RACIAL DISPARITIES IN SCHOOLING: EVIDENCE FROM CAPE-TOWN, SOUTH AFRICA

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DEDICATION

To the love of my life, Upender, for challenging me;

To our most amazing feline babies Kattan, Kitty and Gingi for always reminding us what we fight for;

To my late canine baby Meshi, for unconditional love and friendship;

To the brave warriors of the Animal Liberation Front; and

ABOVE ALL

To the anonynous victims of the Animal Holocaust,

who are tormented and murdered behind the closed doors of factory farms, labaratories and houses of slaughther.

WE WILL OPEN THE DOORS!

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ABSTRACT

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Racial disparities in education in South Africa have been large and enduring post-apartheid. However, moving beyond simple descriptions of these disparities to a more detailed explanation has proven to be elusive. In this dissertation, I develop and estimate a dynamic model of schooling and labor supply of youths in South Africa, and use it to study several potential explanations for the racial disparities and also evaluate policies aimed to mitigate them. The estimation is based on 1420 males age 12-22, drawn from Cape Area Panel Study (CAPS), a rich longitudinal study of the lives of youths in the post-apartheid era in metropolitan Cape Town, South Africa. I find that apartheid heritage explains 40% of the African-white gap in years of schooling, and 16% of the colored-white gap in years of schooling. My findings highlight the role of financial constraints in explaining racial disparities in education. I find that abolishing secondary school fees in all secondary schools will eliminate 49% of the schooling gap between African and whites and 42% of the schooling gap between coloreds and whites. On the other hand, eliminating school fees only in former (apartheid era) African secondary schools will have a small effect on African schooling and no effect on colored schooling. This finding suggests that in the South African context, financial constraints affect human capital primarily via school quality choices and not via school attendance decisions, casting serious doubts on the effectiveness of recent policies aimed to reduce tuitions in former African schools. The findings further suggest that financial constraints are more important at the secondary school level than they are at the college level. Abolishing college fees without altering secondary school fees will mostly benefit whites and will have a small effect on African and colored schooling.

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Chapter 1

Introduction

The South African education system has a legacy of gross inequality. Under the apartheid regime, the provision of education was segregated and unequal by design according to one's race or ethnic origin. The white minority had access to high quality public education, with modern schools, abundant resources and highly qualified teaching staff, whereas African schools were systematically deprived of all of the above. The colored population, which is heavily concentrated in Cape Town and the Western Cape Province, occupied an intermediate status between the African and the white populations, and, although better than African schools, colored schools were significantly inferior to white schools.

The decade following the end of the apartheid brought about tremendous change in South Africa's education system. The segregated system was unified into a single national race-blind system and numerous initiatives led the drive to equalize public expenditure among the former white, colored and African schools. However, it is widely recognized that these changes have not led to tangible improvements in educational outcomes for the majority of African and colored populations (Van der Berg 2002, Fiske and Ladd 2004). African and colored students perform abysmally

on international standardized tests even when compared with students from poorer African countries (Van der Berg, 2005, Crouch and Vinjevold, 2005). Repetition and dropout rates amongst African and colored students are high and matriculation rates low, with little evidence of improvement post-apartheid (Fiske and Ladd 2004).

Moving beyond simple descriptions of these disparities to a more detailed explanation has, however, proven to be elusive. In this dissertation, I provide quantitative evidence for the causes of these racial differences, and on the effects of several policy schemes designed to reduce them. In particular, I investigate to what extent these racial differences are due to (i) differences in access to quality education due to financial constraints, (ii) differences in preferences for schooling and work, (iii) labor market discrimination, and (iv) differences in observed and unobserved 'endowments', which, in the South African context reflect, in part, the heritage of the apartheid.

South Africa provides an interesting laboratory to examine the effects of school quality on educational outcomes and its impact on racial disparities. There is considerable evidence that despite the significant shift in fiscal resources in the post-apartheid era, quality differentials between former white, colored and African schools are still rampant, and have decreased little post apartheid (Van de berg 2007, Motala *et al.* 2009, Fiske and Ladd 2004, 2005). Furthermore, although education in South Africa is a constitutional right, it is generally not free, and schools are encouraged to charge fees both at the primary and at the secondary school levels. School fees vary greatly between schools. Fiske and Ladd (2004) find that although the median secondary school student in the Western Cape faces a fee of about 250 rand a year, close to 18 percent of the students face fees in excess of 2,000 rand a year, and more than 15 percent face fees which are less than 100 rand a year.[1] There is also a very

[1] The South African rand was traded at 10.3 per US dollar in August 2002, when CAPS Wave 1 began.

high correlation between the fees charged by the school and the school quality as reflected by school's former education department, with former white schools charging the highest school fees and former African schools charging the lowest school fees (Fiske and Ladd 2004).

