The Effect of Adult Returns to Schooling on Children's School Enrollment, Theory and Evidence from South Africa

by

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Abstract: We study how the returns to education in the adult labor market affect children's school enrollment. We show that when families are liquidity constrained, the expected relationship between higher returns and children's schooling is ambiguous. When liquidity constraints matter, the relationship can only be assessed empirically. For most African South African liquidity-constrained households, we find a positive relationship that is quite robust. Our results suggest that the appropriate policy focus to raise children's school enrollment in these households is on initiatives that raise the returns to education in the adult labor market, and that ease current "cash flow" problems. We see no reason to focus on other specific characteristics of the households or children, except perhaps gender.

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Our main interest in this paper is with how the returns to education in the adult labor market affect children's school enrollment. Given the ubiquitous emphases on the pay-off to human capital as a determinant of schooling and on the importance of schooling in policymaking related to economic development, it is surprising that very little work addresses this topic empirically at the household level in developing countries.

Most of the work that does exist pertains to India, and much of that work does not enter a rate of return measure directly into empirical specifications but instead infers the signal running from rates of return to schooling through a third channel. Andrew Foster and Mark Rosenzweig (1996 and 2004) infer the signal through studying the effects of technological change, i.e., the green revolution, on schooling of children from households that are affected by the change in comparison to those that are not. In their 1996 paper, they show that schooling increased most among children from rural areas where technological change was most advanced and adapted most rapidly. Their 2004 paper demonstrates that only the schooling of children from land-owning households was affected directly and positively by technological change. They suggest that since only the land-owning households own the means and have the opportunity to implement the change, only they enjoy a technology-induced increase in returns to schooling and adjust their children's schooling upward in response. Anjini Kochar (2004) argues that schooling decisions of rural Indian households are affected not only by the returns where they live, but also in places where their adult children may migrate. She shows that rural children receive more schooling if the differential in wages between educated and less-educated workers in a close-by urban area is higher.

We are aware of only two papers on developing countries that include explicit measures of rates of return to schooling as explanatory variables of schooling demand. In his study of

school enrollment in India, Futoshi Yamauchi-Kawana uses estimated rates of return at the village level as an explanatory variable. He finds that returns affect schooling positively, but perhaps not to the extent they should due to externalities related to the need for others to be more educated to fully reap the benefits of one's own education.[1] Kathryn Anderson, Elizabeth King and Yan Wang (2003) estimate province-level returns to schooling for mothers and fathers in Malaysia, and find that mothers' return has a statistically significant positive impact on children's educational attainment. A positive relationship, but not significance, remains when boys and girls are considered separately. In our paper, we are concerned about the relationship between expected returns to schooling at the regional level and children's school enrollment in South Africa.[2]

We begin with an adaptation of the theory of altruistic parents making schooling-versus-child-labor choice presented by Baland and Robinson (*BR:* 2000). Our adaptation of the *BR* model specifies that the returns to schooling for an individual child depend explicitly on the returns enjoyed by adults in the labor market whose boundaries coincide with where the child lives. We show that higher labor market returns unambiguously increase schooling if the child's household faces no liquidity or "cash-flow" constraints, but that the relationship is ambiguous if liquidity constraints bind. In the latter instance, an improvement in labor market returns gives an incentive for the parent to substitute child time away from work and into education; however, liquidity constraints lead to an offsetting negative income effect. This income effect appears because the constrained parent who wishes to find a way to take some of the benefit implied by an improvement in returns in terms of current household consumption has no mechanism for

[1] This summary is based on that in Behrman (1999).
[2] The similarity between our work and that of Yamauchi-Kawana and Anderson et. al., is the consideration of an explicit measure of an expected rate of return as an explanatory variable. In addition to differences in country and data sets, there are a number of differences in theoretical approaches that lead to differences in the way these measures are used in empirical specifications, and in how empirical results are interpreted.

doing so other than adjusting upward the child's working time. Taking the substitution and income effects together, we see that this parent will either not increase each child's education as much as if she faced no liquidity constraints, or she may decrease education.

The ambiguity in theory implies that where liquidity constraints are important, the sign of the impact of improved labor market returns --not just the size-- on school enrollment is an empirical question. We address this question using a sample of African South African Households from the 1993-94 South Africa Integrated Household Survey (SAIHS).[3] In section II, we discuss the data, our empirical strategy, and some special econometric issues we confront.

Section III discusses our results. Except for households from the upper five per cent of the income distribution, we find that the estimated rate of return has a statistically significant positive effect on school enrollment. This result is very robust: it shows up in simple descriptive statistics and remains as our econometrics becomes more sophisticated and inclusive of more control variables. We also find interesting differences by gender: females have higher rates of return but lower school enrollment rates than males, and the marginal impact of improvements in the rate of return on school enrollment is also smaller for females. For households in the upper five per cent of the income distribution, the rate of return is generally insignificant, but the pattern of significance of other variables suggests that liquidity constraints matter for females from these households, as they do for both males and females from poorer households.

[3] There were several reasons we chose South Africa as a case study on the relationship between school enrollment and adult labor market conditions. First, we were able to obtain a good household dataset. Second, under apartheid, African workers and households had limited mobility in terms of place of employment and of residence, and therefore, the return to education in the local labor market would be applicable to the potential adult earnings of the children living in that area. Third, there is regional variation in primary and secondary school enrollment rates among African South Africans (but little among whites, which is why we exclude them). Fourth, while African South Africans are generally poor, South Africa is a fairly wealthy country, so that there is a plausible possibility of finding groups in this sample for whom liquidity constraints do, and others for whom they do not, bind (Gormly, 2002).

In the concluding section of this paper we discuss the implications of our results for policy and future research. We argue that our results suggest, at least in the case of South Africa, that efforts concerned with increasing school enrollment (and possibly also decreasing child labor) should be focused in three areas: (1) school quality or other initiatives that raise the labor market returns to schooling; (2) the relaxation of binding liquidity constraints; and, (3) understanding why school enrollment of females is lower than males, even though the payoff from schooling to females appears to be higher.

I. Theory

The theory that guides our empirical work is a simple adaptation of the basic model of Baland and Robinson (*BR*: 2000). A family lives for two periods, contains one altruistically inclined parent and n selfish children, and the parent makes all decisions for all family members. The children live in the parent's household in period 1 (childhood), and maintain separate households in period 2. Utility is defined over household consumption levels: c_1, c_2, and c_c are, respectively, the parent household's consumption in periods 1 and 2, and each adult-child household's consumption. The related utility flows are $u(c_1)$, $u(c_2)$ and $\delta n v(c_c)$, where $u(.)$ and $v(.)$ are increasing and concave in their arguments, and δ indexes the degree of altruism the parent feels toward each child.

