dose of d compared to a dose of \tilde{d} , we proceed as follows

$$\hat{\theta}(d) = \hat{\mu}(d) - \hat{\mu}(\tilde{d}) \quad \forall d \in D$$

The authors suggest computing the confidence intervals for the estimates using bootstrap methods.

4.3 ECONOMETRIC RESULTS

As described in the prior section, our estimation strategy to satisfy the weak ‘unconfoundedness’ orthogonality assumption is to include a ‘usually unobservable variable’ into the set of covariates X_i . Conditional on these variables, our including the variable for ‘eagerness’ to apply for the CSG allows us, we argue, to remove most of the biases in comparisons by different levels of treatment.

Table 4 shows the estimates of the first and second stages of the evaluation of the impact of the CSG on HAZ (Model I). The first-stage estimates indicate the importance that the eagerness variable has on explaining the treatment dose. As Hirano and Imbens (2004) argue, the parameters of the second stage do not have a direct meaning, so whether the treatment has a statistically significant impact on the outcome cannot be inferred from the parameters listed in Table 4.

To evaluate CSG treatment effects, we estimate $\theta(d)$ over the $d = [0:01; 1:00]$ interval depicted in Figure 2. Here the baseline against which we compare all treatment levels is set at reference level $\tilde{d} = 0.01$. We thus compare the gains in HAZ from receiving the CSG for different proportions of ‘the window of nutritional opportunity’ against receiving a ‘small’ dose.

Figure 2 shows on the right axis a non-parametric estimate of the distribution of CSG treatment in the KIDS data (shown as the red or dotted line). The peak of the distribution is close to receiving treatment for three-quarters of the windows of nutritional opportunity and decreases quickly after that. The solid line (measured on the left axis) is our estimates for $\theta(d)$ for different values of d measured in the horizontal axis.