In addition, research suggest that despite the promotion of race-blind policies, most African and colored students still attend formerly African and colored schools (Fiske and Ladd 2004). Because race and economic status, too, are highly correlated in South Africa (Van de berg 2007), it is important to understand how school quality affects educational outcomes, and whether and how financial constraints affect school choices of low income individuals.

To this end, I formulate and estimate a structural dynamic model of schooling and work decisions over the life cycle. In the model, starting at age 12, young adults make annual decisions about whether to attend school, work or stay at home (in college, decisions to attend school and work are not mutually exclusive). I consider three types of schools that represent three school qualities - former white schools, former colored schools and former African schools. It is assumed that everyone attends primary school and that the type of this school is an initial condition in the model. Individuals who complete primary school, then make decisions regarding their secondary school type, with same three options. As in Eckstein and Wolpin (1999), Arcidiacono (2004), Stange (2009) and Joensen (2008), individuals who attend school face uncertainty over their academic advancement. In this model, the probability to pass a grade in school also depends on the quality of school attended. Individuals cannot borrow to pay for their school fees during their secondary school phase and college, but conditional on school attendance, they receive transfers from their families, which they take as (weakly) exogenous. I explicitly control for both observed and unobserved sources of heterogeneity that may affect selection into different types of schools as well as

wage offers, school advancement probabilities and preference parameters. Permanent unobservable heterogeneity is incorporated in the form of two discrete types that are assumed to be known to the individual but unknown to the econometrician (Heckman and Singer, 1984). Wage offers represent a price paid to the human capital embodied in a person, and following Behrman and Birdsall (1983), Card and Krueger (1992a,b) and Bravo *et al.* (2010), I allow the returns to schooling to depend on the school attended. Labor market experience accumulates endogenously as a function of past labor supply choices. The model is estimated using maximum likelihood.

The estimation is based on 1420 young males drawn from Cape Area Panel Study (CAPS), a longitudinal study of the lives of youths and young adults in metropolitan Cape Town, South Africa. The data set, collected in four waves between 2002 and 2006 covers a wide range of outcomes, including schooling, employment, health, family formation, and intergenerational support systems. Critical to this study, CAPS contains retrospective data on work and schooling that allows the construction of a full yearly schooling and work history for all individuals in the sample from age 12 to 22. It also contains information on the type of primary and secondary school attended, and information on intergenerational school-related transfers.

The model builds on two main streams of literature: first - literature on the effects of financial constraints on educational outcomes and, second - literature on the impact of school quality on educational outcomes (see section 2 for comprehensive review of this literature). However this study extends the previous literature in several important dimensions.

First, unlike previous research that has investigated the impact of financial constraints on attendance and drop-out decisions of young adults, typically in their post-secondary education level (Lochner and Monge - Naranjo 2011), this study also investigates the effects of such constraints on decisions regarding the quality of the schools

individuals choose to attend. Furthermore, it focuses on an earlier phase of education – secondary school – in addition to post-secondary education.

Second, this study investigates the impact of school quality on grade advancement, an issue that has rarely been addressed. Several studies suggest that lower student test scores are associated with increased probability of grade repetition (Harbison and Hanushek 1992, Gomes-Neto and Hanushek 1994). That is, students in low quality schools may fail more grades because they have not learned as much as they progress through school. Analyzing the relationship between test scores and grade progression in post-apartheid South Africa, Lam *et al.* (2008) find significant effects of test scores in predicting grade progression for all race groups. However, they find that the relationship is weaker for African students than for white and colored students. These findings led the authors to suggest that these differences result, in part, from variation in schooling environments of different race groups. However, their analysis does not examine school environments, and thus does not offer empirical support for the proposed school quality effects. One study that explicitly examines the correlation between school quality and progress through school is Anderson (2000). Using South African 1995 October Household Survey, Anderson (2000) finds a correlation between school fees (used to proxy school quality) and the speed with which children advance through school. Students who are behind for their grade have less money spent on their school fees and on other school related expenses. However, the cross-sectional nature of the data does not allow disentangling whether students who have attended better (more expensive) schools throughout their lives fail less because of the school quality effect, or because students with higher skills come from families that invest more in their education. Using a panel data such as CAPS, I can address the issue of non-random selection of students into schools of different quality and to overcome bias issues that arise in cross sectional studies.