The parent's decisions must obey period-by-period income constraints, and also liquidity constraints that limit the ability of families to borrow from outside and from each other. The first period budget constraint says that c_1 equals the sum of the parent's income, a_1, the children's income, $n(1-e)$, less the amount the parent saves for period 2, s. The parent allocates each child's childhood to two activities: school (e) and work ($1-e$), which is compensated at wage unity. The parent's second period consumption equals her income, a_2, plus her savings, less any

altruistically motivated bequest, *b*, she makes to each of her children. Each adult-child's household consumption equals his income plus the bequest received from his parent. An adult child's income depends on the amount of education he received as a child, and also on some exogenous parameter, θ, that affects the individual returns to education. An adult child's wage is written as equivalent to a human-capital production function, $h(e,\theta)$, which is increasing and concave in its arguments.[4] The liquidity constraints are that savings and bequests cannot be negative.

The parent's decision problem is written as:

$$\max_{\{s,e,b\}} u(a_1 + n(1-e) - s) + u(a_2 + s - nb) + \delta n v(h(e;\theta) + b))$$
$$\text{s.t. } s \geq 0;\ b \geq 0$$

Compared with the original problem stated by *BR*, our only modification is the addition of θ as an argument of $h(.)$. In our empirical specification, θ will be a vector of variables. Of particular interest, however, will be one of those variables: the average rate of return to education in the province of origin for the child. We interpret this either as an indicator of adult labor market conditions or as an indicator of school quality. [5]

BR show that if the decision problem yields positive solutions for *s* and *b*, i.e., the liquidity constraints do not bind, then its Kuhn-Tucker conditions imply that the solution for *e* is socially efficient and satisfies:

$$h_1(e;\theta) = 1. \qquad (1)$$

Condition (1) is the well-known decision rule for investment: invest until the marginal benefit of the investment equals its marginal cost. There are two points of interest about (1). One is that the implied demand for children's education depends only on factors that affect the human

[4] $h(.)$ is also assumed to satisfy properties that ensure that the solution for *e* is interior, e.g., $h(0,\theta)=1$ and $h_1(0,\theta)>1$.

[5] Case and Yogo (1999) discuss the relationship of school quality and returns to schooling in South Africa.

capital production function, and *not* on parental income, family size, or on the degree of altruism that parent's show their children (as long as they show their children some).[6] The other point of interest follows from what (1) implies about how *e* changes with changes in θ:

$$\frac{\partial e}{\partial \theta} = -\frac{h_{12}}{h_{11}} \tag{2}$$

If, for example, schooling and good adult labor market conditions or school quality are complements in the production of higher levels of human capital and therefore higher wages, as it seems natural to assume they are, (2) implies that $\frac{\partial e}{\partial \theta} > 0$, i.e., education increases with improvement in either factor.

A number of features differ in the solution for *e* if either of the liquidity constraints binds. First, as *BR* show, the education choice is inefficiently low and the child labor choice inefficiently high. Second, the Kuhn-Tucker conditions from the parent's decision problem no longer imply that the solution for *e* is unaffected by a_1, a_2, δ and *n*. Instead they imply that education increases with the parent's income in either period and also with her altruism, but decreases with the number of children: $\frac{\partial e}{\partial a_i} > 0$[7], $\frac{\partial e}{\partial \delta} > 0$, and, $\frac{\partial e}{\partial n} < 0$. Third, and of particular

[6] This has been noted before. See, e.g., Becker and Tomes (1986), Jacoby and Skoufias (1997), and Acemoglu and Pischke (2001). That these variables affect the demand for education when there is some capital market imperfection, as we discuss below as is the case in the *BR* model when liquidity constraints bind, is also addressed by these authors.

[7] We note that the relationship between *e* and *a* differs from that predicted by Rogers and Swinnerton (2003). They allow for children also to be altruistic towards their parents with the result that poor parents receive transfers from their children. In that instance, it is shown that the relationship in liquidity constrained families between *e* and parent's income is not everywhere increasing. As an empirical matter, the existence of generous state pensions in South Africa crowds out much of the transfer (remittance) from adult children to households containing their parents, and many South African households containing elderly parents also contain the remitter's spouse and children, thereby making it hard to determine how much of the remaining transfer is really "meant" for the parents (Jensen, forthcoming). Therefore, we do not expect the phenomenon that Rogers and Swinnerton discuss and link to evidence elsewhere in the world, to be very important in the South African context. For this reason, we choose not to consider "two-sided" altruism in our presentation of the *BR* model, and we assume the relationship between *e* and *a* to be monotonic in our empirical work.

interest, is the fact that the reaction of education demand to improved school quality or adult labor market conditions is no longer unambiguously positive. It is:

$$\frac{\partial e}{\partial \theta} = -\frac{\delta n\{h_{12}(e;\theta)v'(c_c) + h_1(e;\theta)h_2(e;\theta)v''(c_c)\}}{\nabla}, \qquad (3)$$

where $\nabla < 0$ is the second-order condition for e from the parent's maximization problem.

Note that (3) embodies substitution and income effects of opposite signs. According to the first term in brackets in the numerator of (3), an improvement in adult labor market conditions or school quality provides an incentive for the parent to substitute child time away from work and into education, just as it does for a parent who is not liquidity constrained; however, liquidity constraints lead to the second term in the numerator which introduces an offsetting negative income effect. This income effect appears because the constrained parent who wishes to find a way to take some of the benefit implied by an improvement in school quality or adult labor market conditions in terms of c_1, has no mechanism for doing so other than adjusting upward the child's period-1 working time.[8,9] She will either not increase each child's education as much as if she faced no liquidity constraints, or she may decrease education. [10]

II. Data and Empirical Strategy

We estimate our model using data from the South Africa Integrated Household Survey (SAIHS).[11] The SAIHS is a cross-sectional household-based survey that was conducted during

[8] Unconstrained families can adjust for the decreasing effect of increasing e on c_1 by lowering s, and then subsequently adjust c_2 for the decreased s by decreasing b, so that adult-children in other unconstrained families end up implicitly paying for the increase in education through decreased receipt of bequests.

[9] Behrman and Knowles (1999) also discuss ways in which quality may substitute for quantity in affecting levels of educational attainment. They illustrate the phenomenon using data from Vietnam.

[10] Even so, it is not necessarily the case that $\frac{\partial e}{\partial \theta}$ is less in constrained than in unconstrained households. Since the functions that make up the partial derivative are evaluated at different values of their arguments, and the comparison of the value of the derivative at these arguments depends on third-order derivatives of utility functions, it is not possible generally to compare the value of this derivative in constrained versus unconstrained households.

[11] The SAIHS was conducted as part of the World Bank's Living Standards Measurement Study. The Southern Africa Labour Development Research Unit (SALDRU) in the School of Economics at the

the nine months leading up to the April 1994 democratic elections. Information is available on living conditions, employment, schooling, health, and attitudes from 8,848 households located in the 14 provinces and African 'homelands'.[12] We restrict our attention to African households, of which 6,533 were surveyed.