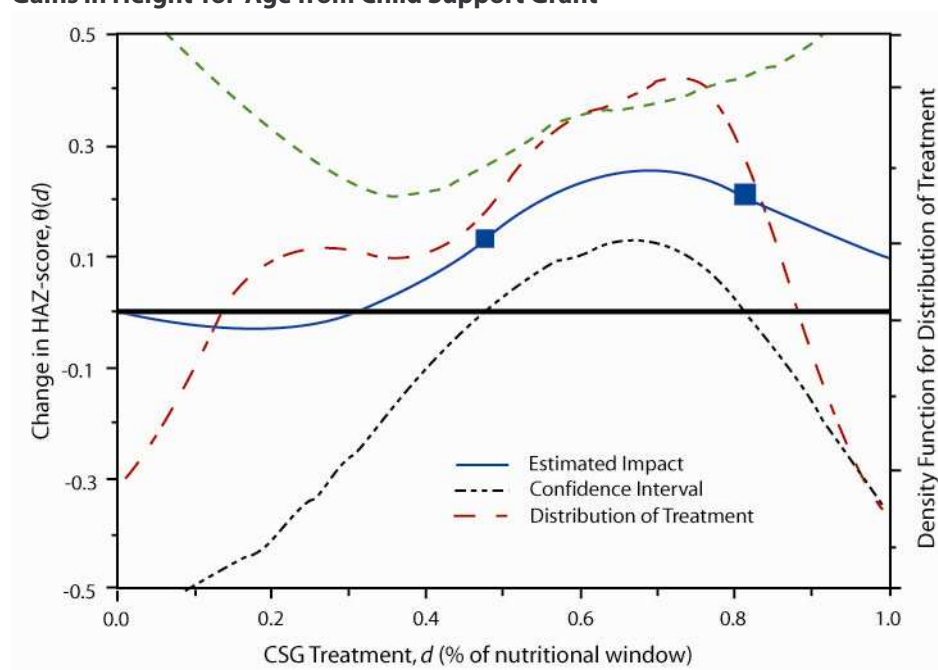
TABLE 4

First and Second Stages of GPS Estimation

Variable	Model I		Model II	
	Coefficient	s.d	Coefficient	s.d
First stage: maximum likelihood estimates				
Contrast	0.386	0.055	0.705	0.065
Eagerness	0.003	0.0002	0.003	0.0002
Boy (=1)	-0.004	0.023	0.008	0.017
Caregiver's age	-0.001	0.001	-0.001	0.001
Caregiver's educ.	-0.001	0.003	-0.003	0.003
Caregiver's married (=1)	-0.017	0.024	-0.019	0.019
Caregiver's sex	-0.007	0.031	-0.016	0.024
Caregiver works (=1)	0.039	0.026	0.036	0.022
Child's age	No		-0.097	0.006
Village fixed effects	No		Yes	
Second stage: OLS				
α_0	-0.61	0.43	-1.70	0.73
α_1	0.7	1.83	1.41	1.50
α_2	-214.96	174.89	-96.75	133.46
α_3	0.39	0.66	0.77	0.60
α_4	-7.07	25.5	-22.88	13.58
α_5	1.1	0.56	-0.01	0.36

s.d.: Standard deviations.

FIGURE 2

Gains in Height-for-Age from Child Support Grant

These point estimates show that for treatments covering less than 20 per cent of the nutritional window, we find no gains. The gains are at a maximum when the treatment covers around two-thirds of the nutritional window. A child receiving treatment for two-thirds of the window, on average, has 0.25 more HAZ than a child with a treatment covered for only one per cent of the window. This gain is statistically significant when we include the confidence intervals (shown as dashed lines).

The portion of the impact curve for which we can reject the hypothesis of zero impact is demarcated with rectangles. The decline of the gains in HAZ after a dosage of 80 per cent cannot be interpreted as an indicator that treatment is less effective after that level, since this decline coincides with a growth of the width of the interval estimator provoked by a small number of dosage levels beyond that point (as shown by the distribution function).

4.3.1 Robustness Analysis: Cohort and Village Effects

As discussed in section 3.2.2 above, it is possible for these results to be biased if changes in the supply of health-related public goods are spuriously correlated with the extent of CSG treatment (violating the non-confoundedness assumption since health care facilities would then be correlated with dosage and the distribution of dosage would in turn not be orthogonal to expected height outcomes). As shown in that earlier section, community leaders have generally perceived a lack of improvement in health care services over the time of the CSG rollout. If this perception is correct, at least in the areas covered by KIDS, our estimated impact effects should not be biased upwards by this spurious correlation.

However, in order to check for the robustness of our results to possible changes in health care availability, or to other changes not related to the public provision of health facilities, we adjust the specification of our model to control for both birth cohort and locational effects. The modified model includes the age of the child receiving the CSG, as well as cluster fixed effects.²⁰

The parameters from the two-stage estimation with this new specification are shown in Table 4 above (Model II). The estimated impact, $\theta(d)$, is very similar to the impact curve in Figure 2. The main difference is that the interval estimate expands modestly and the treatment range over which we can reject the hypothesis of zero treatment effect shrinks to dosage levels between 40 per cent and 60 per cent. The estimated impact remains a z-score improvement of about 0.3 over this central range.

4.3.2 Heterogeneous Impacts by Age of First Treatment

The impact measures calculated so far presume that the impact of a given dosage (say 25 per cent) is the same irrespective of whether that dosage was given to a 6-month or a 36-month old child. There is some indication in the literature that very young children may be even more sensitive to nutritional changes than, say, 2-year olds. Hoddinott and Kinsey (2001), for example, find that the nutritional impact of a negative income treatment (created by a drought) varies by the child's age during the 'treatment'. In particular, they find that the impact on child height and growth is larger for children aged 12-24 months during the drought than for those aged 24-60 months.

Pursuing this idea, we check to see whether the impact of the CSG differs depending on when the child was first treated. To do this, we modify the definition of $\hat{\mu}(d)$ above so that expectations of treatment effects are estimated over the subset of children first treated during the first year of life (subset A_1), the second year of life (A_2), and the third year of life (A_3):

