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Intergenerational education mobility of black and white South Africans*

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Abstract Using the October Household Surveys, we found that the intergenerational education mobility of whites is higher than that of blacks. Among blacks, females have a higher intergenerational education mobility than males, while the poorest have the lowest intergenerational education mobility. The lower education mobility of blacks than that of whites indicate that factors such as access to the credit market, as well as the availability and quality of schools, are important determinants of educational attainment. Interestingly, the cross section estimates of black intergenerational education mobility do not differ from those obtained by using pseudopanel data, which control for unobserved community effects.

Keywords Education · Intergenerational mobility · South Africa

JEL Classification I21 · J24

1 Introduction

South Africa emerged from apartheid with stark racial, wealth, and wage inequalities (Mwabu and Schultz 2000). It is estimated that white South Africans own 87% of the land (Percival and Homer-Dixon 1995), while close to 50% of black South Africans, who constitute about 80% of the population, live in poverty (Bhorat et al. 2001). As investing in one's human capital leads to gains in earnings (Schultz 1961; Mincer 1974), education is, therefore, one way out of poverty. So as to determine

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whether future generations of black South Africans will fare better than their forefathers, we investigate the determinants of intergenerational mobility in education. The estimates of the determinants of intergenerational education mobility of black and white South Africans allow us to assess the persistence of apartheid-inherited distortions and to identify policies that may improve educational outcomes.

Although there are many studies of intergenerational mobility (see Table 1), few have been concerned with South Africa. To the best of our knowledge, that of Thomas (1996) is the first such study. Using the 1991 South African census, he documents the growth in educational attainment, convergence across racial groups, but finds that blacks are still substantially less educated than whites. His estimates indicate that the educations of black and Indian parents matter most for their children's schooling. However, as reported by the author, the 1991 census excludes the so-called independent states, which account for a large share of the black population in South Africa. It is therefore of interest to see how robust those results are on a representative sample of blacks.[1]

We also differ from Thomas (1996), and many other analyses of intergenerational mobility, by exploring the extent to which our estimates are robust to unobserved household and community effects. These factors may matter through a number of channels, such as aggregate human capital effect (Datcher 1982; Borjas 1995), and affect firms' technological choice (Azariadis and Drazen 1990; Acemoglu 2002), which in turn determine private decisions to invest in education. Cross sectional studies cannot account for such characteristics because one needs both time series and cross-sectional (panel) data. Such a failure may lead to biased estimates. On the one hand, we may overestimate the impact of the head-of-household's education if the true effect is channeled, for example, through access to the credit market for those who are better educated. Similarly, the distortions created by apartheid, such as limited geographical mobility through the pass laws, and the geographical inequality in educational infrastructure, may have also affected an individual's educational decisions. On the other hand, we may underestimate the impact of parents' education on children's attainment if there are measurement errors and we do not observe children who no longer live with their parents.

Unfortunately, to the best of our knowledge, there are no representative panel data for South Africa. One partial geographical panel, known as the KwaZulu-Natal Income Dynamics Survey (KIDS), is available. KIDS resurveyed households in the KwaZulu-Natal province who were first interviewed in 1993 for the Project for Statistics on Living Standards and Development. Apart from being concerned with only one out of nine provinces in South Africa, the KIDS could not locate 16% of households that were originally interviewed in 1993. These problems preclude us from using the KIDS. We therefore resort to Deaton's (1985) method to create a pseudopanel by linking five cross-sectional October Household Surveys (OHS) spanning from 1995 to 1999. We are the first to use a representative sample of blacks, and to account for unobserved household and community characteristics, in a study of intergenerational mobility in South Africa.

We establish the following results: Whites have higher intergenerational education mobility than blacks. The magnitude of our estimate of black intergenerational

[1] Apartheid South Africa consisted of four independent states (Bophutatswana, Ciskei, Transkei, and Venda) and six homelands (Gazankulu, Kangwane, Kwa Ndebele, Kwa Zulu, Lebowa, and Qwaqwa).

Table 1 Some estimates of intergenerational mobility in the literature

Author(s)	Year	Country	Dependent variable	Data	Estimate
Soltow	1965	Norway	Income	Cross section	0.14
Sewell and Hauser	1975	United States	Income	Cross section	0.15
Atkinson	1981	United Kingdom	Income	Panel	0.36
Atkinson	1983	United Kingdom	Income	Cross section	0.43
Becker and Tomes	1986	United States	Income	Cross section	0.20
Behrman and Taubman	1985	United States	Income	Cross section	0.18
Behrman and Taubman	1990	United States	Income	Panel	0.40–0.60
Solon	1992	United States	Income	Panel	0.41–0.53
Zimmerman	1992	United States	Income	Cross section	0.25–0.42
Zimmerman	1992	United States	Income	Panel	0.40–0.54
Zimmerman	1992	United States	Wages	Cross section	0.26–0.49
Zimmerman	1992	United States	Wages	Panel	0.37–0.39
Peters	1992	United States	Income	Panel	0.17–0.23
Peters	1992	United States	Wages	Panel	0.14–0.23
Corcoran, Gordon, Laren, and Solon	1992	United States	Income	Panel	0.37
Gustafsson	1994	Sweden	Income	Panel	0.20
Borjas	1995	United States	Wages	Panel	0.22–0.46
Borjas	1995	United States	Education	Panel	0.17–0.36
Thomas	1996	South Africa	Education	Panel	0.2–0.4
Dearden, Machin, and Reed	1997	United Kingdom	Wages	Panel	0.22–0.59
Dearden, Machin, and Reed	1997	United Kingdom	Education	Panel	0.42–0.44
Couch and Dunn	1997	United States	Wages	Panel	0.13
Couch and Dunn	1997	Germany	Wages	Panel	0.12
Couch and Dunn	1997	United States	Education	Panel	0.26–0.37
Couch and Dunn	1997	Germany	Education	Panel	0.03–0.48
Björklund and Jäntti	1997	Sweden	Income	Panel	0.22–0.36
Björklund and Jäntti	1997	United States	Income	Panel	0.29–0.52
Mulligan	1997	United States	Wages	Panel	0.35–0.61
Mulligan	1997	United States	Consumption	Panel	0.41–0.71
Corak and Heisz	1999	Canada	Income	Panel	0.20
Gang and Zimmermann	2000	Germany	Education	Panel	0.82–1.33
Burns	2001	South Africa	Education	Panel	0.13–0.37
Nimubona and Vencatachellum	2007	South Africa, blacks	Education	Cross section	0.23
Nimubona and Vencatachellum	2007	South Africa, blacks	Education	Pseudopanel	0.25
Nimubona and Vencatachellum	2007	South Africa, whites	Education	Cross section	0.19

mobility is close to the average of those found for other countries, while that for whites is close to the lowest estimates (see Table 1). Our estimates of black intergenerational mobility obtained by using cross-section or pseudopanel data are not significantly different. This result can be interpreted as meaning that, in the case of black South Africans, the different biases that arise when using cross-section data cancel each other.

We also find that the poorest black children have the lowest intergenerational education mobility but that this is not the case for whites, and that intergenerational mobility is higher for black females than for black males. This last result reflects the unique characteristic of South Africa in that, contrary to other developing countries (Schultz 2002), black females are on average more educated than black males.[2] Indeed, under apartheid, black males could find employment on the mines where strength, rather than education, was rewarded. Children in both black and white female-headed households accumulate less education than when the household head is a male. However, ceteris paribus, a child benefits more from one additional year of schooling of a female than of a male head-of-household. Female children are those who benefit the most from one additional year of schooling of a female head-of-household. Finally, we find that those who live in rural areas accumulate less schooling than those in urban areas. Moreover, these estimates of intergenerational education mobility are robust to accounting for unobserved household and community characteristics.

A number of policies to accelerate the schooling of blacks can be formulated from our results. First, as in other countries, the South African government would benefit by investing more in girls' education because of the additional benefit children derive from better-educated mothers. Second, alleviating credit and labor market constraints, if they are part of the unobserved household characteristics, appear to be as important as better-educated parents. Finally, income or wealth redistribution is likely to increase schooling, either through relaxing the credit constraint which families face, or changing parents' expectations about the returns to education.

The remainder of this paper is as follows: Section 2 briefly describes apartheid-era policies, which are likely to have distorted blacks' educational outcomes. We then outline a simple model of intergenerational mobility in Section 3, and discuss the econometric specification and estimation procedures in Section 4. The main characteristics of the 1995 to 1999 OHS and the variables used in our specifications are given in Section 5. We present the estimates of our model, and the lessons for intergenerational mobility, in Section 6. Finally, Section 7 concludes. All proofs are in the Appendix.

2 Apartheid-inherited distortions

We briefly review the institutional and legislative constraints which undermined the provision of education for black South Africans, and the labor market conditions which may have reduced their expected returns from education. We argue that these constraints have affected individuals' educational outcome.

[2] The lower education attainment of females than males is also documented among some immigrant groups in Europe. van Ours and Veenman (2003) find that first-generation female immigrants in the Netherlands do worse than the second-generation ones and native Dutch people. This is not the case for males once they control for age and parents' education.