The SAIHS survey instrument was designed to collect school enrollment status for people between seven and 24 years old. Case and Deaton (1998) discovered that several children younger than seven were erroneously coded at that age; therefore, we further narrow the population of potential students to be eight to 24 years of age.

Our empirical dependent variable, school enrollment, does not correspond directly with the theoretical concept of the demand for education for a child (e). We adapt our theory to fit this empirical restriction by imagining that at the time of survey, we observe a child in school if e exceeds the amount of schooling already accumulated, $\hat{e}$. Coding observance of school enrollment as $e^*=1$, we have

$$\begin{aligned} e^* &= 1 \quad if \quad e - \hat{e} > 0, \\ e^* &= 0 \quad if \quad e - \hat{e} \leq 0; \end{aligned} \tag{4}$$

The variables that affect e also affect whether or not $e^*=1$. Thus, the explanatory variables for school enrollment depend on whether or not we have a sample of liquidity-constrained families.

Edmonds (2002a) presents evidence that liquidity constraints do exist in another sample of African South African families; therefore, we have reason to write our limited dependent variable model as: [13]

$$\text{Prob}(e^*=1) = \Phi(\beta_0 + \beta_1\theta + \beta_2\delta + \beta_3 a_1 + \beta_4 n). \tag{5}$$

University of Cape Town coordinated and managed the collection of data. See www.worldbank.org/lsms for more information.

[12] The geographic boundaries that identify these areas are as defined in 1993 and 1994

[13] We observe these families only during "childhood," so we do not observe a_2.

Assuming that the stochastic element of the education demand function is normally distributed, (5) is a probit. We first run variations of (5) on our entire sample.

We also want to know whether there are unconstrained families in our sample. It is intuitive to see from our discussion of the *BR* model that a high level of household income is needed for a parent to save, educate her children, *and* finance bequests to them. It is also easy to see that how high that income needs to be for each family depends on the family's particular values of θ, δ and *n*. If we wanted to separate precisely constrained from unconstrained families in our sample, we would need a subsidiary empirical model to determine each family's income threshold for becoming unconstrained. However, we do not attempt to be so precise. Rather, in later analysis we split the sample at the 95th percentile of family income, and run (5) separately on samples below the 95th percentile, and at the 95th and above. If there is evidence of absent liquidity constraints, it should be in the latter sample of families. From our discussion in the previous section, we infer that a test of the absence of liquidity constraints in this sample is the absence of statistical significance among all explanatory variables *but* those in the θ vector.

As (5) is still written in terms of the theoretical concepts of our explanatory variables, we now discuss how we match these concepts to measures available in the data, and certain econometric issues in doing so.

A**. The θ variables**

Our main concern is with how adult labor market returns to education affect child schooling. Accordingly, we need a measure of the returns to adult education, and some variation in these returns across our sample of children. We estimate a Mincer earnings equation for adults 25 years and older in each of the 14 provinces by gender to obtain a 28-element vector of

estimated rates of return on schooling.[14] Individual observations on male children are assigned the rate of return for adult males in their province, and similarly for females. The use of an estimated explanatory variable in the probit introduces an econometric complication: the variance matrix associated with the probit coefficients needs to be adjusted upward for the presence of this variable.[15]

We also include child's age; his or her age crossed with the rate of return; his or her order among school-aged persons in the household; whether he or she lives in an urban area; and the schooling, in years achieved, of the household's head as θ variables. The older the child, the more likely it is that he or she will have already accumulated the desired amount of human capital. Age controls for $\hat{e}$. We cross age with the rate of return to allow for the fact that the rate of return variable measures the average return to *any* additional year of schooling, not the *specific* year in which a student is considering enrolling. The average rate may have a differential impact on the demand for additional schooling that depends on how much human capital has already been accumulated.

Order among school-aged household members is included because of some recent evidence that suggests that factors external to the household create order-based differences in comparative advantage in household production and market-based work (Edmonds, 2002b),

[14] The equation is $\ln E_i = \Sigma_p \Sigma_g p_i * g_i [\tau_{1pg} + \tau_{2pg}(\text{ED\_LEVEL}_i) + \tau_{3pg}(\text{AGE}_i) + \tau_{4pg}(\text{AGE}_i)^2 + \tau_{5pg}(\text{RURAL}_i)] + \varepsilon_i$, where, $\ln E_i$ is the natural log of weekly earnings for individual 'i'; p and g respectively index 14 province and 2 gender indicators that take on values of 1 if person i is of the specific province or gender but zero otherwise; ED_LEVEL_i is the highest level of education completed by the worker; AGE_i is the worker's age in years; RURAL_i is set equal to one is the worker resides in a rural area, and zero otherwise. We estimate the equation by OLS. Because a sizeable proportion of African adults in South Africa do not report a wage, we examined whether selection bias might affect the estimated rates of returns. Our selection equation included measures of land rights, household debt, household income, household size, number of children under 18, age, and province dummies. When we ran the selection-corrected earnings equation men and women together, the coefficient on the Mills ratio was not statistically significant. When we ran the selected-corrected equation for men, the Mills ratio was significant but there was little change in the rate of return estimates. For women, the Mills ratio was insignificant.

[15] See Murphy and Topel (1985) for an explanation as to why. We use the correction they outline, which is also discussed in Greene (2003).

which may also affect the likelihood of school enrollment. Urban status is included as a θ variable on the grounds that schools are generally more likely to be available in urban areas. Finally, households with better-educated heads might be able to complement the input of formal schooling so as to raise its return to their children.

B. **The a_1 variable and its instrument**

Our measure of a_1 is total monthly household income. We confront two econometric problems with this measure. First, in another application using the SAIHS data, Case and Deaton (1998) demonstrate significant measurement error. Second, if children spend time working at the expense of going to school, if family labor supply decisions are made jointly, or both, total household monthly income is codetermined with the education decision.[16] Either of these problems introduces a stochastic component to a_1 that is correlated with the stochastic component of education demand. Without an appropriate instrument, the probit coefficient on a_1 will be biased downward.

Fortunately, a good instrument for income exists. In 1993, eligibility for old-age pensions for African women over 60 and men over 65 was granted.[17] The pension eligibility of one or more household members has in some way been used successfully in a number of studies of African South African families as an exogenous source of (potential) income variation.[18] The number of pension-eligible household members is our instrument for a_1.

The instrumentation method we use is outlined in Smith and Blundell (1986), and its

[16] Many others have discussed this issue. See, for example, Behrman (1999), Bhalotra and Tzannatos (2001), Deb and Rosati (2002), and Edmonds (2002).

[17] There are a number of detailed descriptions of the pension program available in the literature. See, for example, Lund (1993), Van der Berg (1994), Case and Deaton (1998), and Duflo (2000).