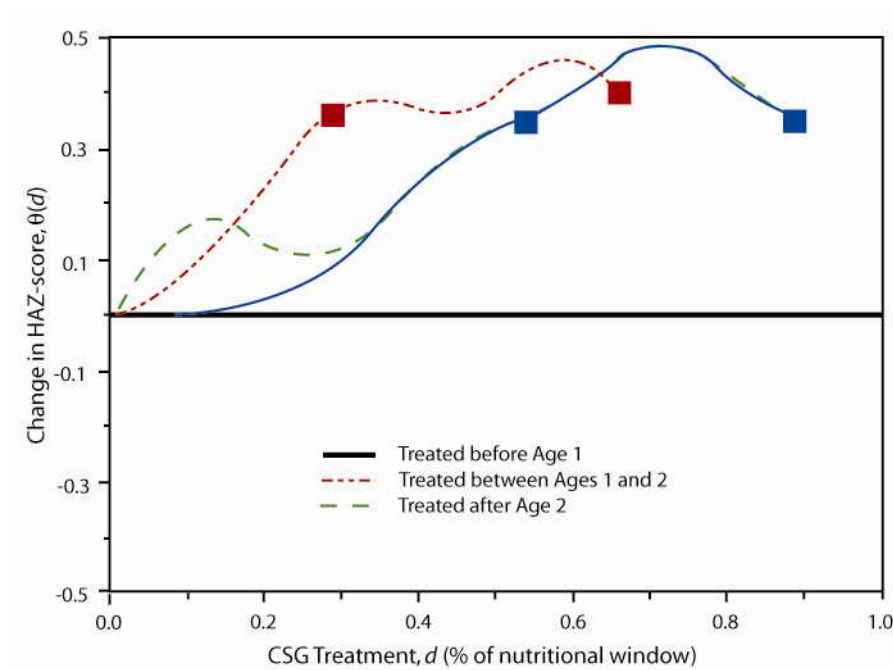
$$\hat{\mu}_j(d) = \frac{1}{N_j} \sum_{i \in A_j} (\hat{\alpha}_0 + \hat{\alpha}_1 \cdot d_i + \hat{\alpha}_2 \cdot d_i^2 + \hat{\alpha}_3 \cdot \hat{r}(d, X_i) + \hat{\alpha}_4 \cdot \hat{r}(d, X_i)^2 + \hat{\alpha}_5 \cdot d_i \cdot \hat{r}(d, X_i))$$

for $j = \{1; 2; 3\}$ and where N_j is the number of observations for each group j .

Given the nature of our CSG treatment measure, a child first receiving payments in the third year of life can receive a dosage no greater than one-third, while a child first treated in the second year can have dosages no greater than two-thirds. Children treated within their first 12 months can be recorded as having dosages along the entire dosage domain.

FIGURE 3

Heterogenous Treatment Effects by Age of Treatment



Using the Model II results, Figure 3 shows the estimated impact of the CSG on HAZ scores for children aged less than 12 months, 12-24 months and 24-36 months when they started receiving the CSG. As with Figure 2, squares have been projected onto the estimated impact curves to mark off the range over which we can reject the hypothesis of zero treatment effects. Only the relevant domain is displayed for each curve (for example, estimated impacts for children first treated after age two extends only to a dosage of one third since that is the maximal treatment that such a child could receive).

As inspection of Figure 3 reveals, the impact of the CSG on height-for-age is positive when treatment started at the youngest age, but the magnitude of the impact decreases with the age of initial treatment. When treatment begins after age two, the estimated impact is still

positive, but no longer statistically significant for any dosage levels (which by construction cannot exceed one third). In comparison with the effects estimated based on the assumption that impacts are homogenous irrespective of the age of treatment (Figure 2), the maximum estimated HAZ gain is larger, around 0.45 for children who begin treatment earlier in life (versus 0.25 under the assumption of homogenous effects).

This finding of larger effects for children who benefit from cash transfer payments at a younger age is consistent with other literature on nutrition cited by Hoddinott and Kinsey (2001, p. 410). In contrast to de Janvry and Sadoulet (2006), who suggest that cash transfers be focused on older children as a way to maximize school enrolment effects, these findings would suggest that cash transfers should emphasize reaching children at a very young age, at least in terms of nutritional effects.

In the next section we explore what these gains in HAZ mean in terms of life-time earnings by linking our estimates to information on the potential long-run economic returns to increased nutrition and height.