2.1 Education

The philosophy of education during apartheid is well summarized by Hendrik French Verwoerd, the architect of apartheid, when he was Minister of Native Affairs:

> There is no place for him [a black man] in the European community above the level of certain forms of labour...For that reason it is of no avail to him to receive a training which has as its aim absorption into the European community, where he cannot be absorbed. [Senate Debates, 7 June 1954]

The 1953 Bantu Education Act was grounded in that view. It established segregated schools (Malherbe 1977, p 547), limited the resources for black education, and constrained its quality and curriculum. Government spending on black education remained constant and low until the early 1970s (Fedderke and Luiz 2002, Fig. 1). Although government expenditure on black education increased during the 1970s, the gap with white students remained large. Samuel (1996, p 22) estimates that, in 1976, the government spent 7,000 rands on each white student for the duration of their schooling, and 350 rands per black student. It was only by 1989 that the black/white government expenditure ratio reached close to 25% (Goduka 1999, p 85). In addition, many teachers in African schools were inexperienced, under qualified, and faced low teacher–pupil ratios. The average teacher–pupil ratio in 1970 in African schools was 1:65, compared to 1:20 in white schools (Goduka 1999, p 38), while only 7% of teachers in African schools had a university degree in 1986 (Samuel 1990, p 40).

This state of affairs prompted black students to protest. They resisted the Bantu Education Act, boycotted classes, and eventually rioted in Soweto in 1976. This led the government to drop Afrikaans as a compulsory medium of instruction, but little else was done. Eventually, the Bantu Education Act was replaced by the Education and Training Act in 1980, but the fundamental inequalities still persisted (Samuel 1996, p 28). Moreover, many blacks could not afford schooling of good quality because of high costs. Limited credit market and the lack of collateral prevented parents from borrowing to send their children to school. These factors may have meant low incentives for blacks to attend school, and caused many to drop out [see Samuel (1990, pp 35 and 41) for evidence]. This partly explains the wide gap between the share of blacks and whites that graduated from secondary school.

In addition to the underprovision of education for blacks, the apartheid government also discriminated against blacks in the labor market. We now discuss some of those policies with a focus on how they may have affected educational outcomes.

2.2 Labor market

The 1950 Group Areas Act, which segmented communities, and the Population Registration Act, which classified people according to their race, were the cornerstones of legislative apartheid. The mobility of blacks was regulated through a pass system and limited access to the housing market until the late 1980s. According to the 1970 Bantu Homelands Citizenship Act, every black was a citizen of one of 10 Bantustans or homelands. The housing regulations for non-Bantustan townships

stipulated that all residents had to be listed on a lodger's permit, failing which they would not obtain identification documents from the Department of Home Affairs. Local authorities could remove the "redundant, idle, and unsuitable" from urban areas.

While employed black males were accommodated in urban areas, women were regarded as "surplus appendages" who belonged to rural areas (Friedman and Hambridge 1991, p 161). Female migrants to urban areas were confronted with an acute housing problem. Friedman and Hambridge (1991, p 169) refer to instances where women were not allowed to live in formal townships and were forced into shack settlements. As a result, apartheid led to a high (low) male/female ratio in urban (rural) areas, and severe racial inequalities. Although influx control and residential segregation were no longer on the statute books by 1990, their effects persisted and other legislations restricting the mobility of blacks were adopted. For instance, the Housing Regulations for non-Bantustan townships were retained, and laws against squatting and slums were tightened (Unterhalter 1987, p 41).

These labor mobility constraints may have had adverse effects on parents' decisions to invest in their children's education. Many males were better off taking employment in mines where physical strength, rather than education, was remunerated. All this evidence therefore points to many children not attending school because of poverty, political reasons, and low expected returns from education because of institutional constraints.

3 Investment in education

We draw on Becker and Tomes (1979) to construct a simple model of parents' decisions to invest in their children's education. The model captures some of the stylized facts summarized in Section 2 and allows us to derive some testable hypotheses about optimal investment in education. We use those results to justify our empirical strategy in Section 4. We first describe the basic assumptions and environment of the model economy (Section 3.1). Next, we investigate how education choices vary with the characteristics of the parents and economy (Section 3.2).

3.1 The model

Consider a two-period economy populated by a measure one of adults and a measure $N \geq 1$ of children. Each household is composed of N children and one parent. A parent lives for one period, and each child lives for two. An adult is endowed with h units of human capital, which are distributed over a bounded support. Each parent supplies his/her human capital on the labor market for a wage w. Firms hire human capital on a perfectly competitive labor market to produce a homogenous good and operate with the following constant returns to scale production function:

$$Y = AH, \tag{1}$$

where H is the amount of human capital hired by the firm and A is a scale factor. It follows that an agent endowed with h units of human capital earns a wage that is equal to his/her marginal product:

$$w(h) = Ah \tag{2}$$

The wage schedule (Eq. 2) exhibits positive returns to education, which have been well documented since Mincer (1974), and evidence for South Africa is provided in Michaud and Vencatachellum (2003).[3]

An adult derives utility from consuming c units of the homogenous good, and from each of his children's human capital, denoted h', when they become adults. We formalize an adult's utility as:

$$U(c, h') = u(c) + Nh', \tag{3}$$

where u is a concave function which satisfies Inada conditions. We assume it costs γ units of the homogenous good to purchase one unit of education.[4] Credit markets are assumed to be imperfect. As a result, education can only be financed by the family's income. Consequently, a parent endowed with h units of human capital, and who purchases e units of education for each child, has a budget constraint of:

$$c = w(h) - \gamma eN, \tag{4}$$

where w is given by Eq. 2 and the consumption of each child is normalized 0.

If a parent purchases e units of education for each child, the latter acquires h' units of human capital as an adult according to the following production function:

$$h' = f(e, h, \lambda), \tag{5}$$

where λ is a measure of the quality of facilities in the community where the household lives. These facilities can include factors such as the quality of schooling facilities, the quality of schoolteachers, the pupil/teacher ratio, and the support that students may obtain from the neighbors in their education. Concerning the latter, parents may group together to provide after-school support for the children in a particular neighborhood. In this case, those students may perform better at school and acquire more education. It would make sense to assume that the quality of the after-school support is increasing in the average level of human capital, and wealth, in the community. We assume that Eq. 5 is concave in each of its arguments and that f_{eh} and $f_{e\lambda}$ are both positive.

Each adult maximizes his/her utility by choosing his/her optimal investment in each child's education, denoted e^*. Substituting Eqs. 4 and 5 in Eq. 3 gives:

$$e^* = \arg\max_{<e>} \{u(w(h) - \gamma eN) + f(e, h, \lambda)N\}. \tag{6}$$

Solving for e^* as a function of the parameters of the model allows us to investigate the determinants of parents' optimal investment in their children's education. This is the subject of the next section.

[3] Psacharopoulos and Patrinos (2002) review the rates of returns to education literature.

[4] One could assume a generic cost function without any change in the results. The linear cost function allows for better tractability. For instance, the cost of education could be assumed to depend on the quality of school facilities in the community. While we incorporate community effects in the production of human capital, Eq. 5, we would obtain the same qualitative results by including them in the cost function.

3.2 Optimal choice

Proposition 1 *The optimal investment in a child's education by a parent endowed with h units of human capital is given by the implicit function* $e^*(h, \gamma, \lambda, N)$, *which is such that:*

1. *Parents with higher human capital invest more in their children's education.*
2. *Parents with more children invest less in each child's education— there is a quantity–quality trade off.*
3. *An increase in the cost of education reduces a parent's investment in each child's education.*
4. *Parents who live in communities with better facilities invest more in education.*

The intuition for Proposition 1 is straightforward. A parent equalizes his marginal utility from consumption and investment in each child's education. Parents with more human capital enjoy higher disposable income. Given that both consumption and education are normal goods, the parent invests more in each child's education, and consume more, following an increase in wages. As all children are treated in an identical manner, having more children means that there are less ressources which a parent can invest per child. A higher cost of education translates into a negative income effect and parents react by investing less in their children's education. Finally, better community facilities increase the marginal benefit from investing in education and, as a result, parents have more incentives to invest in their children's education. This last result is particularly important for blacks in South Africa because discriminatory policies conducted during apartheid still means that many black townships have very poor facilities.

Our model could be amended to include nonwage incomes that are not necessarily increasing in human capital. For example, intrafamily private transfers are an important source of income in many developing countries (Lucas and Stark 1985; Lee et al. 1994). Such transfers have the same effect as an increase in the parent's income and would lead to more investment in each child's education. Moreover, some parents may have access to the credit market, where they could borrow for consumption and investment in their children's education. Not all parents can access these loans because some lack physical or social collateral. Access to such credit market would relax the parents' budget constraint and allow them to invest more in their children's education. Better access to the credit market, and intrafamily transfers, can be viewed as being family-specific. Those families which have physical collateral, are well-established in their neighborhood, or where the head of the household is more educated, may access the credit market more easily.

Given the distortions documented in Section 2, we could also allow wages to be influenced by geographical factors. Although pass laws no longer exist, those surveyed faced these constraints when they made their schooling decisions. Clearly, given Proposition 1, those who expect low returns to education would be less inclined to attend school. It can be argued this is the case for older black South African males who, for a long time, could find work in mines where strength rather than education was rewarded. Similarly, the quality of schools impacts parents' decisions to educate their children. Richer communities should have better schooling facilities. This is indeed the case for white South Africans. Hence, in addition to its

impact on the production of education as specified in Eq. 5, we expect geographical characteristics to matter for education decisions through its income effect.