Furthermore, this study is one of the first to incorporate school quality measures into a structural dynamic model framework. To the best of my knowledge, only one study, Bravo *et al.* (2010), has so far incorporated school quality measures in a structural dynamic model approach. However, having only data on school attainment and school sector (which the authors use to proxy school quality), Bravo *et al.* (2010) consider only the effects of school quality on earnings. CAPS, on the other hand, contains detailed data on school advancement which allows me to extend the framework of Bravo *et al.* (2010) by considering the effects of school quality on grade advancement in addition to earnings. Bravo *et al.* (2010) find high returns to school quality. However, if school quality has also positive effect on advancement through school, one would expect students attending higher quality schools to complete more schooling and have higher school matriculation probabilities. The effects of school quality on grade advancement are thus likely to reinforce previous results, implying that a policy intended to improve the provision of quality schooling may have greater impact than suggested before.

In this dissertation I find marked differences amongst secondary schools of different quality. The estimates suggest that former white schools induce the highest enrollment (highest utility from attending schools), highest probability to pass a school grade and highest returns to years of schooling, while former African schools induce the lowest. Furthermore, the quality of a secondary school has pronounced impact also on progress through college, with individuals attending former white secondary schools having the highest probability to complete a grade in college, and individuals attending former African secondary schools having the lowest.

In addition to differences amongst schools, the estimates reveal important differences among races in their structural parameters. Africans receive the lowest wage offers for given schooling and employment histories, and whites the highest. This may

reflect discrimination in the labor market, i.e., lower skill rental prices for Africans and, to much lesser extent, for colored. Additionally, or alternatively, it may also reflect that Africans (and colored) have lower skill endowments at age 12 (independent of type). The estimates further indicate that Africans have the lowest representation amongst the 'high' skill endowment type, and whites the highest, which reflects, in part, the different treatments these three groups were exposed to during the apartheid era. In addition, white, colored and African young men differ in their preferences to leisure and schooling; coloreds receive the lowest utility value from leisure and whites the highest. Africans receive the highest utility value from attending secondary school, and whites receive the highest utility value from attending college.

I perform a number of counterfactual experiments to assess the relative importance of each factor. I find that there is no one single factor that can account for the entire gap in schooling outcomes amongst races. I further find that the same factors may have different impact on Africans and coloreds. For example, while age 12 initial endowments have a large contribution to the African-white gap in schooling, their contribution to the colored-white gap in schooling is substantially smaller. I further find that although there are substantial differences in preferences for schooling and leisure amongst races, they do not contribute to the large racial gap in schooling. Surprisingly, labor market discrimination, too, mitigates racial disparities in education, especially for Africans, because with less attractive labor market opportunities individuals stay longer in school.

The structural framework also permits an evaluation of the importance of financial constraints and the potential success of alternative monetary interventions to influence schooling of African and colored young men, and to mitigate racial disparities in education amongst the three races. Abolishing secondary school fees in all three school systems has a very large effect on African and Colored youth, though only small effect

on whites. The simulation suggests that with this intervention, all individuals would choose to attend former white secondary schools. Due to increased enrolment levels and faster progression through schools, by the age of 23, African men complete, on an average, 11.86 years of schooling, colored men complete 11.67 years of schooling, and white men complete 13.38 years of schooling (an increase of 1.4, 1.2 and 0.08 years, respectively). Abolishing school fees only in former African and former colored secondary schools has a substantial effect on Africans; with this change 98% of them attend former colored schools, and they complete on average 11.10 years of schooling. It would have a moderate effect on colored; an increase of 0.25 years of schooling, but no effect on whites. Abolishing schools fees only in former African secondary schools will have a small effect on Africans (an increase of 0.09 years of schooling), and no effect on colored and whites. Lastly, abolishing school fees at the post-secondary school level without altering secondary school fees will mostly benefit whites (average increase of 0.13 years of schooling), and will have a smaller effect on Africans and coloreds, suggesting that intervention at post-secondary school level will only reinforce the already overwhelming racial gap in education, while intervention at the secondary school level can dramatically decrease racial gaps in education.