5 FROM CASH TRANSFER FLOWS TO HUMAN CAPITAL STOCKS

The nutrition of young children is of importance not only because of concern over their immediate welfare, but also because nutrition in this formative stage of life is widely perceived to have a substantial persistent impact on their physical and mental development. This in turn affects their school success and later labour market productivity.

Improving the nutritional status of malnourished infants and small children may, therefore, have important payoffs over the long term (Behrman and Hoddinott 2005). In this section we try to quantify the gains in height-for-age (z-scores) found in the previous section in terms of adult wages. We then use these monetary figures to calculate private returns to CSG payments.

Consider the case of a male child who is treated before age one and receives CSG benefits for two-thirds of the first three years of life. The gains in the child's z-score would be estimated to be around 0.40.²¹ To compute the gains in height for an adult, we assume that as an adult, this child will have a z-score 0.4 higher than the current average male between 25-35 years of age. This assumption is consistent with the evidence that early childhood height losses and gains are irreversible, leading to a permanent change in the child's position in the height distribution.²²

Using data from the 1998 wave of KIDS, we obtained the z-score of adult males aged 25-35 as well as their average monthly wage earnings. The average z-score for this adult group is 0.68, and a z-score gain of 0.4 translates into a 3.5 cm, or 2.1 per cent, gain in adult height.²³

A number of authors have examined the impact of adult height on wages. In the context of lower-income countries, adult height is regarded as an indicator of a broad array of human capabilities, including health, cognitive development and work capacity.²⁴ The study by Thomas and Strauss (1997) takes a particularly careful look at the relation between wages and health in Brazil. Controlling for achieved levels of education, they report for urban males an elasticity of wages with respect to height of 2.43 to 3.36. Using these elasticities, the gains in monthly South African wages from an increment in height of 2.1 per cent would be between R190 and R262.

Note that these calculations ignore any general equilibrium effects that would occur from having a better nourished adult population.²⁵ While it would be good to have similar elasticity estimates specifically for South Africa, we use the Thomas and Strauss estimate as a way to arrive at a rough evaluation of the benefits of the increased height generated by the CSG.

To compute the returns to the CSG payments, we calculate the present discounted value of a flow of R190 (and R262) from age 25 to 65 years, when retirement is expected. Note that this approach assumes that the individual is fully employed throughout this time period. At an annual real discount rate of five per cent, it yields a discounted present value of R11,123 (R15,357) at birth.

Given the cost of 20 months of the CSG ($20 \times R170$), our calculations show a Benefit-Cost ratio between 3.3 and 4.5. If we instead more realistically assume that the individual is unemployed 50 per cent of the time (with unemployment spells randomly distributed across the life cycle), then these figures are cut in half, with the estimated cost ratios falling to between 1.6 and 2.3.

While these numbers need to be treated with extreme caution, and are at best only indicative of the order of magnitude of the long-term gains that might be anticipated from the CSG, there are several reasons why these impressive returns to the CSG may be conservative. First, this simple analysis ignores the impact that z-scores can have on educational attainment and progress. Second, we did not include the potential gains from receiving the grant after the window of opportunity (from age three to 14).

In addition to understanding the height-wage elasticity in South Africa itself, future efforts to evaluate the impact of cash transfer flows on the future value of human capital might look more closely at how wages and earnings evolve over the life-cycle. The analysis here has simply assumed that wage gains are once and for all and persist over the life cycle. In addition, the simple calculations here have not considered the horrific drop in life expectancy that HIV/AIDS has brought to South Africa. The effects of this pandemic on the labour market have yet to be fully understood.

6 CONCLUSION

Cash transfer programmes have taken on an increasingly important role in the anti-poverty programmes of middle-income countries. While a number of these programmes have been modelled on Mexico's *Progresa* programme (e.g., those in Brazil, Honduras and Nicaragua), South Africa's Child Support Grant (CSG) has followed its own logic. Implemented at the same time as *Progresa* in 1998, the CSG has targeted child support payments to children's caregivers (who are almost exclusively women). Unlike *Progresa*, receipt of the CSG is not conditional on particular child behaviour (school attendance and regular medical check-ups). Indeed, as originally implemented, the CSG was limited to children under seven years of age.