We acknowledge that our model is very stylized and has a number of limitations. First, we assumed an exogenous household size. This could be seen as a second stage where parents have already chosen the household size in a first stage. A more realistic model would allow parents to also chose the number of children, but similar results as in Proposition 1 would still be obtained [see, for instance, Kalemli-Ozcan (2003)]. Second, we assume that children living in the same household have the same education. Although this is a common assumption in a child labor model (Baland and Robinson 2000), and we do not know of any model that relaxes it, this is clearly not the case in real life. However, we would expect Proposition 1 to still hold if we allow asymmetric investment in children's education. This is left for future work because our objective is mainly an empirical one. While bearing those caveats in mind, we can now test the comparative static results given in Proposition 1 using South African data. To perform those tests, we next discuss the specification of the empirical model and potential biases when using cross-section data and suggest a robustness check.

4 Empirical strategy

Intergenerational mobility studies investigate how a measure of children's outcome (e.g., income and education) correlates with that of their parents (Solon 1999). In that spirit, and given the focus of our paper, we start with a simple approximation of the demand for education e^*. Denote the educational attainment of person i, who lives in community j, by y_{ij}. In its simplest form, y_{ij} is a linear function of the educational attainment of i's parents, denoted by p_{ij}, and of a mean zero error term, ε_{ij},:

$$y_{ij} = \beta_0 + \beta_1 p_{ij} + \varepsilon_{ij}. \tag{7}$$

The parameter β_1 measures the degree of dependance of educational outcome across generations. A higher value of β_1 means lower intergenerational education mobility, and if $\beta_1 < 1$, educational attainment converges over time.

As emphasized in Sections 2 and 3, intergenerational mobility is affected by factors other than parents' education. These omissions have been pointed out in the literature. Datcher (1982) remarks that Eq. 7 may be wrongly specified because it ignores the characteristics of a household's region of residence.[5] Similarly, Borjas (1995) finds that the average human capital in the community matters for children's educational attainment. It follows that ordinary least squares (OLS) estimates of Eq. 7 are biased if the error term is correlated with the omitted community characteristics. Such correlations exist if a family has access to the credit market because of unobserved social network or asset. Another possibility, as pointed out by Tansel (2002), is the distance of the household from a location that has good employment prospects. He finds that this has a negative impact on educational attainment. However, we do not have information on those community characteristics and they would be incorporated in the error term in Eq. 7. This is not without consequence on the estimate of β_1, as we discuss next.

[5] We use household and family interchangeably in this paper, although we know they capture different realities.

4.1 Robustness check

To allow for community effects, denote a family by m and decompose the error term in an individual-specific component, ε_{imj}; a family-specific one, denoted by γ_{mj}; and a community one, f_j, to obtain:

$$y_{imj} = \beta_0 + \beta_1 p_{mj} + \gamma_{mj} + f_j + \varepsilon_{imj} \tag{8}$$

The subscripts in Eq. 8 are ordered from the lowest to the highest aggregation level. However, as a household is observed only once in cross-section data, we cannot distinguish between a parent's human capital p_{mj} because it is the same for all household members and the household fixed effect γ_{mj}. One solution is to observe families across generations. We rewrite Eq. 8 to include a time (or generation) t subscript:

$$y_{imjt} = \beta_0 + \beta_1 p_{mjt} + f_j + \gamma_{mj} + \varepsilon_{imjt} \tag{9}$$

Note that Eq. 9 has no time subscript on the family and community fixed effects, which are time-invariant by assumption. The availability of panel data would allow us to account for, and estimate, family fixed effect. However, to our knowledge, there does not exist such data on a representative sample of the South African population. We only have cross-sectional survey data. One solution is to use repeated cross-sectional data to construct a pseudopanel to estimate Eq. 9.

The pseudopanel estimator was first derived by Deaton (1985) to overcome the absence of panel data in many countries. Let a household m belong to a cohort (or a cell) c and take simple population averages of Eq. 9 over all those who belong to c.

$$y_{ct} = \beta_0 + \beta_1 p_{ct} + \gamma_c + \varepsilon_{ct} \tag{10}$$

The community and family fixed effects are now aggregated in a common cell fixed effect. As the population expectations values are unobserved, Deaton (1985) suggests using the observed sample means computed from micro surveys for each variable in Eq. 10. He derives an estimator (Deaton 1985, Eq. 23) that is consistent, even when some variables in Eq. 10 are measured with errors.

Note that Eq. 10 can be estimated only if the population average of parents' education by cell (p_{ct}) differs over time. This difference is what allows us to identify β_1 from the constant. There are two reasons for the population mean of parents' education by cell to change over time. First, the population of parents is not the same over the years. Older parents, with low education, die, and younger, more educated dults, become parents. Second, individuals can change location over time, meaning that the population average of education can change in the different surveys.

4.2 Some benefits of the pseudopanel method

Moffitt (1993) shows that Deaton's estimator, which is outlined in Appendix A.2, can be interpreted as an instrumental variable, which has been advocated by Solon (1989) for studies of intergenerational mobility.[6] The intuition why this is the case

[6] Note, however, that Solon (1992) points out that instrumental variable may yield upward-biased estimates.

is as follows: If parents' education and community fixed effects are not independent, we must search for an instrument that is correlated with the former but not with the latter. An important class of such valid instruments is those which are only a function of time (Moffitt 1993, p 102, Section 3). Using a function of time, i.e., different surveys, makes sense as long as parents' educations vary over time while community fixed effects do not. Hence, pseudopanel estimators can be interpreted as instrumental variables and yield consistent parameter estimates even though parents' education and community fixed effects may be correlated.

In addition to controlling for unobserved effects, pseudopanel has other advantages that are of interest to us. Although we should use a representative sample of children (alive or dead) matched with their parents, it is unlikely that one household survey would allow us to do that. Cross sectional surveys are likely to yield a nonrandom sample because some children may have migrated from the household, married, or died, while some still attend school. Using the educational attainment of only those children who still live with their parents is not likely to yield a random sample. Indeed, some parents may be deceased, or the child may not have grown up with his/her parents. Moreover, those who are poorly educated may leave the household early in search of employment while the others will still be at school and in the household. We also have no information on the education of deceased children. The latter may originate from poorer, less educated households, and those children would not have been well educated. The same type of bias may arise from observing children in households where the parents have died.[7]

Therefore, while unobserved community effects may lead us to underestimate intergenerational mobility, other factors may cause it to be overestimated. Consequently, the direction of the bias on intergenerational mobility is not known a priori when cross sectional data are used. Pseudopanel data seem appropriate to investigate whether the estimates obtained from cross sectional data are robust.

The correlation between unobserved characteristics and the explanatory variables in studies of intergenerational mobility has recently been the subject of renewed interest. When faced with such problems, there are two avenues that have been explored in the literature. The first one consists of finding an instrument that allows for the elimination of such bias. This is the avenue taken, for example, by Shea (2000). Such studies rely on the credibility of how the instruments for parents' income or education have no explanatory power in educational attainment. A second solution consists of first differencing the outcome of interest between individuals who share similar unobservable characteristics. This allows one to get rid of any correlation between the error term and the explanatory variables. Behrman and Rosenzweig (2002) use such a method on a sample of twins while Plug (2004) use a sample of adoptees. At issue is the availability of such data for South Africa. To the best of our knowledge, such data are not available for South Africa. Moreover, as pointed out by Chadwick and Solon (2002), the homogeneity of the sample of twins means it is difficult to make inference about the population of interest. However, the spirit of pseudopanel tackles the same type of problems raised by the

[7] See Tansel (2002, Section 4.1) for more discussions about biases arising from sample selection. Very few studies have data on the household of origin and the educational attainment of past generations. Binder and Woodruff (2002) is one such recent study but they do not account for unobserved household characteristics on intergenerational mobility.

above-mentioned literature and allows us to achieve the same goal by using data that avoid the homogeneity inherent to twin or adoptee samples.

4.3 Nonlinearity

Another source of potential bias is if intergenerational mobility is nonlinear across different segments of the population. We can ask ourselves, as in Thomas (1996), whether the relation between educational outcome and parents' human capital is linear because community effects may have different impacts across social groups. Indeed, it could be argued that, even within a community, people socialize with those who have similar income or preferences. In this case, the poor are less likely to benefit from human capital externalities arising from socialization. For that reason, we also estimate Eq. 7 by allowing all parameters to differ by the parents' educational quartile. Finally, because the number of years of schooling is a discrete bounded variable, adoptee may be inappropriate. We therefore also use the ordered logit and probit to estimate Eq. 7.

We next describe the variables that are used to estimate Eq. 7 and explain how we construct the pseudopanel so as to estimate Eq. 10. These results will then be reported in Section 6.

5 Survey data

We have five independent yearly OHS for 1995 to 1999. The OHS was discontinued thereafter, and the 1994 one is not representative of the population. Using Proposition 1, and the empirical strategy outlined in Section 4, we specify the number of years of schooling as a linear function of the child's characteristics, those of the head of household, and place of residence. The distortions inherited from apartheid-era policies justify that we distinguish between blacks and whites in the analysis of our data. We abstract from Indians and coloreds because of their small number and geographical concentration.

The dependent variable of interest is the educational attainment of the current generation who are at least 15 years old, and are the sons or daughters of the head of the household (who is the child's mother or father). That cut-off age is motivated by the definition of the legal minimum age, used by Statistics South Africa, to compile labor market participants and the relatively high labor market participation of those in the 16-to-18 age category. We use Moll (1993) to convert a respondent's highest education into number of years of education. The summary statistics for blacks and whites are reported in Tables 2 and 3, respectively, and the race and province distributions of respondents appear in Table 4. On average, the current generation of young blacks has 8.5 years of schooling, meaning that it has completed primary school, while young whites have 10.8 years of schooling.