[18] For example, Case and Deaton (1998), Case (2001) Duflo (2000) Bertrand, Mullainathan and Miller (2001), and Edmonds (2002). Eligibility rather than receipt is preferred since receipt itself may be endogenous. A remaining problem with eligibility is whether it effects household composition, e.g., do elderly Africans start co-habitating with younger family members once they become pension eligible? Many of the studies already cited find that this does not happen generally.

desirability relative to other methods is discussed in Newey (1986). The idea behind the method is to remove the correlation between a_1 and the stochastic portion of education demand by conditioning education demand, and the enrollment probit it implies, explicitly on an estimate of the stochastic component of a_1. First, we regress a_1 on its instrument and the remaining explanatory variables in (5). Based on these results, we construct a fitted value, $\hat{a}_1$, and subtract it from a_1 to estimate of the stochastic portion of a_1 (V-hat) which we multiply by an estimable coefficient and add to the argument of $\Phi(\cdot)$ in (5). We subsequently correct the variance matrix associated with the resulting probit coefficients to account for the presence of this constructed variable.[19]

C. **The δ variables**

As measures of parental altruism, we include indicator variables for whether the individual's mother and father are living in the household. A wealth of anecdotal evidence suggests that working children are more likely to be abused if they live and work in households that are not their parents'; and, some more systematic recent econometric evidence[20] suggests that parents value their children's utility, and more so than do other adults who have guardianship of children. Therefore, the presence of a parent in liquidity-constrained households may have a positive and significant effect on the probability that a child is enrolled in school. We separate mother's presence from father's because mother's characteristics have been observed in other studies to have a stronger effect on children's education (Behrman, 1997).

D. **The *n* variable**

[19] The "correct" variance matrix in Smith and Blundell is identical to the one that comes from applying a Murphy-Topel correction.
[20] E.g., the studies in Grootaert and Patrinos (1999); Bhalotra (2001); and, Case, Paxson, and Ableidinger (2002).

This is simply the number of individuals under age 25 living in the household. We treat household size as exogenous: it is beyond the scope of this paper to consider questions of endogenous fertility.

III. Results

Table 1 contains the samples sizes for the samples that we use to calculate the provincial and gender-specific rates of return on schooling in the adult labor market, panel 1, and the samples that we use to estimate our model of school enrollment, panel 2. Unsurprisingly, there are more men than women wage earners. By comparison, there are roughly equal numbers of males and females in our sample of school-aged persons, although in some provinces the ratio of boys and girls varies markedly from one-to-one.

In Table 2, we present the estimated rates of return and enrollment rates by province and gender. There is variation in enrollment rates and rates of return across provinces, and by gender within provinces. Figure 1 illustrates the gender dimension of this. Females generally have higher rates of return but lower enrollment rates than males. Moreover, the simple correlation between the rate of return and enrollment is smaller for females than for males. This suggests that there are important and complex gender-related differences in enrollment decisions made by households; therefore, we conduct our subsequent empirical work separately for males and females.

We present the average values of the explanatory variables by enrollment status and income group for males in Table 3a, and for females in Table 3b. For both males and females the estimated rate of return is significantly higher for the enrolled group than the not-enrolled group in all income groups. For males, there are, on average, no significant income differences by enrollment status. Enrolled females on average reside in higher income households than non-

enrolled females, even when we restrict our sample to the highest income households. For males, the differences across enrollment status in the δ variables and the number of school-age persons in the household (n) are significant for families below the 95th percentile of monthly household income, but not for those at or above the 95th percentile. For females, statistically significant differences in the δ variables persist into the highest income group.

In Tables 4a (males) and 4b (females), we present the estimated marginal effects from a number of variations of our probit model of school enrollment. For the average male, who in our sample is 15.19 years old, the estimated rate of return has a positive and significant marginal effect on school enrollment in all specifications. The sign and significance of the rate of return are similarly robust for females, although the average marginal effect is smaller for females than it is for males. Figure 2, which is constructed based on the specification corresponding to columns (8) of the tables, illustrates that this gender difference exists across all school ages, although it is significant at the five per cent level only at ages 20 and above. Figure 2 also shows that the marginal effect is low at young ages for both boys and girls, suggesting that the demand for schooling is very inelastic then, possibly because basic education is considered a necessity. For males the marginal effect of the rate of return on schooling on enrollment climbs throughout the age span, but the slope of the marginal effect turns negative for females past the age of 20.

Comparing the result from the probit specifications to those from the probit-IV specifications, we see that instrumenting income produces interesting results. For males, instrumenting raises the marginal effect of income on school enrollment by a factor of roughly 75; for females, it increases the marginal effect by a factor of about 6. The effect of income on school enrollment is significant for males only after income has been instrumented, but it is significant for females in all specifications that include it.

Instrumenting for income has an interesting impact on some other variables. The effect of urban residence goes from positive to negative for both sexes; for males the effect gains significance, but the reverse occurs for females. The effect of the household head's education level on enrollment changes from positive and statistically significant to negative and insignificant for both males and females. The implication of these results is that when income is not properly measured, the household head's education and urban residential status, both of which have positive simple correlation with monthly household income, have a tendency to pick up the effect of income on enrollment.

Other significant variables in the instrumented equations are the indicator variable for mother at home and the number of school-aged persons in the household. For both males and females, mother living in the household matters to school enrollment and the effect is larger for females than for males. The number of school-aged persons living in the household has a significant and negative impact for females, but the effect is not significant for males.

With Tables 5a (males) and 5b (females), we search for a sub-sample of families that is not liquidity constrained. Our test for the absence of liquidity constraints is the joint significance of only the θ variables. Wald statistics necessary for conducting this test are presented at the bottom of the tables. For all sub-samples of the data, except for males in the highest income households, we reject the hypothesis of absent liquidity constraints. We find it remarkable that the statistically positive effect of household income persists for females in the highest income households.

Two other features of Tables 5a and 5b are worthy of remark. First, the effect of household head's education is positive and significant only for females from highest income households and only in the most inclusive specification. That the education of the adult decision

maker affects the educational attainment of children is a point of emphasis in much of the received literature and in policy discussions. Our results suggest that this emphasis could be weakened. Finally, for those in the highest income households, the only significant θ variables to the enrollment decision are age, for males and females, and household head's education, for females. The rate of return on education is not significant on average. This may be a symptom of small sample sizes, but it also may be a signal that the general opportunities that develop for these children as they age may be better than for those from lower income households.

IV. Conclusions

In this paper, we have studied school enrollment with a particular emphasis on the relationship between regional rates of return to schooling in the adult labor market and children's school enrollment. We show that theoretical ambiguity about the sign of this relationship in liquidity-constrained households makes it an empirical question that should be looked at on a context-by-context basis. For African South Africans, we generally find a significant positive relationship between the rate of return and enrollment, suggesting that successful efforts to raise the rate of return should have a positive impact in this context.