In this context, this Working Paper has shown that these targeted unconditional CSG payments have bolstered early childhood nutrition, as signalled by child height-for-age. While it is of course possible that conditioning CSG payments on, say, medical check-ups would have further increased programme effects, we do find robust effects even in the absence of such conditioning. In contrast to the literature on the elasticity of nutrition with respect to income, income and nutrition appear to be more tightly wedded in the case of CSG payments, perhaps because the income increases are assigned to women.

While income transfers such as those of the CSG or the *Progresa* programme in Mexico should help immediately to redress contemporaneous poverty, the deeper question is whether they help facilitate a longer-term (inter-generational) pathway from poverty. One way that they might contribute to this goal is by enhancing the durable human capital stock of the next generation.

Augmenting our estimates of the nutritional effects of the CSG with best estimates from the literature on the elasticity of wages with respect to adult height, we calculate that the present value of increased future earnings is much higher (by 60 per cent to 130 per cent) than the cost of early-life CSG support. While these estimates are crude first attempts, they do point us toward the sort of longer-term analysis needed to determine when short-term cash transfers translate into the long-run asset increases needed to sustainably reduce poverty in the future.

APPENDIX: MEASUREMENT OF HEIGHT IN KIDS

The 2004 Fieldworkers' manual for the KwaZulu-Natal Income Dynamics (KIDS) has the following instructions regarding the measurement of height for children.

Children younger than 2 years (24 months)

- The measuring board is placed on an even, uncarpeted area.
- The child is placed on the measuring board, lying on his/her back with the crown of his/her head touching the fixed headboard and the shoulders touching the base of the board. One fieldworker is needed to hold the child in this position.
- A second fieldworker ensures that the child's heels touch the board and straightens the legs (knees not bent) before sliding the footboard against the soles of the child's heels.
- The measurement is taken on the inside of the footboard to the nearest 0.1cm.
- The measurement is recorded in the space provided on the questionnaire. Repeat the procedure once.
- If the two readings vary by more than 0.5cm the measurement MUST be repeated.

Children 2 years of age and older

- The stadiometer is placed on an even, uncarpeted area.
- The child's shoes are removed (as are hats, bonnets, ribbons, clips etc).
- The child is positioned as follows: facing the fieldworker, shoulders relaxed with shoulder blades, buttocks and heels touching the measuring board, arms relaxed at sides, legs straight and knees together and feet flat, heels touching together.
- With the child looking straight ahead the headpiece (Frankfurt plane) is slid down until it touches the crown of the head.
- The reading is taken to the nearest 0.1cm.
- The measurement is recorded in the space provided in the questionnaire and repeated once.
- If the two readings vary by more than 0.5cm the measurement MUST be repeated (until both readings are within 0.5 cm).

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NOTES

1. For example, see the studies by Subramanian and Deaton (1996), Bouis and Haddad (1992) and Behrman, Rosenzweig, and Foster (1994). Haddad, Alderman, Appleton, Song, and Yohannes (2003) provides a review of the literature over the last 20 years.

2. Other Latin American cash transfer programmes include the *Bolsa Escola* programme in Brazil (Arends-Kuenning, Fava, Kassouf, and de Almeida 2005), the Social Protection Network programme in Nicaragua (Maluccio and Flores 2005) and PRAF in Honduras (Glewwe and Olinto 2005).

3. A number of the key studies on the income elasticity of nutrition drew on data generated as part of the International Food Policy Research Institute's (IFPRI's) commercialization of agriculture studies. In most cases, the IFPRI studies concerned communities where technological and other changes enhanced returns to male assets, raising the issue as to whether low estimated nutritional elasticities represented immutable family preferences or simply a re-weighting of child nutrition by unfriendly male preferences (see the discussion in the summary volume by von Braun and Kennedy (1994)).

4. On the basis of their ex ante analysis, Kakwani, Soares, and Son (2005) suggest that without school attendance conditionalities, cash transfers in Africa will not increase school attendance. They do not, however, speak to the question of the necessity of conditionalities to boost nutrition.

5. In a recent paper, Araujo and Schady (2006) evaluate the impact of an unconditional cash transfer programme in Ecuador. However, unlike the CSG, programme administrators in Ecuador did emphasize the importance of school enrolment when beneficiaries signed up for the programme, leading some households to believe that enrolment requirements existed.