5.1 Main characteristics of the explanatory variables

Education of the head of household A black parent has an average of 4.5 years of schooling, which is about half that of the current generation of black children.

Table 2 Descriptive statistics of the OHS for blacks, 1995–1997

	Year of the OHS				
	1995	1996	1997	1998	1999
Number of children older than 15	19,962	12,506	23,151	12,693	16,523
Average age of children	23.8	23.7	24.2	23.7	23.9
Average number of years of schooling of children					
Male and female	8.6	8.5	8.3	8.5	8.6
Female	8.7	8.7	8.6	8.7	8.9
Male	8.4	8.3	8.1	8.2	8.4
Average number of years of schooling of children living in					
Eastern Cape	8.3	7.8	7.5	7.8	8.1
Free State	8.6	8.6	8.4	8.6	8.7
Gauteng	9.8	9.5	9.3	9.6	9.8
KwaZulu-Natal	8.6	8.5	8.3	8.4	8.3
Limpopo	9.2	8.7	8.7	8.5	8.9
North-West	8.2	8.0	8.0	8.2	8.3
Mpumalanga	8.3	8.6	8.3	8.5	8.7
Northern Cape	7.3	7.7	7.9	8.4	8.2
Western Cape	8.8	9.4	9.1	9.3	8.8
Urban sector	9.3	9.2	9.0	9.2	9.3
Rural sector	8.1	8.0	7.9	8.0	8.0
Average age of household head	55.3	54.3	55.0	54.8	54.7
Average number of years of schooling of household head					
Male and female	4.7	4.53	4.35	4.41	4.71
Female	4.6	4.4	4.2	4.4	4.5
Male	4.8	4.7	4.6	4.5	4.9
Average number of children per household	4.0	4.0	3.8	3.7	3.7

Table 3 Descriptive statistics of the OHS for whites, 1995–1997

	Year of the OHS				
	1995	1996	1997	1998	1999
Number of children older than 15	1,872	832	1,301	978	1,203
Average age of children	20.2	20.9	21.1	21.6	21.2
Average number of years of schooling of children					
Male and female	10.8	10.8	10.5	10.7	11.1
Female	10.8	11.0	10.5	10.7	11.3
Male	10.8	10.7	10.6	10.7	10.9
Average number of years of schooling of children living in					
Eastern Cape	10.5	10.8	10.8	10.8	11.3
Free State	10.4	10.4	10.4	10.6	11.0
Gauteng	11.1	10.9	10.6	10.9	11.3
KwaZulu-Natal	11.1	10.7	10.9	11.0	11.4
Limpopo	10.7	10.6	9.7	10.5	10.3
North-West	10.7	10.8	10.4	10.6	10.5
Mpumalanga	10.3	10.8	10.1	10.5	10.9
Northern Cape	10.4	11.0	10.3	10.4	10.6
Western Cape	10.8	11.2	10.4	10.8	11.2
Urban sector	10.8	10.8	10.5	10.7	11.1
Rural sector	10.7	11.3	10.4	11.0	11.0
Average age of household head	48.9	49.4	49.7	51.1	50.2
Average number of years of schooling of household head					
Male and female	11.9	11.8	11.1	11.1	12.1
Female	11.3	11.3	10.7	10.7	11.4
Male	12.0	11.8	11.2	11.3	12.3
Average number of children per household	1.9	1.9	1.9	1.9	1.9

Table 4 Race and province distributions in the OHS

Province	Size	Indians	Blacks	Colored	Whites
1995					
Western Cape	2,558	2.6	16.7	66.2	14.5
Eastern Cape	5,402	0.56	84.2	11.9	3.4
Northern Cape	993	0.3	32.3	56.3	11.1
Free State	2,273	0.1	84.0	8.6	7.3
KwaZulu-Natal	6,422	9.4	84.3	2.7	3.7
North-West	2,243	1.7	88.3	5.2	4.8
Gauteng	2,602	7.2	64.8	9.2	18.8
Mpumalanga	3,166	1.6	91.3	2.3	4.8
Limpopo	863	1.2	90.4	1.7	6.7
South Africa	26,522	3.7	75.3	14.0	7.1
1996					
Western Cape	1,126	0.5	26.5	63.7	9.3
Eastern Cape	2,895	0.4	89.3	7.0	3.3
Northern Cape	536	0	38.6	58.2	3.2
Free State	897	0	86.9	1.9	11.3
KwaZulu-Natal	3,018	15.2	82.1	0.4	2.3
North-West	1,153	0	93.5	4.08	2.43
Gauteng	2,484	4.6	79.4	3.7	12.3
Mpumalanga	1,062	0	93.31	0	6.69
Limpopo	2,164	0	97.7	0.4	1.9
South Africa	15,335	3.8	81.6	9.2	5.4
1997					
Western Cape	2,965	1.8	19.5	71.5	7.2
Eastern Cape	3,909	0.4	88.9	9.2	1.6
Northern Cape	1,214	0.1	28.1	66.7	5.1
Free State	2,201	0.1	93.6	2.3	4.0
KwaZulu-Natal	6,262	9.7	86.9	1.2	2.3
North-West	2,714	0.0	95.7	1.8	2.5
Gauteng	3,698	2.6	76.0	5.7	15.7
Mpumalanga	2,709	0.9	95.6	0.7	2.8
Limpopo	3,276	0.0	99.6	0.1	0.3
South Africa	28,948	2.8	80.0	12.8	4.5
1998					
Western Cape	1,794	1.7	21.7	63.7	12.9
Eastern Cape	2,338	0.0	86.7	10.6	2.6
Northern Cape	840	0.0	37.0	56.2	5.2
Free State	1,239	0.1	92.3	1.9	5.7
KwaZulu-Natal	2,955	13.1	81.7	1.7	3.6
North-West	1,700	0.4	94.7	1.2	3.7
Gauteng	1,835	2.9	76.1	3.8	17.1
Mpumalanga	1,488	0.1	94.2	0.7	4.9
Limpopo	2,025	0.2	98.8	0.2	0.9
South Africa	16,214	3.0	78.3	12.6	6.0
1999					
Western Cape	2,070	1.2	17.7	70.3	10.5
Eastern Cape	3,118	0.5	84.9	9.9	4.3
Northern Cape	850	1.1	37.7	54.0	7.3
Free State	1,554	0.0	89.5	2.7	7.8
KwaZulu-Natal	3,666	9.2	86.9	1.4	2.4
North-West	2,117	0.4	94.4	1.9	3.3
Gauteng	2,615	2.6	78.1	5.3	14.0
Mpumalanga	2,023	0.5	94.7	0.5	4.3
Limpopo	2,725	0.2	97.5	0.1	2.2
South Africa	20,738	2.3	79.7	12.1	5.8

White parents are, on average, more educated than black ones and their educational attainment is not statistically different from that of the current generation of white children (Table 3). The better educational performance of the current generation of blacks is in part the consequence of the change in education policies since the end of the 1980s and better access to education (see Section 2.1).

The correlation between the educational attainments of a black head of household and that of the current generation of black children equals 0.34, and is statistically significant at the 1% level. The corresponding number for whites is 0.16 and is also statistically significant at the 1% level. As expected, the educational attainment of whites is less constrained by their own parents' education than is the case for blacks. These intergenerational education measures constitute summary statistics that can be compared with some of the estimates reported in Table 1. Given those simple correlations, as in other studies, we expect children of better-educated parents to achieve higher educational attainments. Note that these correlations are simply summary measures, which can be compared with other studies, but cannot be given a causal interpretation.

Child's gender As documented in studies of the South African labor market (Michaud and Vencatachellum 2003), black females are, on average, more educated than black males (see Table 2). This differs from other developing countries, where the opposite usually holds (Schultz 2002), and for whites where, over the 1995-to-1999 period, there is no significant difference between males and females (Table 3). Alderman and King (1998) suggest that the lower education of females in low-income countries may reflect differences in transfers that parents expect to receive from their children. Such an explanation is not inconsistent with what is observed for blacks in South Africa. Indeed, for a long time, the best-paid jobs available to blacks were in the mines, which employed almost only males, and where physical strength, rather than education, was remunerated.

Gender of the head of household In some countries, children benefit more from their father's education than from their mother's (Schultz 1984; Behrman and Taubman 1985; Gang and Zimmerman 2000), while in others the opposite holds (Birdsall 1985; Schultz 1993). However, while both daughters and sons benefit in a similar way from their father's education, Behrman and Taubman (1985) find that daughters benefit more than sons do from their mother's education. In the face of those studies, Schultz (2002, p 212) concludes that "adding to a mother's schooling will have a larger beneficial effect on a child's education."

We can distinguish between male-headed and female-headed households. Almost all households that are female-headed are in fact single-parent households. A preliminary analysis of our data indicates that a child's education and that of either a female-headed or male-headed household is positively correlated: 0.34 for blacks and 0.16 for whites. By including the gender of the head of household as an explanatory variable in the multivariate analysis, we will be able to investigate whether that correlation is robust.

Age of the child From the evidence summarized in Section 2, it appears that older black South Africans faced more severe education constraints than younger ones because of the apartheid discriminatory policies. We must recall that the Bantu

Education Act was implemented in 1953 with the explicit purpose of restricting the quality of education for blacks. Moreover, black education was heavily underfunded compared to that of whites during the whole apartheid period (Fedderke and Luiz 2002). We therefore expect the number of years of education to be inversely related to the age of black children in South Africa. The simple bivariate correlation between a black child's age and educational attainment equals −0.19, and is statistically significant at the 1% level.[8] Interestingly, that correlation is positive (0.16) for whites. This difference between blacks and whites is simply a consequence of the discriminatory education policies during apartheid.