Our results further tell us that liquidity constraints matter to the school enrollment decision in South Africa, so that a focus on easing "cash-flow" problems for poorer African families may be a productive additional emphasis for policy.[21] We see no particular reason to focus on other specific characteristics of individual households or children, since the statistical importance of these likely traces to the existence of liquidity constraints, except for gender.

The fact that schooling returns have a differential impact on girls' and boys' enrollment shows up across all our empirical work. The general result is easy to state: women's labor

[21] In drawing this conclusion, we add to a growing body of empirically based insights concerning the importance of easing liquidity constraints to encouraging schooling or to discouraging child labor. A recent discussion of these literatures is in Beegle, Dehehjia and Gatti (2003).

market returns are generally higher, but girls' school enrollment rates are lower and generally less responsive to market returns. If this means that females in South Africa are disadvantaged relative to males, we think the follow on implication is that the disadvantage traces to differential treatment by their parents or guardians rather than to discrimination in the labor market. The precise reasons why South African households might treat girls differently is an important question for further research.

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Table 1: Sample Sizes

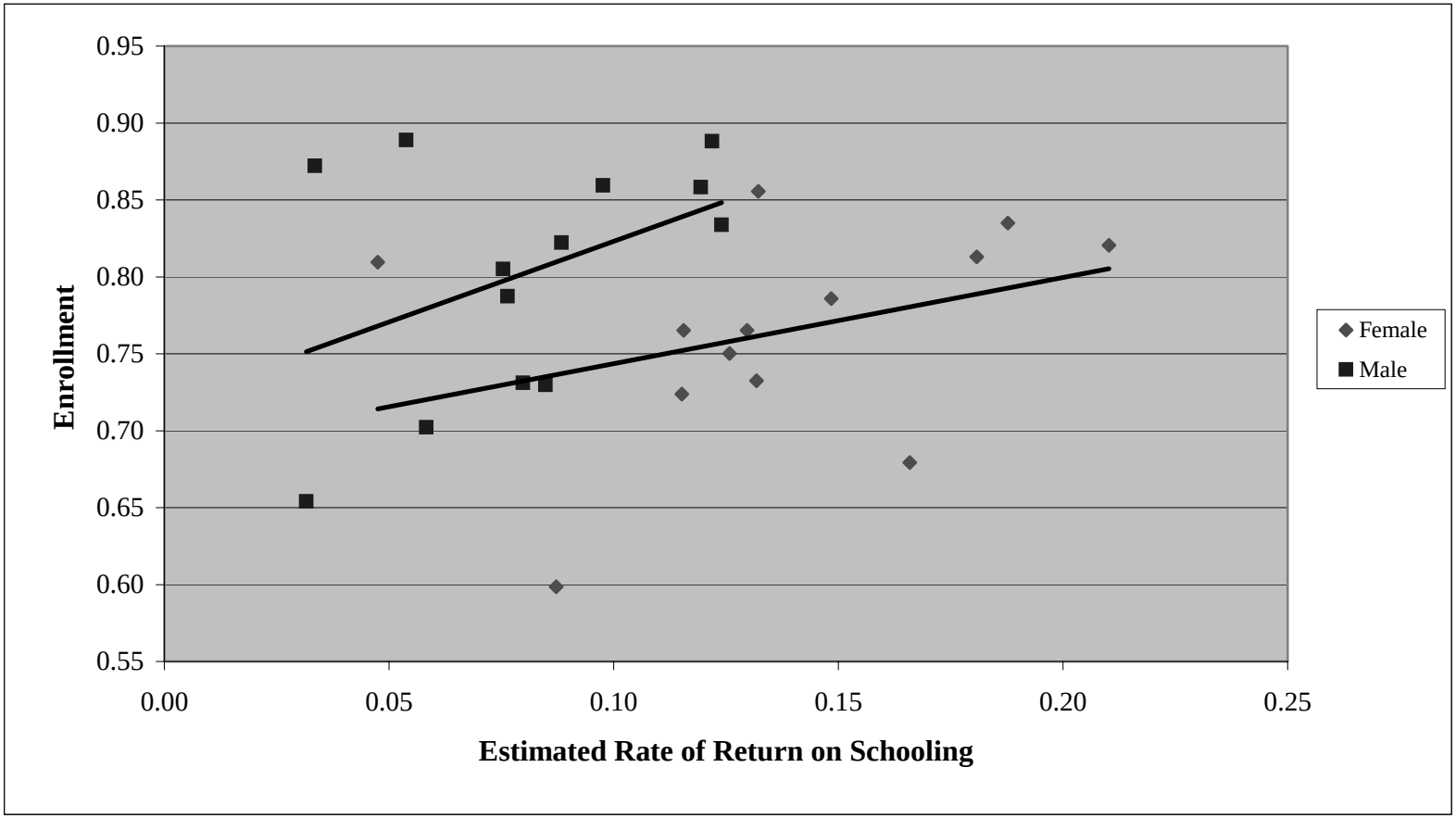
	For calculation of rates of return in the adult labor market		For (5)	
Province	Male	Female	Male	Female
Cape	170	100	272	265
Natal	109	93	159	142
Transvaal	973	520	971	968
Orange Free State	281	159	397	426
Kwazulu	282	229	1,383	1,481
Kangwane	58	45	197	214
Qwa-qwa	13	7	44	56
Gazankulu	46	28	270	270
Lebowa	92	98	796	873
Kwandebele	39	31	133	126
Transkei	65	46	785	934
Bophuthawana	172	131	496	543
Venda	47	32	134	132
Ciskei	45	40	185	195
	2392	1559	6222	6625

Table 2: Estimated Rates of Return on Schooling and Enrollment Rates by Gender and Province of Residence

	Est. Rt. of Rtn on Schooling			Enrollment Rates		
Province	Female	Male		Female	Male	
Cape	0.17	0.06	**	0.68	0.70	
Natal	0.09	0.03		0.60	0.65	
Transvaal	0.13	0.08	**	0.73	0.73	
Orange Free State	0.12	0.12		0.77	0.83	*
Kwazulu	0.13	0.08	*	0.75	0.79	*
Kangwane	0.18	0.09	**	0.81	0.82	
Qwa-qwa	0.38	0.14	**	0.75	0.80	
Gazankulu	0.13	0.05	*	0.86	0.89	
Lebowa	0.19	0.12	*	0.84	0.89	*
Kwandebele	0.05	0.03		0.81	0.87	
Transkeit	0.15	0.08		0.79	0.81	
Bophuthawana	0.12	0.08		0.72	0.73	
Venda	0.13	0.12		0.77	0.86	
Ciskei	0.21	0.10	**	0.82	0.86	

** indicates a 1% statistical difference in rates of return (or enrollment rates) across gender
* indicates a 5% statistical difference in rates of return (or enrollment rates) across gender

Figure 1: Provincial Rates of Return and Enrollment Incidence, by Gender



NOTE: The Qwa-qwa province is omitted from figure 2 because it is an outlier.