These results have important implications for the debate over school fees in South Africa and in other developing countries. South Africa's decision to permit schools to impose compulsory fees on their students was made at a time when other African countries such as Ethiopia, Ghana, Kenya, Malawi, Mozambique and Uganda started moving in the opposite direction by abolishing primary school fees. The principal argument in the literature for abolishing fees is that they are a major cause of non-enrollment among the poor, and, indeed, many African countries experienced a sharp surge in enrollment following their abolishing of primary school fees (World Bank, 2009). Sensitive to this critique, the South African government passed the Education

Laws Amendment Act No. 24 in 2005 to allow the Minister of Education to declare some schools no-fee schools, especially those serving poverty-stricken communities. No-fee school policy implementation started at the beginning of 2007 and the policy is implemented mainly in formerly African schools in the poorest provinces of South Africa. However, the results from the model simulations indicate that a policy that abolishes school fees only in former African schools does little to increase enrollment and to mitigate racial disparities in education. This research, thus, casts serious doubts on the common policy debate about perceived trade-offs between wide access to schooling opportunities and the development of high-quality schools. Addressing the issues of school quality differentials across different types of schools and of segregation induced by large disparities in prices are crucial for achieving racial equality in education.

The rest of the dissertation is organized as follows. Section two discusses the existing literature and reviews the South-African education system during the apartheid and its heritage post-apartheid. Section three describes the model and the estimation approach. Section four presents the data, and section five presents the empirical results. Section six presents the counterfactual experiments and section seven concludes.

Chapter 2

Literature Review

2.1 Summary of Literature on School Quality

2.1.1 School Quality and Educational Outcomes

Quantity of schooling is easily measured, and data on school attainment are readily available. Quality, on the other hand, is harder to measure. Thus, one of the challenges in estimating the impact of school quality on human capital accumulation has simply been how to measure quality. Most past analyses of human capital ignore any quality differences across schools, essentially assuming that a year of schooling is a year of schooling irrespective of the school's quality. Some researchers have however attempted to capture school quality using different approaches.

One approach adopted in prior research is to use test scores as proxies for school quality. Mounting evidence testify to the importance of test scores in understanding schooling outcomes. For instance, Rivkin (1995) finds that variations in test scores capture a considerable proportion of the systematic variation in high school completion and in college continuation, and that test score differences can fully explain black-white differences in schooling in the U.S. Bishop (1991) and Hanushek *et al.* (1996)

find that test scores are highly correlated with school attendance, and Hanushek and Pace (1995) find that college completion is significantly related to higher test scores at the end of high school. However, this approach is likely to yield biased estimates for the effect of school quality because test scores are affected not only by school quality but also by other factors such as family background and individual ability differences.

A second approach to account for differences in school quality has been to use school input measures, such as expenditure per student, average class size or teacher credentials, in an educational production function approach. This approach has yielded mixed results and has been subjected to considerable criticism (Harbison and Hanushek 1992, Hanushek 1995, 1996, 2003). Hanushek (1996) notes that "three decades of intensive research leave a clear picture that school resource variations are not closely related to variations in student outcomes". He suggests that schools are characterized by widespread inefficiency and therefore, commonly used inputs measures are of little use, at least in the developed world context.

The situation is somewhat different for developing countries. Reviewing this literature, Hanushek (1995), Hanushek and Harbison (1992), Lockheed and Hanushek (1988) and Todd (2010) conclude that in the developing world context some inputs have been found to be consistently and significantly related to improvements in educational outcomes. This has also been true in the specific case of South Africa. Case and Deaton (1999) examine the relationship between student-teacher ratios and school outcomes immediately before the end of the apartheid government. Controlling for household background, they find strong and significant effects of student-teacher ratios on enrollment, on years of completed schooling, and on test scores for numeracy. Using 1996 South African census and two national surveys of school quality, Case and Yogo (1999) find that quality of schools, as proxied by student-teacher ratios, has a large and significant effect on educational attainment. Reducing the student-teacher

ratio by 10 students would, all else equal, increase completed schooling by 0.6 years.

Researchers have also exploited a related measure – the former education department of a school under the apartheid regime – as measure of its quality (Van der Berg 2007, Yamauchi 2011). As I describe in more detail in section 2.3, the segregated school system under the apartheid regime was intentionally designed to have striking differences in qualities between the schools meant for each of the races. These differences in school qualities have persisted post-apartheid, making former school departments a natural measure for school quality. Indeed, Van der Berg (2007) finds that racial composition of schools, as a proxy for former school department, is a major explanatory factor in explaining matriculation rates of South African students in early 2000s. Similarly, using school level data from early 2000s, Yamauchi (2011) finds that racial composition of schools and the former apartheid department of education significantly affect school fees, which are linked to quality of education. I too use former school departments as a proxy for school quality.