Rural/urban Children in the rural sector can be expected to accumulate fewer years of education because the opportunity cost of schooling may be higher due to their help needed in agricultural or farming activities or because of the lack of schooling facilities, which increase the cost of schooling. As reported in Table 2, there is, on average, about one year of education between blacks who live in the urban and rural sector, while there is no such difference for whites. Not surprisingly, blacks who live in the Gauteng province, which is the industrial and mining hub of South Africa, have the highest average educational attainment. By opposition, those who live in the Eastern Cape, which is one of the poorest provinces of South Africa, have one of the lowest educational attainments. As for whites, there is no significant geographical variation in educational attainment.

This simple descriptive analysis paints a picture of blacks having significantly lower educational attainment than whites both over time and geographically. Moreover, the intergenerational transmission of education for blacks seems to be more constrained by their parents' educational attainment than is the case for whites. We must now move to a multivariate analysis so as to investigate how robust this preliminary analysis is.

5.2 Setting up the pseudopanel

The use of a pseudopanel requires that we use observable characteristics of the children to classify them in separate cells for each survey. Both Deaton (1985) and Verbeek and Nijman (1990) point out that these characteristics should be time invariant, and there must be sufficient observations per cell for the estimators to be consistent. Therefore, these two considerations involve some tradeoff in the construction of the cells. These considerations also mean that we cannot estimate the intergenerational mobility of whites by using the pseudopanel method because of their small sample size and geographical concentration.

The first natural split is to separate the children by their gender. Indeed, parents may have preference differences for male or female children, or they may expect future income differences, which imply that the returns to education may differ across gender. In this case, their education investment decision will be a function of the child's gender. Next, the gender of the head of the household is the second criterion that seems appropriate. The third characteristic that we use is the province of residence of the child. It captures the opportunities and constraints that the child

[8] The correlation is calculated for children who no longer attend school.

Table 5 Descriptive statistics of the Pseudo-Panel cells for blacks

Criteria			OHS 95			OHS 96			OHS 97		
Child's gender	Province	Parent's gender	Number of pairs	Average Education of Child	Head of Household	Number of pairs	Average Education of Child	Head of Household	Number of pairs	Average Education of Child	Head of Household
Male	Western Cape	Male	103	8.2	4.6	66	9.1	5.8	129	8.7	6.2
		Female	103	8.8	6.0	66	8.7	7.0	133	8.3	6.4
	Eastern Cape	Male	1,107	8.2	5.0	590	7.6	4.4	698	7.2	4.2
		Female	1,131	7.8	5.2	678	7.1	4.5	1,025	7.1	4.6
	Northern Cape	Male	89	7.1	3.8	46	7.4	4.2	101	7.6	5.1
		Female	59	7.0	4.4	45	8.4	5.5	76	7.5	4.6
	Free State	Male	560	8.7	4.6	189	8.7	4.6	505	8.0	4.7
		Female	357	8.6	5.2	165	8.4	5.2	455	8.1	4.3
	KwaZulu Natal	Male	1,475	8.6	4.9	566	8.5	4.7	1,229	8.1	4.3
		Female	1,073	8.3	4.3	470	7.8	4.2	1,321	8.0	3.9
	NorthWest	Male	545	8.1	4.5	298	8.1	4.9	615	7.9	4.0
		Female	359	7.4	3.7	232	7.6	4.3	606	7.7	4.3
	Gauteng	Male	464	9.8	6.8	469	9.5	6.5	800	9.3	6.4
		Female	334	9.4	6.4	436	9.1	6.2	556	8.8	5.9
	Mpumalanga	Male	943	8.3	3.4	275	8.8	3.7	642	8.1	3.2
		Female	408	8.2	3.2	189	8.5	3.0	589	8.0	3.0
	Limpopo	Male	221	9.3	4.9	403	8.6	2.9	635	8.7	4.0
		Female	136	8.8	2.8	560	8.6	2.8	928	8.5	3.0
Female	Western Cape	Male	93	9.0	5.0	70	10.0	7.0	157	9.5	6.4
		Female	122	9.1	6.0	75	9.9	7.0	155	9.6	6.5
	Eastern Cape	Male	1,035	8.7	4.8	572	8.4	4.6	696	8.1	4.2
		Female	1,242	8.6	5.4	699	8.3	4.8	1,049	7.9	4.8
	Northern Cape	Male	98	7.3	4.0	63	7.3	4.0	86	8.3	5.3
		Female	51	7.7	4.2	48	7.9	5.6	73	8.5	5.5
	Free State	Male	571	8.5	4.3	224	8.5	4.3	575	8.5	4.6
		Female	413	8.6	4.8	166	8.8	5.2	510	8.8	4.4

Table 5 (continued)

Criteria			OHS 95			OHS 96			OHS 97		
Child's gender	Province	Parent's gender	Number of pairs	Average Education of Child	Head of Household	Number of pairs	Average Education of Child	Head of Household	Number of pairs	Average Education of Child	Head of Household
Female	KwaZulu Natal	Male	1,484	9.0	5.0	672	8.8	4.6	1,224	8.5	4.4
		Female	1,254	8.5	4.2	626	8.6	4.4	1,641	8.5	4.1
	NorthWest	Male	582	8.7	4.6	298	8.2	4.4	648	8.2	3.8
		Female	456	8.3	4.1	241	8.1	4.2	721	8.2	4.0
	Gauteng	Male	495	10.1	7.6	509	9.8	6.6	818	9.8	6.7
		Female	328	9.8	6.3	448	9.5	6.5	615	9.3	6.1
	Mpumalanga	Male	976	8.5	3.5	294	8.5	3.6	709	8.7	3.6
		Female	503	8.3	3.3	204	8.3	2.8	636	8.3	3.0
	Limpopo	Male	222	9.5	4.9	424	8.7	3.6	648	9.0	4.2
		Female	156	8.8	2.9	607	8.9	2.4	1,031	8.6	3.1

Table 5 Descriptive statistics of the Pseudo-Panel cells for blacks (continued)

Criteria			OHS 98			OHS 99		
Child's gender	Province	Parent's gender	Number of pairs	Average Education of Child	Head of Household	Number of Pairs	Average Education of Child	Head of Household
Male	Western Cape	Male	108	8.8	6.3	70	8.8	6.1
		Female	68	9.2	6.5	78	8.2	6.6
	Eastern Cape	Male	443	7.5	4.3	607	7.8	4.9
		Female	549	7.1	4.9	722	7.4	5.1
	Northern Cape	Male	88	8.5	3.9	65	7.8	4.9
		Female	62	7.8	5.2	84	8.2	5.3
	Free State	Male	288	8.6	4.4	316	8.5	4.5
		Female	256	8.3	4.5	322	8.4	4.3
	KwaZulu Natal	Male	515	8.5	4.5	748	8.1	4.4
		Female	585	7.9	4.4	748	7.9	4.1
	NorthWest	Male	400	8.2	3.7	503	8.2	4.6
		Female	367	7.7	4.5	437	7.9	4.6
	Gauteng	Male	386	9.5	7.2	535	9.8	7.3
		Female	310	9.0	6.0	443	9.2	6.4
	Mpumalanga	Male	359	8.4	3.3	461	8.7	4.0
		Female	314	8.3	3.0	456	8.5	3.3
	Limpopo	Male	420	8.3	3.2	589	8.9	4.8
		Female	537	8.1	2.8	741	8.6	3.7
Female	Western Cape	Male	98	9.4	6.3	94	9.2	5.6
		Female	111	9.6	7.5	107	9.0	5.8
	Eastern Cape	Male	464	8.6	4.4	550	8.8	4.8
		Female	569	8.2	4.5	685	8.5	5.1
	Northern Cape	Male	86	8.8	3.4	70	7.9	3.5
		Female	70	8.2	5.5	74	8.7	5.1
	Free State	Male	316	8.9	4.7	362	8.8	4.3
		Female	282	8.6	4.5	344	8.9	4.4

Table 5 (continued)

Criteria			OHS 98			OHS 99		
Child's gender	Province	Parent's gender	Number of pairs	Average Education of Child	Head of Household	Number of Pairs	Average Education of Child	Head of Household
Female	KwaZulu Natal	Male	595	8.8	4.3	711	8.8	4.3
		Female	717	8.5	4.2	865	8.4	4.5
	NorthWest	Male	434	8.4	4.1	472	8.3	4.0
		Female	402	8.2	4.7	486	8.7	4.9
	Gauteng	Male	360	10.0	7.1	518	10.3	7.2
		Female	334	9.7	6.4	445	9.6	6.2
	Mpumalanga	Male	375	8.7	3.6	474	8.7	3.8
		Female	354	8.7	3.1	500	8.9	3.3
	Limpopo	Male	392	8.6	3.8	557	9.3	5.1
		Female	650	8.9	3.3	702	8.9	3.6