Table 3a: Average values for school-age males by income group and enrollment status

		Overall		Lower 95%		Upper 5%	
		Not enrolled	Enrolled	Not enrolled	Enrolled	Not enrolled	Enrolled
a	Total monthly household income	1056.71	1109.76	837.30	862.23	5899.74	5089.95
		(56.342)	(19.263)	(19.058)	(10.102)	(1041.983)	(154.584)
θ	Estimated rate of return on schooling	0.0812	0.0858 **	0.0814	0.0859 **	0.0756	0.0844 **
		(0.0006)	(0.0003)	(0.0006)	(0.0004)	(0.0024)	(0.0013)
	Age in years	19.40	14.11 **	19.32	14.12 **	21.11	13.98 **
		(00.128)	(00.061)	(0.132)	(0.062)	(00.511)	(00.251)
	Household in urban region (1 = YES)	0.29	0.28	0.29	0.27	0.49	0.49
		(00.013)	(00.006)	(0.013)	(0.007)	(00.068)	(00.029)
	Education level of household head	2.73	3.31 **	2.65	3.11 **	4.35	6.51 **
		(00.085)	(00.048)	(0.085)	(0.047)	(00.530)	(00.247)
	Placement in sibling order (1 = Eldest)	1.83	2.75 **	1.82	2.73 **	1.89	3.06 **
		(0.00005)	(0.00002)	(0.038)	(0.024)	(0.00137)	(0.00034)
δ	Mother at home (1 = Yes)	0.68	0.80 **	0.67	0.80 **	0.84	0.78
		(00.013)	(00.006)	(0.014)	(0.006)	(00.050)	(00.024)
	Father at home (1 = Yes)	0.43	0.55 **	0.42	0.55 **	0.73	0.63
		(00.014)	(00.007)	(0.014)	(0.007)	(00.061)	(00.028)
n	Number of school-aged persons in HH	4.99	5.32 **	4.93	5.30 **	6.27	5.63
		(00.085)	(00.040)	(0.086)	(0.041)	(00.393)	(00.183)
	Sample size	1,269	4,953	1,214	4,663	55	290
	Enrollment rate	0.80		0.79		0.84	

** indicates a 1% statistical significance in difference of means across enrollment status.

* indicates a 5% statistical significance in difference of means across enrollment status.

Table 3b: Average values for school-age females by income group and enrollment status

		Overall			Middle 90%			Upper 5%		
		Not enrolled	Enrolled		Not enrolled	Enrolled		Not enrolled	Enrolled	
a	Total monthly household income	930.94	1121.41	**	811.52	860.88	*	4508.88	5344.75	*
		(24.535)	(26.216)		(16.877)	(9.905)		(240.221)	(337.548)	
θ	Estimated rate of return on schooling	0.1393	0.1436	**	0.1397	0.1441	**	0.1276	0.1356	*
		(0.0009)	(0.0005)		(0.0010)	(0.0006)		(0.0034)	(0.0018)	
	Age in years	20.13	14.12	**	20.09	14.05	**	21.38	15.22	**
		(0.097)	(0.060)		(0.099)	(0.061)		(0.369)	(0.261)	
	Household in urban region (1 = YES)	0.27	0.28		0.26	0.26		0.56	0.50	
		(0.011)	(0.006)		(0.011)	(0.006)		(0.071)	(0.029)	
	Education level of household head	2.88	3.32	**	2.79	3.13	**	5.48	6.41	
		(0.083)	(0.047)		(0.083)	(0.047)		(0.593)	(0.230)	
	Placement in sibling order (1 = Eldest)	1.64	2.73	**	1.64	2.74	**	1.68	2.68	**
		(0.027)	(0.023)		(0.027)	(0.024)		(0.155)	(0.100)	
δ	Mother at home (1 = Yes)	0.59	0.81	**	0.59	0.80	**	0.66	0.82	*
		(0.012)	(0.006)		(0.013)	(0.006)		(0.068)	(0.022)	
	Father at home (1 = Yes)	0.38	0.54	**	0.38	0.53	**	0.46	0.65	*
		(0.012)	(0.007)		(0.013)	(0.007)		(0.071)	(0.028)	
n	Number of school-aged persons in HH	5.32	5.39		5.29	5.38		6.14	5.57	
		(0.075)	(0.039)		(0.076)	(0.040)		(0.477)	(0.174)	
	Sample size	1,548	5,077		1,498	4,782		50	295	
	Enrollment rate	0.77			0.76			0.86		

** indicates a 1% statistical significance in difference of means across enrollment status.

* indicates a 5% statistical significance in difference of means across enrollment status.

Table 4a: Estimated Marginal Effects for Males

			Probit					Probit, IV		
		xbar	1	2	3	4	5	6	7	8
θ	Age in years	15.19	-0.03406**	-0.03400**	-0.03409**	-0.03330**	-0.03360**	-0.03658**	-0.03651**	-0.03593**
			(0.00146)	(0.00184)	(0.00185)	(0.00177)	(0.00184)	(0.00227)	(0.00213)	(0.00208)
	Estimated rate of return on schooling	0.08	1.28010**	1.36005**	1.36676**	1.33609**	1.34070**	1.58407**	1.60738**	1.60755**
			(0.39767)	(0.39549)	(0.39534)	(0.39436)	(0.39409)	(0.42035)	(0.41323)	(0.41319)
	Resides in urban area (1 = Yes)	0.29		0.00812	0.00642	0.01331	0.01401	-0.05164	-0.05865*	-0.06351*
				(0.01563)	(0.01607)	(0.01554)	(0.01564)	(0.03109)	(0.02812)	(0.02962)
	Sibling order (1 = eldest)	2.56		0.00119	0.00077	0.00139	-0.00067	-0.01178	-0.01381	-0.00961
				(0.00589)	(0.00588)	(0.00583)	(0.00616)	(0.00829)	(0.00766)	(0.00715)
	Education of household head	3.19		0.01137	0.01101**	0.01120**	0.01132**	-0.00234	-0.00414	-0.00497
				(0.00210)	(0.00215)	(0.00212)	(0.00210)	(0.00660)	(0.00541)	(0.00560)
a	Total household monthly income	1098.94			0.000004	0.000002	0.000002	0.00012*	0.00014**	0.00015**
					(0.000005)	(0.000005)	(0.000005)	(0.00005)	(0.00004)	(0.00005)
δ	Mother at home (1 = Yes)	0.77				0.05117**	0.04999**		0.04052**	0.04248**
						(0.01541)	(0.01486)		(0.01487)	(0.01456)
	Father at home (1 = Yes)	0.53				0.03833**	0.03802**		0.01310	0.01266
						(0.01276)	(0.01276)		(0.01614)	(0.01623)
n	Number of school-aged persons in HH	5.25					0.00156			-0.00376
							(0.00250)			(0.00268)
	V-hat							-0.00012*	-0.00014**	-0.00014**
								(0.00006)	(0.00005)	(0.00005)
	χ^2 (regression)		564.56**	593.36**	603.56**	661.92**	675.39**	614.69**	679.76**	693.43**
	χ^2 (theta)		550.25**	588.37**	596.22**	651.48**	661.56**	588.02**	659.90**	680.93**
	χ^2 (income)				0.54	0.17	0.15	4.95*	9.81**	671.48**
	χ^2 (delta)					26.02**	26.74**		9.31**	9.92**
	χ^2 (n)						0.39			10.67**
	χ^2 (delta, n, income)				0.54	26.03**	26.75**	4.95	36.02**	38.63**
	Sample size	6222								