6. In September 2004, there were slightly over seven million children aged 0-6 years in South Africa. Administrative data from the Department of Social Development indicate that 3.54 million of them were receiving the CSG.

7. The KIDS data set can be downloaded from <http://sds.ukzn.ac.za>.

8. Z-scores (z) are defined as $z = \frac{h - \bar{h}}{\sigma_h}$ where h is height, \bar{h} and σ_h are, respectively, the mean and standard

deviation of height given the age. The references for the z-scores were obtained from the U.S. Center for Disease Control.

9. Nutritionists discuss how many nutrients the human body can absorb from food compared to preformed nutrients (i.e., fortified foods or pharmaceutical supplements). For example, Penniston and Tanumihardjo (2006) discuss the case of vitamin A (or β -carotene) where the absorption rate is 70-90 per cent from preformed vitamin A but only 20-50 per cent from regular food. For the latter, the rate of absorption depends on dietary and non-dietary factors.

10. In addition, in many studies, the constructed variable is not 'nutrient intake' but rather 'nutrients available' as acknowledged by Subramanian and Deaton (1996), among others. The main problem here is that a non-negligible part of the purchased (or cooked) food is lost or wasted, leading to an overstatement of intake. Also, obtaining nutrient availability from food consumption is more complicated for items such as food consumed away from home, affecting especially households with higher income or those in urban areas. Finally, this transformation also is affected by issues such as the quality of the food purchased (Behrman and Deolalikar 1988). Food quality is rarely included in household surveys.

11. The key idea here is that the selection is based on observables. The information used to select candidates allows the researcher to identify the set of covariates that explain participation in a 'programme'.

12. Children born after the date when eagerness fell to its minimum value were assigned the asymptotic eagerness value as their expected application delay.

13. In a simple regression analysis of z-scores, the coefficient of the eagerness variable is positive and highly significant even in the presence of other covariates, including CSG treatment.

14. Given the available panel data, another option would be to use anthropometric measures from earlier rounds of the KIDS data to underwrite a difference-in-difference analysis. Unfortunately, there are only 87 beneficiary children for whom we have anthropometric data in both 1998 and 2004, and 323 non-beneficiary children. Making matters worse, children in this panel sub-sample are by definition older and very few of them (four) received any CSG support during the critical first three years of their lives.

15. In fact, when binary methods were used, we were not able to identify a significant treatment effect of the CSG (full results are available upon request from the authors).

16. Alternative approaches for non-binary treatment include Imbens (2000) for categorical treatments. See also Behrman, Cheng, and Todd (2004).

17. With continuous treatment, several restrictions apply to the probability space. See Hirano and Imbens (2004) for details.

18. See theorem 1 in Hirano and Imbens (2004).

19. As the authors note, the averaging is over the score evaluated at the treatment level of interest, $r(d, X)$ and not over the GPS $R = r(D; X)$. Theorem 2 in Hirano and Imbens (2004) formally demonstrates the relation between $\beta(d, r)$ and $\mu(d)$. It also shows that $\beta(d, r) = E[Y(d) | r(d, X) = r]$

20. The KIDS data are drawn from 68 enumerator districts, or clusters, scattered randomly across the KwaZulu-Natal province.

21 Our estimate transforming z-scores to children's height do not vary by gender.

22. This assumption is consistent with the conventional pediatric wisdom that a child's height (z-score) at age two is an excellent predictor of adult height (z-score)

23. Recall that z-scores (z) are defined as $z = \frac{h - \bar{h}}{\sigma_h}$ where h is height, and \bar{h} and σ_h are, respectively, the mean and

standard deviation of height given the age. Changes in height are computed by $\Delta h = \sigma_h \Delta z$.

24. In contrast, work on developed countries (such as Postelwaite, Persico, and Silverman (2004)) interpret greater adult height as an indicator of higher status or other social processes that boost adult earnings.

25. In principal, these general equilibrium effects could be negative (if returns diminish to increasingly plentiful human capital), or positive (if returns to human capital increase once the labour market becomes sufficiently dense in better nourished, and better educated workers).



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