Table 6 Estimates using individual survey data for blacks

Dependent variable: Number of years of education of a child							
Explanatory variables	Full sample	Male children quartile			Female children quartile		
		First	Second	Third	First	Second	Third
Years of education of household head	0.228*** (0.003)	0.293*** (0.008)	0.230*** (0.007)	0.137*** (0.005)	0.265*** (0.008)	0.222*** (0.005)	0.125*** (0.004)
Child's age	−0.026*** (0.002)	−0.031*** (0.003)	0.012*** (0.003)	0.062*** (0.002)	−0.044*** (0.003)	0.006*** (0.002)	0.064*** (0.001)
Child is a female	0.454*** (0.021)						
Number of children in the household	−0.014** (0.006)	−0.016 (0.013)	−0.025** (0.010)	−0.028*** (0.009)	0.006 (0.012)	−0.003 (0.007)	−0.010 (0.006)
Female head of household dummy	−0.249*** (0.036)	−0.272*** (0.073)	−0.346*** (0.059)	−0.330*** (0.049)	−0.269*** (0.067)	−0.226*** (0.040)	−0.254*** (0.036)
Female head of household dummy times number of years of education of the household head	0.027*** (0.005)	0.013 (0.012)	0.020** (0.010)	0.020** (0.008)	0.050*** (0.011)	0.028*** (0.007)	0.025*** (0.006)
Child lives in the rural area	−0.299*** (0.021)	−0.302** (0.049)	−0.235*** (0.041)	−0.234*** (0.034)	−0.313*** (0.045)	−0.249*** (0.028)	−0.124*** (0.025)
Province of residence of the child[a]							
Eastern Cape	−1.133*** (0.037)	−1.662*** (0.091)	−1.524*** (0.074)	−1.021*** (0.062)	−1.073*** (0.085)	−0.965*** (0.052)	−0.561*** (0.046)
Free State	−0.555*** (0.043)	−0.672*** (0.109)	−0.591*** (0.089)	−0.245*** (0.074)	−0.790*** (0.099)	−0.559*** (0.060)	−0.384*** (0.054)
KwaZulu/Natal	−0.565*** (0.035)	−0.650*** (0.089)	−0.493*** (0.073)	−0.246*** (0.061)	−0.726*** (0.081)	−0.385*** (0.050)	−0.167*** (0.045)
Limpopo	−0.034 (0.041)	−0.021 (0.101)	0.154* (0.082)	0.213*** (0.067)	−0.272*** (0.093)	−0.006 (0.057)	0.076 (0.050)
Northern Cape	−1.236*** (0.089)	−1.469*** (0.193)	−1.239*** (0.158)	−0.474*** (0.130)	−1.461*** (0.181)	−1.195*** (0.110)	−0.561*** (0.098)
North West	−0.837*** (0.043)	−1.080*** (0.102)	−0.810*** (0.084)	−0.290*** (0.069)	−1.012*** (0.093)	−0.592*** (0.057)	−0.261*** (0.051)
Mpumalanga	−0.345*** (0.043)	−0.546*** (0.103)	−0.150* (0.084)	0.157** (0.069)	−0.663*** (0.094)	−0.359*** (0.057)	−0.041 (0.051)
Western Cape	−0.493*** (0.064)	−0.828*** (0.173)	−0.726*** (0.141)	−0.512*** (0.116)	−0.361** (0.152)	−0.355*** (0.093)	−0.212*** (0.083)

Table 6 (continued)

Dependent variable: Number of years of education of a child							
Explanatory variables	Full sample	Male children quartile			Female children quartile		
		First	Second	Third	First	Second	Third
Year of the October Household Survey[b]							
1996	−0.124*** (0.035)	−0.223*** (0.081)	−0.128* (0.066)	−0.031 (0.055)	−0.168** (0.074)	−0.104** (0.045)	0.002 (0.040)
1997	−0.283*** (0.029)	−0.438*** (0.068)	−0.419*** (0.056)	−0.219*** (0.046)	−0.201*** (0.062)	−0.188*** (0.038)	−0.125*** (0.034)
1998	−0.116*** (0.034)	−0.306*** (0.080)	−0.214*** (0.065)	−0.140*** (0.054)	−0.015 (0.072)	−0.014 (0.044)	−0.039 (0.025)
1999	−0.056* (0.032)	−0.344*** (0.074)	−0.307*** (0.061)	−0.128*** (0.050)	−0.135** (0.068)	−0.093** (0.042)	0.025 (0.037)
Constant	8.794*** (0.065)	7.115*** (0.149)	8.419*** (0.119)	9.274*** (0.093)	7.833*** (0.140)	8.708*** (0.082)	9.310*** (0.069)
Number of observations	83,171	40,233	40,233	40,233	42,938	42,938	42,938
R2 (Pseudo R2)[c]	0.134	(0.093)	(0.064)	(0.044)	(0.088)	(0.061)	(0.043)

The numbers in parenthesis are the standard error
*The parameter is statistically different from 0 at the 10% level
**The parameter is statistically different from 0 at the 5% level
***The parameter is statistically different from 0 at the 1% level
[a]The reference province is Gauteng
[b]The reference year is 1995
[c]The pseudo-R square is for the estimates by quartile

Table 7 Estimates using individual survey data for whites

Dependent variable: number of years of education of a child							
Explanatory variables	Full sample	Male children quartile			Female children quartile		
		First	Second	Third	First	Second	Third
Years of education of household head	0.188*** (0.018)	0.180*** (0.030)	0.178*** (0.021)	0.108*** (0.014)	0.144*** (0.035)	0.173*** (0.019)	0.111*** (0.016)
Child's age	0.085*** (0.007)	0.126*** (0.012)	0.152*** (0.006)	0.132*** (0.003)	0.090*** (0.012)	0.114*** (0.005)	0.111*** (0.003)
Child is a female	0.073 (0.051)						
Number of children in the household	−0.077*** (0.024)	−0.148*** (0.049)	−0.058 (0.037)	−0.059** (0.025)	−0.104* (0.058)	−0.085** (0.034)	0.000 (0.029)
Female head of household dummy	−1.795*** (0.518)	−2.312** (0.944)	−2.473*** (0.628)	−2.277*** (0.418)	−2.554*** (0.840)	−2.269*** (0.463)	−1.333*** (0.404)
Female head of household dummy times number of years of education of the household head	0.147*** (0.045)	0.172** (0.083)	0.189*** (0.055)	0.195*** (0.037)	0.218*** (0.073)	0.185*** (0.040)	0.111*** (0.035)
Child lives in the rural area	0.068 (0.090)	0.142 (0.171)	0.156 (0.121)	0.065 (0.080)	−0.059 (0.218)	−0.107 (0.125)	0.000 (0.106)
Province of residence of the child[a]							
Eastern Cape	−0.148* (0.089)	−0.356* (0.204)	−0.178 (0.144)	−0.059 (0.096)	−0.387* (0.227)	−0.170 (0.126)	−0.111 (0.108)
Free State	−0.371*** (0.110)	−0.630*** (0.197)	−0.423*** (0.139)	−0.132 (0.093)	−0.275 (0.228)	−0.004 (0.127)	−0.111 (0.109)
KwaZulu/Natal	0.000 (0.098)	−0.215 (0.189)	−0.006 (0.133)	0.072 (0.088)	−0.059 (0.218)	0.114 (0.122)	0.111 (0.101)
Limpopo	−0.455*** (0.150)	−1.007*** (0.306)	−0.203 (0.218)	−0.108 (0.145)	−0.468 (0.394)	−0.332 (0.221)	−0.222 (0.181)
Northern Cape	−0.356*** (0.115)	−0.627** (0.251)	−0.303** (0.176)	−0.238** (0.116)	−0.495 (0.306)	−0.520*** (0.170)	−0.444*** (0.145)
North West	−0.248** (0.098)	−0.569** (0.247)	−0.619*** (0.167)	−0.245** (0.111)	−0.225 (0.288)	−0.273* (0.160)	0.000 (0.128)
Mpumalanga	−0.298*** (0.094)	−0.451** (0.213)	−0.277** (0.151)	−0.107 (0.100)	−0.189 (0.244)	−0.351*** (0.137)	−0.333*** (0.116)
Western Cape	−0.135* (0.074)	−0.482*** (0.152)	−0.085 (0.107)	0.059 (0.071)	−0.297* (0.176)	−0.148 (0.098)	−0.111 (0.082)

Table 7 (continued)

Dependent variable: number of years of education of a child							
Explanatory variables	Full sample	Male children quartile			Female children quartile		
		First	Second	Third	First	Second	Third
Year of the OHS[b]							
1996	0.014 (0.074)	−0.133 (0.174)	−0.100 (0.122)	0.059 (0.081)	0.239 (0.201)	0.170 (0.112)	0.111 (0.095)
1997	−0.186** (0.074)	0.083 (0.151)	0.215** (0.107)	−0.120* (0.070)	−0.045 (0.173)	0.055 (0.097)	−0.111 (0.081)
1998	−0.062 (0.073)	0.113 (0.161)	0.120 (0.114)	−0.251*** (0.076)	0.315* (0.188)	0.004 (0.106)	−0.111 (0.081)
1999	0.170** (0.077)	−0.003 (0.152)	0.047 (0.107)	−0.072 (0.072)	0.306* (0.179)	0.258*** (0.099)	0.222*** (0.084)
Constant	7.128*** (0.291)	5.754*** (0.499)	6.104*** (0.325)	8.182*** (0.206)	6.572*** (0.536)	7.030*** (0.287)	8.444*** (0.239)
Number of observations	6,048	3,249	3,249	3,249	2,799	2,799	2,799
R2 (Pseudo R2)[c]	0.115	(0.096)	(0.121)	(0.021)	(0.074)	(0.107)	(0.026)

The numbers in parenthesis are the standard error
*The parameter is statistically different from 0 at the 10% level
**The parameter is statistically different from 0 at the 5% level
***The parameter is statistically different from 0 at the 1% level
[a]The reference province is Gauteng
[b]The reference year is 1995
[c]The pseudo-R square is for the estimates by quartile

is likely to face when education decisions are made. These three criteria yield 36 cells per survey, for a total of 180 observations. The sample statistics for the 36 cells and five OHS, using only the sample of blacks, are reported in Table 5. As expected, the pseudopanel exhibits similar characteristics to the cross-sectional data.