** indicates significance at the 1% level

* indicates significance at the 5% level

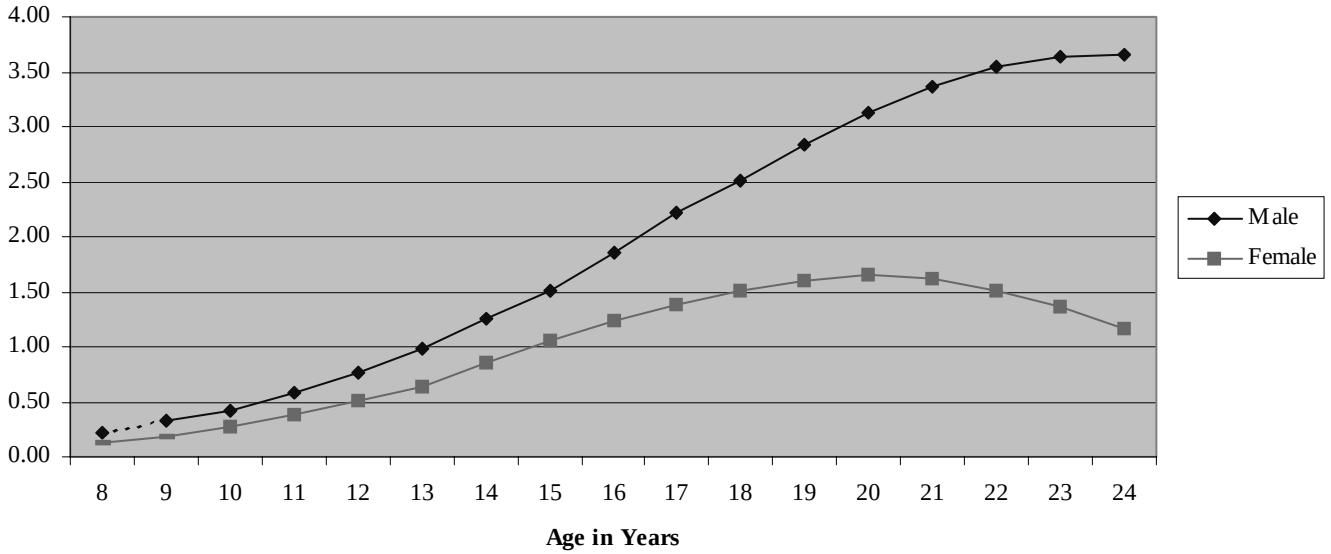
Table 4b: Estimated Marginal Effects for Females

			Probit					Probit IV		
		xbar	1	2	3	4	5	6	7	8
θ	Age in years	15.52	-0.04438**	-0.04332**	-0.04389**	-0.04230**	-0.04121**	-0.04592**	-0.04541**	-0.04374**
			(0.00143)	(0.00177)	(0.00177)	(0.00176)	(0.00184)	(0.00196)	(0.00195)	(0.00199)
	Estimated rate of return on schooling	0.14	0.65370*	0.73208*	0.80636**	0.82700**	0.82245**	1.05118**	1.13534**	1.14684**
			(0.30212)	(0.30054)	(0.30143)	(0.29648)	(0.29714)	(0.32582)	(0.30888)	(0.30902)
	Resides in urban area (1 = Yes)	0.27		0.03918**	0.03006*	0.03690**	0.03397*	-0.00928	-0.01853	-0.02841
				(0.01352)	(0.01335)	(0.01361)	(0.01395)	(0.02065)	(0.02003)	(0.02097)
	Sibling order (1 = eldest)	2.48		0.00910	0.00586	0.00537	0.01150*	-0.00086	-0.00352	0.00655
				(0.00541)	(0.00540)	(0.00530)	(0.00555)	(0.00573)	(0.00551)	(0.00568)
	Education of household head	3.22		0.01062**	0.00787**	0.00881**	0.00838**	-0.00225	-0.00391	-0.00555
				(0.00183)	(0.00188)	(0.00186)	(0.00190)	(0.00414)	(0.00341)	(0.00350)
a	Total household monthly income	1076.91			0.000030**	0.000026**	0.000028**	0.00013**	0.00015**	0.00017**
					(0.000005)	(0.000005)	(0.000005)	(0.00004)	(0.00003)	(0.00003)
δ	Mother at home (1 = Yes)	0.76				0.10367**	0.10731**		0.09814**	0.10390**
						(0.01621)	(0.01621)		(0.01606)	(0.01612)
	Father at home (1 = Yes)	0.50				0.01974	0.02050		-0.01132	-0.01235
						(0.01246)	(0.01242)		(0.01490)	(0.01497)
n	Number of school-aged persons in HH	5.37					-0.00452*			-0.00802**
							(0.00215)			(0.00214)
	V-hat							-0.00010**	-0.00013**	-0.00014**
								(0.00004)	(0.00003)	(0.00003)
	χ^2 (regression)		991.34**	1021.17**	1061.25**	1048.59**	1108.17**	1074.71**	1060.48**	1131.31**
	χ^2 (theta)		961.23**	989.60**	997.15**	965.68**	1005.28**	969.35**	940.18**	986.95**
	χ^2 (income)				29.45**	24.86**	26.32**	11.30 *	23.89**	26.23**
	χ^2 (delta)					78.04**	84.34**		47.20**	52.86**
	χ^2 (n)						4.42 *			14.03**
	χ^2 (delta, n, income)				29.45**	101.38**	109.46**	11.30 *	105.28**	122.76**
	Sample size	6625								

** indicates significance at the 1% level

* indicates significance at the 5% level

Figure 2: Marginal effect of the rate of return on schooling by age and gender



Note 1: The marginal effect of the rate of return of education for persons who are age `k' is computed using the following formula:

$$\frac{\partial \Phi(X'\beta)}{\partial(\text{edrtn})} = \phi\left(\overline{X}'_{age=k}\beta\right)\left(b_{edrtn} + b_{edrtnXage}(age = k)\right),$$

where $\phi(\cdot)$ is the normal density function; the $\overline{X}_{age=k}$ vector contains the average values of the explanatory values for the sub-sample of persons who are age 'k'; the vector β contains the complete set of coefficient estimates; and, b_{edrtn} and $b_{edrtnxage}$ are the estimated coefficients on the estimated rate of return and the estimated rate of return crossed with age, respectively, from the probit.