One could argue in favor of more, or different, criteria to construct the cells. One such criterion could be if the children live in urban or rural areas. Doing so would give us 72 cells per survey. However, in that case, the density of the cells is too small and we cannot use additional criteria like the region of residence or the children's age. Nevertheless, as a mitigating factor, these characteristics are included as explanatory variables. However, it would be of interest in future work to investigate the extent to which the results obtained from pseudopanel data are robust to using different criteria to construct the cells.

We estimate Eq. 10 by (1) OLS, (2) including a fixed effect for each cell, (3) including a random effect for each cell, (4) using the estimator proposed by Deaton (1985), and (5) the estimator derived by Verbeek and Nijman (1990). For the sake of comparison, we also estimate the intergenerational mobility of white South Africans by using cross sectional data only.

6 A discussion of the results

The OLS estimates of Eq. 7 obtained from cross-sectional data are reported in Table 6 for blacks and in Table 7 for whites. The estimates obtained from the ordered logit and probit are in Table 8 for blacks and Table 9 for whites. We then report the pseudopanel estimates, for blacks only, in Table 10. As the ordered logit and probit estimates are similar to the OLS and pseudopanel ones, we focus on the latter two for ease of exposition.

Overall, the model fits the data quite well and our estimates tend to validate Proposition 1. Children of more educated parents are more likely to achieve higher educational attainment. In fact, the estimates obtained by using cross-section data are very close to those of Borjas (1995) for the United States and other countries, as summarized in Table 1. Our estimate would indicate that, ceteris paribus, the convergence of education in the black population is not too different from what is observed elsewhere.

However, there are some important differences between blacks and whites. As expected, whites are, on average, more mobile than blacks. One additional year of parent schooling has a higher impact on the educational attainment of black than of white children. This result is consistent with whites having access to better schooling facilities, which allow them to better acquire education and be less constrained by their parental background. Moreover, when we allow the parameters to differ by the parents' educational quartile, we find that the poorest black children have the lowest intergenerational mobility. The same is not true for whites where, in fact, the estimate of intergenerational mobility does not differ much by parents' educational quartile.

The gender of the head of household matters for the child's education, irrespective of the specification. Ceteris paribus, black or white children in female-headed households acquire less education than those in male-headed households. This result may arise because females are among the poorest in South Africa (Bhorat et al. 2001). Consequently, female-headed households may face more severe

Table 8 Multinomial ordered logit and probit estimates for blacks

Dependent variable: number of years of education of a child		
	Oredered logit	Ordered probit
Number of years of education of the household head	0.134*** (0.002)	0.079*** (0.001)
Age of the child	0.000 (0.001)	−0.001** (0.001)
Child is a female	0.288*** (0.012)	0.155*** (0.007)
Number of children in the family	−0.010*** (0.003)	−0.006*** (0.002)
Household head is a female	−0.168*** (0.020)	−0.097*** (0.011)
Female head of household dummy times Number of years of education of the household head	0.014*** (0.003)	0.008*** (0.002)
Child lives in the rural area	−0.175 (0.013)	−0.108*** (0.007)
Province of residence of the child[a]		
Eastern Cape	−0.701 (0.023)	−0.389*** (0.013)
Free State	−0.366 (0.027)	−0.204*** (0.015)
KwaZulu/Natal	−0.301 (0.023)	−0.179*** (0.013)
Limpopo	−0.004* (0.026)	−0.007 (0.015)
Mpumalanga	−0.716 (0.052)	−0.417*** (0.029)
Northern Cape	−0.459 (0.027)	−0.267*** (0.015)
North West	−0.176 (0.027)	−0.103*** (0.015)
Western Cape	−0.338 (0.040)	−0.184*** (0.023)
Years of the OHS[b]		
1996	−0.060 (0.021)	−0.038*** (0.012)
1997	−0.173 (0.017)	−0.123*** (0.010)
1998	−0.072 (0.020)	−0.063*** (0.011)
1999	−0.062 (0.020)	−0.020* (0.011)
Number of observations	83,171	83,171
Pseudo-R square	0.028	0.029

The numbers in parenthesis are the standard error
*The parameter is statistically different from 0 at the 10% level
**The parameter is statistically different from 0 at the 5% level
***The parameter is statistically different from 0 at the 1% level
[a]The reference province is Gauteng
[b]The reference year is 1995

budget constraints and be unable to afford to educate their children. In addition, the latter may have to work to contribute to household expenses, in which case the children cannot attend school. It is of interest to note that children benefit more from one additional year of schooling if the head of the household is a female rather than a male. This result is similar to that of Schultz (1984) and has important policy implications. It means that education policies that target females would help not only the current generation climb out of poverty but also their children who are more likely to acquire more schooling.

We find that older black children are likely to be less educated than younger ones, while the opposite holds for white children. We attribute this to the distortions that we documented in Section 2. Therefore, as time goes by, and the distortions in the labor and education markets disappear, black children should accumulate more education. Hence, any measures that accelerate the pace at which those barriers are removed and improve the quality of schooling should have a positive effect on the

Table 9 Multinomial ordered logit and probit estimates for whites

Dependent variable: number of years of education of a child		
	Ordered logit	Ordered probit
Number of years of education of the household head	0.186*** (0.015)	0.106*** (0.009)
Age of the child	0.141*** (0.008)	0.059*** (0.004)
Child is a female	0.089* (0.046)	0.042 (0.027)
Number of children in the family	−0.098*** (0.022)	−0.063*** (0.013)
Household head is a female	−2.679*** (0.510)	−1.226*** (0.263)
Female head of household dummy times Number of years of education of the household head	0.219*** (0.045)	0.099*** (0.023)
Child lives in the rural area	0.060 (0.083)	0.042 (0.049)
Province of residence of the child[a]		
Eastern Cape	−0.237*** (0.089)	−0.125** (0.051)
Free State	−0.287*** (0.090)	−0.197*** (0.055)
KwaZulu/Natal	0.041 (0.088)	0.011 (0.051)
Limpopo	−0.448*** (0.146)	−0.302*** (0.083)
Mpumalanga	−0.320*** (0.083)	−0.201*** (0.049)
Northern Cape	−0.434*** (0.105)	−0.244*** (0.062)
North West	−0.325*** (0.096)	−0.195*** (0.058)
Western Cape	−0.184*** (0.069)	−0.102*** (0.040)
Year of the OHS[b]		
1996	0.033 (0.083)	0.022 (0.048)
1997	−0.102 (0.064)	−0.092** (0.037)
1998	−0.068 (0.065)	−0.044 (0.038)
1999	0.149** (0.075)	0.116*** (0.043)
Number of observations	6,048	6,048
Pseudo-R square	0.061	0.049

The numbers in parenthesis are the standard error
*The parameter is statistically different from 0 at the 10% level
**The parameter is statistically different from 0 at the 5% level
***The parameter is statistically different from 0 at the 1% level
[a]The reference province is Gauteng
[b]The reference year is 1995

quantity of education. In that respect, the recent policy to ensure universal access to education by removing the school fees barrier appears appropriate.

As expected, our estimates confirm that black children who live in the rural areas of South Africa are less mobile than their urban counterparts. This may occur because schools in rural areas are of poorer quality than those in urban areas. Moreover, children who live in rural areas must very often assist their parents on the farm or perform other activities to generate income for the household. In this case, the opportunity cost of education is higher in rural than in urban areas. This means that policies to bridge the education divide between the urban and rural sector should both address the provision of schooling and look into the means to complement parents' income when they send their children to school. The multivariate analysis confirms that rural whites do not accumulate less education than urban whites. Once again, this result may arise because whites that live in the rural areas are not necessarily poor and they have acquired good schooling facilities during the apartheid era.

Table 10 Pseudopanel estimates for blacks

Dependent variable: average number of years of schooling of children per cell					
Explanatory variables	Model (1) OLS	Model (2) Fixed effects	Model (3) Random effects	Model (4) Deaton	Model (5) Verbeek and Nijman
Years of education of household head	0.25*** (0.058)	0.27*** (0.065)	0.26*** (0.054)	0.25*** (0.001)	0.25*** (0.001)
Child's age	−0.11*** (0.035)	−0.11*** (0.030)	−0.11*** (0.027)	−0.03*** (0.000)	−0.27*** (0.000)
Child is a female	0.44*** (0.041)		0.43*** (0.548)	0.44*** (0.043)	0.44*** (0.043)
Number of children in the household	0.03 (0.099)	0.06 (0.091)	0.04 (0.087)	−0.01*** (0.001)	−0.01*** (0.002)
Head of household is a female	0.10 (0.180)		0.09 (0.233)	−0.05 (0.041)	−0.05 (0.041)
Head of household is a female times	0.00	0.05	0.01	−0.01***	−0.01***
Number of years of education of the household head	(0.044)	(0.101)	(0.049)	(0.001)	(0.001)
Rural sector density in the cell	−1.13*** (0.350)	−0.78* (0.435)	−0.98** (0.397)	−0.30*** (0.005)	−0.30*** (0.006)
Child's province of residence[a]					
Western Cape	−0.67*** (0.111)		−0.68*** (0.138)	−0.49*** (0.079)	−0.49*** (0.079)
Eastern Cape	−0.57** (0.267)		−0.64** (0.261)	−1.01*** (0.086)	−1.01*** (0.086)
Northern Cape	−1.19*** (0.111)		−1.17*** (0.147)	−1.20*** (0.110)	−1.20*** (0.110)
Free State	−0.35** (0.165)		−0.37** (0.166)	−0.48*** (0.060)	−0.48*** (0.060)
KwaZulu/Natal	−0.05 (0.292)		−0.13 (0.296)	−0.46*** (0.520)	−0.46*** (0.052)
North-West	−0.27 (0.252)		−0.33 (0.254)	−0.73*** (0.051)	−0.73*** (0.051)
Mpumalanga	0.18 (0.299)		0.12 (0.260)	−0.18*** (0.065)	−0.18*** (0.065)
Limpopo	0.55 (0.357)		0.46 (0.877)	0.11* (0.066)	0.11 (0.066)
Constant	10.31***(1.006)	9.86*** (0.999)	10.21***(0.877)	8.50*** (0.046)	8.50*** (0.047)
Number of observations	180	180	180	180	180
R-square	0.84	0.85	0.84	0.81	0.81

The numbers in parenthesis are the standard error. They are obtained by bootstrap for models 4 and 5
*The parameter is statistically different from 0 at the 10% level
**The parameter is statistically different from 0 at the 5% level
***The parameter is statistically different from 0 at the 1% level
[a]The reference province is Gauteng

Our pseudopanel estimates (Table 10) confirm most results obtained from cross-sectional data (Tables 6, 7, 8, and 9). Both Deaton's and Veerbeek and Nijman estimators yield an estimate of intergenerational education mobility that is almost identical to that obtained by using individual survey data (0.25 and 0.23, respectively). As explained in Section 4, the use of pseudopanel allows us to (1) account for unobserved cell effects, (2) deal with nonrandomness of the cross sectional sample, and (3) deal with potential correlation between the error term and the explanatory variables. These two effects potentially bias the estimate of intergenerational mobility. It appears that the different biases that arise from unobserved characteristics and possible measurement errors compensate each other. To that extent, our result is similar to that of Bonjour et al. (2003), who conclude that biases arising from measurement errors and unobserved abilities "roughly cancel each other out" (p 1809, Section 4).

Given the differences between the intergenerational mobility of blacks and whites, it appears that these unobservable characteristics do play an important role in children's educational attainment. This is not a surprising result because of the legacy of apartheid policies, which have persistent effects. Although, by definition, those characteristics cannot be observed in our data, we can conjecture that they include such factors as the opportunity cost of schooling, access to the credit market, the cost of schooling and the distance from the nearest school. Hence, education policies that aim to increase the speed at which black children acquire education are more likely to succeed if they can simultaneously address those constraints.

7 Conclusion

This paper estimates the determinants of intergenerational educational mobility among blacks and whites in South Africa. We pay particular attention to how unobserved community characteristics may affect the next generation's educational attainment. We first set up a simple two-period model where altruistic parents invest in their children's education. This allows us to formulate a series of testable hypotheses, namely, that better-educated parents should invest more in their children's education and that children who live in communities with better facilities should be better educated. We then specify an econometric model of human capital mobility. We discuss the impact of not accounting for unobserved family or community effects, and of assuming the specification is stable across different segments of the population. We use five independent OHS for the years 1995 to 1999 to estimate our model.

The magnitude of our estimate of black intergenerational mobility is close to the average of those found for other countries, while that for white intergenerational mobility is higher. We also find that the poorest black children have the lowest intergenerational education mobility but that this is not the case for whites. Moreover, intergenerational mobility is higher for black females than for black males. This reflects the unique characteristic of South Africa in that, contrary to other developing countries (Schultz 2002), black females are, on average, more educated than black males. However, ceteris paribus, a child benefits more from one additional year of schooling of a female than of a male head-of-household. Female children are the ones who benefit the most from one additional year of schooling of a female head-of-household. Finally, we find that those who live in rural areas accumulate

less schooling than those in urban areas. Moreover, these estimates of intergenerational education mobility are robust to accounting for unobserved household and community characteristics.

The estimates of black intergenerational education mobility obtained by using cross-section or pseudopanel data do not differ. This result may mean that, in the case of black South Africans, the different biases that arise when using cross-section data cancel each other. The difference in intergenerational mobility of black and white South Africans indicates that intergenerational mobility will occur at a faster pace if we can remove the barriers that households face in sending their children to school. These household-specific barriers include access to the credit market, as well as the cost and quality of schooling. Finally, we hope that panel data will be available in the future to verify the extent to which our results are robust.

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Appendix

A.1 Proof of Proposition 1

Consider a parent with h units of human capital who earns wages given by Eq. 2. Maximizing Eq. 6 with respect to e, we obtain the following first-order condition:

$$-\gamma u_c(Ah - \gamma e^* N) + f_e(e^*, h, \lambda) = 0. \tag{11}$$

Let

$$F(e^*, h, \lambda, \gamma, N) \equiv f_e - \gamma u_c. \tag{12}$$

Given the properties of the utility function, differentiating Eq. 12 with respect to each one of its arguments, we find that $F_{e^*} < 0$, $F_\gamma < 0$, $F_h > 0$, $F_N < 0$, and $F_\lambda > 0$. Therefore, the implicit function theorem applies, and there exists a function $e^*(h, \gamma, \lambda, N)$, which is such that Eq. 11 holds. Letting $j \in \{h, \gamma, \lambda, N\}$, it follows that $\partial e^*/\partial j$ is of the same sign as F_j.

A.2 Pseudopanel estimators

We explain the implementation of the pseudopanel estimators derived by Deaton (1985) and Verbeek and Nijman (1990) for our model given in Eq. 10. We form two groups of explanatory variables:

1. Time-varying

$$Z'_{ct} = \begin{bmatrix} \text{Head of household's schooling} \\ \text{Children's average age} \\ \text{Share of households living in the rural sector} \\ \text{Number of children in the household} \end{bmatrix}$$

2. Time-invariant. A dummy variable equals 1 if the

$$D'_{ct} = \begin{bmatrix} \text{Child is a female} \\ \text{Head of household is a female} \\ \text{Child lives in province } p \end{bmatrix}$$

where p is one of the nine provinces. It follows that D_{ct} is a (1×11) vector.

Using Z_{ct} and D_{ct}, we rewrite the DGP aggregated at the cell level as:

$$y_{ct} = Z_{ct}\Phi + D_{ct}\Theta + \gamma_c + \varepsilon_{ct}, \tag{13}$$

for $c = 1, \ldots, 36$, $t = 1, \ldots, 5$, Θ, and Φ are two vectors of parameters, γ_c is a cell fixed effect, and ε_{ct} is a mean-zero error term. The specification Eq. 13 does not include a constant because D_{ct} includes all nine provinces. We rewrite Eq. 13 in matrix form, for all 180 observations, as:

$$y = X\beta + \varepsilon \tag{14}$$

where β is a vector of parameter and X is the matrix of all explanatory variables.

Given that we use the sample averages in Eq. 13, y and Z are measured with errors. This is not the case for D, which includes only dummy variables. Deaton (1985) shows that if the aggregated fixed-effects and the explanatory variables are not correlated, and the number of observations per cell is sufficiently high, then OLS estimates of Eq. 13 are consistent. If the explanatory variables and the aggregated fixed effect are correlated, Deaton (1985) shows that the following estimator is consistent:

$$\widehat{\beta}_d = \left(X'X - 180\Sigma\right)^{-1}\left(X'Y - 180\sigma\right) \tag{15}$$

where $\Sigma = \text{var}[Z_{ct} \quad D_{ct}]$, σ is the covariance between the dependent variable and each explanatory variable and 180 is the product of the number of cells (e.g., 36) and OHS (e.g., 5).

The variances Σ and σ are estimated using the microsurvey data and are defined only for the variables that are measured with error. The covariances for time-invariant variables are equal to 0. It follows that all elements of the estimate $\widehat{\Sigma}$ equal 0, except for the first four rows and columns, which are given in the following symmetric matrix:

$$\begin{bmatrix} 16.70 & & & \\ -5.11 & 64.91 & & \\ -0.26 & -0.11 & 0.25 & \\ -0.26 & -3.45 & 0.06 & 3.84 \end{bmatrix}$$

Similarly, using the microsurvey data, we estimate the first four elements of $\hat{\sigma}'$ as:

$$[4.28 \quad -3.02 \quad -0.14 \quad -0.01],$$

while the 11 other elements equal 0.

However, Verbeek and Nijman (1990) show that Deaton's estimator is biased when the number of microsurveys used is small. Recall that T is the number of OHS and equals 5 in our case. They amend Eq. 15 and show that the appropriate consistent estimator is:

$$\hat{\beta}_{vn} = \left(X'X - \frac{180(T-1)}{T}\Sigma\right)^{-1}\left(X'Y - \frac{180(T-1)}{T}\sigma\right). \tag{16}$$

Substituting $\hat{\Sigma}$ and $\hat{\sigma}$ in Eqs. 15 and 16 gives consistent estimators of β. We then calculate the variance of the two estimators by performing 1,000 bootstrap replications.

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