Note 2: The dotted portion of the male profile at ages 8 and 9 years indicates that the marginal effect was not significantly different from zero at the 5% level

Note 3: A statistically significant difference between the marginal effect of the rate of return to schooling for males and females at the 10% level was found at age 19, at the 5% level at ages 20 - 23 years, and at the 1% level at ages 24 years.

Table 5a: Estimated marginal effects for the male sample by income group

			Lower 95%				Upper 5 %		
		x-bar	1	2	3		4	5	6
θ	Age in years	15.20	-0.03617**	-0.03612**	-0.03568**	15.12	-0.01898*	-0.01920*	-0.01817*
			(0.00224)	(0.00211)	(0.00208)		(0.00853)	(0.00812)	(0.00751)
	Estimated rate of return on schooling	0.08	1.56225**	1.60635**	1.60755**	0.08	1.21942	1.20234	1.19459
			(0.42554)	(0.41947)	(0.41956)		(0.66978)	(0.67138)	(0.66095)
	Resides in urban area (1 = Yes)	0.27	-0.03894	-0.04866	-0.05192	0.49	0.03373	0.03271	0.03406
			(0.02684)	(0.02568)	(0.02680)		(0.03645)	(0.03543)	(0.03530)
	Sibling order (1 = eldest)	2.55	-0.00765	-0.01028	-0.00700	2.88	-0.01360	-0.01407	-0.00825
			(0.00756)	(0.00728)	(0.00689)		(0.00874)	(0.00893)	(0.00834)
	Education of household head	3.01	0.00331	0.00142	0.00098	6.16	0.00913	0.00937	0.00962
			(0.00409)	(0.00366)	(0.00373)		(0.00773)	(0.00773)	(0.00783)
a	Total household monthly income	857.08	0.00014*	0.00018**	0.00018**	5219.04	-0.00003	-0.00003	-0.00004
			(0.00006)	(0.00006)	(0.00006)		(0.00005)	(0.00005)	(0.00005)
δ	Mother at home (1 = Yes)	0.77		0.05686**	0.05865**	0.79		0.04289	0.06616
				(0.01591)	(0.01562)			(0.09402)	(0.12418)
	Father at home (1 = Yes)	0.52		0.02458	0.02460	0.65		-0.00778	-0.01315
				(0.01506)	(0.01506)			(0.01966)	(0.02109)
n	Number of school-aged persons in HH	5.23			-0.00287	5.74			-0.00481
					(0.00274)				(0.00431)
	V-hat		-0.00012	-0.00017**	-0.00017**		0.00003	0.00003	0.00004
			(0.00007)	(0.00006)	(0.00006)		(0.00005)	(0.00005)	(0.00005)
	χ^2 (regression)		579.06**	656.03**	671.31**		8.70	9.82	10.52
	χ^2 (theta)		567.12**	639.13**	649.37**		6.06	6.77	6.51
	χ^2 (income)		4.55*	9.91*	9.91*		0.50	0.53	0.61
	χ^2 (delta)			20.51**	22.90**			0.34	0.53
	χ^2 (n)				1.10				1.24
	χ^2(income, delta, n)		4.55*	38.60**	40.87**		0.50	0.66	1.35
	Sample size	5877				345			

** indicates significance at the 1% level

* indicates significance at the 5% level

Table 5b: Estimated marginal effects for the female sample by income group

			Lower 95%				Upper 5 %		
		x-bar	1	2	3		4	5	6
θ	Age in years	15.49	-0.04668**	-0.04611**	-0.04412**	16.12	-0.01797**	-0.01618**	-0.02094**
			(0.00201)	(0.00201)	(0.00200)		(0.00446)	(0.00507)	(0.00666)
	Estimated rate of return on schooling	0.14	1.05668**	1.15399**	1.16713**	0.13	-0.24257	-0.22586	-0.22027
			(0.33764)	(0.32311)	(0.32351)		(0.43927)	(0.37168)	(0.37166)
	Resides in urban area (1 = Yes)	0.26	0.00178	-0.00809	-0.01973	0.51	-0.02131	-0.01443	0.00228
			(0.01958)	(0.01966)	(0.02106)		(0.02493)	(0.01893)	(0.01559)
	Sibling order (1 = eldest)	2.47	-0.00029	-0.00427	0.00774	2.54	0.01711	0.01474	-0.01174
			(0.00623)	(0.00601)	(0.00595)		(0.01584)	(0.01230)	(0.01008)
	Education of household head	3.05	0.00148	-0.00014	-0.00186	6.27	0.00643	0.00618	0.00763*
			(0.00326)	(0.00288)	(0.00303)		(0.00374)	(0.00311)	(0.00361)
a	Total household monthly income	849.10	0.00015**	0.00020**	0.00022**	5223.61	0.00010	0.00009*	0.00008*
			(0.00005)	(0.00005)	(0.00005)		(0.00006)	(0.00004)	(0.00004)
δ	Mother at home (1 = Yes)	0.75		0.11177	0.12026	0.80		-0.02485	-0.01986
				(0.01720)	(0.01740)			(0.01973)	(0.01884)
	Father at home (1 = Yes)	0.49		-0.00322	-0.00385	0.63		0.00910	0.01238
				(0.01489)	(0.01495)			(0.01659)	(0.01717)
n	Number of school-aged persons in HH	5.36			-0.00989**	5.65			0.01770
					(0.00243)				(0.00999)
	V-hat		-0.00012*	-0.00018**	-0.00019**	0.00	-0.00009	-0.00008*	-0.00007*
			(0.00005)	(0.00005)	(0.00005)		(0.00005)	(0.00004)	(0.00004)
	χ^2 (regression)		1058.35**	1048.66**	1122.34**		18.65*	14.63	14.62
	χ^2 (theta)		999.90**	980.11**	1031.12**		18.54**	12.29*	12.07*
	χ^2(income)		8.01*	18.12*	19.98**		3.24	4.33*	4.54*
	χ^2(delta)			62.17**	71.86**			1.14	0.97
	χ^2(n)				16.57**				3.14
	χ^2(income, delta, n)		8.01*	90.51**	106.14**		3.24	6.90	7.21
	Sample size	6280				345			

** indicates significance at the 1% level

* indicates significance at the 5% level