Recently, researchers have attempted to infer school quality using longitudinal data of student educational outcomes. Rivkin *et al.* (2005) estimate the effect of teacher quality on performances of primary school students in the State of Texas. The authors exploit repeated performance observations for individual students and multiple cohorts using a fixed effect approach as a means of controlling explicitly for student heterogeneity and the nonrandom matching of students, teachers, and schools. They find that teacher quality (and therefore, school quality) matters greatly to student performances. A 'good' teacher (one standard deviation of quality above the mean) as compared to the mean teacher quality would lead the average student to move up over four percentile points in a year, which means that if a student had a good teacher as opposed to an average teacher for five years in a row, the increased learning would be sufficient to close entirely the gap between a typical low-income student and

a higher-income student (i.e. one not on free or reduced lunch). Interestingly, they find that the effects of observable teacher and school characteristics are generally small and concentrated among younger students.

Educational outcome-based measures of school quality are also employed by Hanushek *et al.* (2008) to investigate how school quality affects drop-out decisions of primary school students in Egypt. Hanushek *et al.* (2008) estimate variations in school quality, based on student outcomes in different schools and then use the estimates of school quality as a potential determinant of dropout behavior. They find that with the individual's own ability and achievement held constant, a student attending a higher-quality school will tend to stay in school, whereas a student attending a lower-quality school is more likely to drop out and complete fewer grades. Furthermore, they find that bringing all schools up to the best-quality school would reduce the dropout rate estimated in their sample by two-thirds or more.

2.1.2 School Quality and Earnings

Much of the prior research has not considered the direct impact of school quality on earnings. Most attention has been, and still is, directed at the returns to years of schooling or school attainment. However, school quality is likely to have direct implications for cognitive skills, and thus, for earnings. There is consistent evidence that cognitive skills, as measured by test performance, are closely related to individual productivity and earnings in the U.S. (e.g., Mulligan 1999, Murnane *et al.* 2000, Lazear 2003). Similar results have been shown in studies for other developed and developing countries, though the evidence from these countries is fairly limited[1]. Studies that have explicitly examined the correlation between school quality and earnings suggest

[1]For studies in developing countries see: Boissiere, Knight, and Sabot (1985), Knight and Sabot (1990), Glewwe (1996), Angrist and Lavy (1997), Jolliffe (1998), Moll (1998), Vijverberg (1999), and Behrman, Ross, and Sabot (2008).

that there are high returns to school quality. Using earning data from U.S 1980 census, Card and Krueger (1992a) find that men who were educated in states with higher-quality schools have a higher return to additional years of schooling. Rates of return are also higher for individuals from states with better-educated teachers. In addition, Card and Krueger (1992b) find that improvements in the relative quality of black schools in the U.S explain 20 percent of the narrowing of the black-white earnings gap between 1960 and 1980.

Behrman and Birdsal (1983) were the first to extend the standard Mincerian approach to incorporate school quality measures in addition to quantity of schooling, and show that exclusion of school quality may upwardly bias the estimated returns to years of schooling. Hanushek *et al.* (2008) further suggest that inclusion of school quality may resolve the paradox of high premature school drop-out in developing countries. Though it is widely accepted that schooling in developing countries has a high payoff, especially for lower levels of schooling (e.g., Psacharopoulos 1994, Psacharopoulos and Patrinos 2004), if rate of return is based solely on quantity of schooling ignoring the big differences in school quality in developing countries, and if quality and quantity of schooling completed are positively correlated, then the estimates suggested by the literature are the returns for individuals who attend relatively high quality schools and complete more schooling, and they do not reflect the returns that an individual who only has the option of attending a lower quality school would receive had he completed schooling in a low quality school. Under this argument, individuals behave rationally in dropping out of low quality schools at an early age. However, Hanushek *et al.* (2008) use a standard static Mincerian earning model (augmented by achievements as a proxy for school quality), and thus, they do not offer empirical support for their proposed forward–looking strategic behavior.

To my knowledge, only one study, Bravo *et al.* (2009), has so far incorporated

school quality measures in a structural dynamic model approach. Bravo *et al.* (2009) estimate a dynamic behavioral model of schooling and labor force participation decisions to study the effects of school vouchers on educational outcomes and earnings in Chile. They allow the returns to schooling to depend on the type of primary and secondary school attended (municipal school, private subsidized school and private non-subsidized school), and on whether attendance took place in the pre-or-post school voucher regime (Chile started its voucher program in 1980), thus allowing changes in the quality of schooling due to the change in the regime. Their findings suggest that returns to schooling are lowest in municipal schools and are highest in the private nonsubsidized schools, and that the reform improved the quality of primary schools, but not that of secondary schools. They further show that the voucher reform altered school choices of individuals who move away from low quality municipal schools, and that with vouchers, individuals achieve higher educational attainment levels and higher high-school and college graduation rates. These findings support the importance of school quality in determining educational outcomes of students, though, interestingly, the authors find that the voucher reform did not lead to increased overall mean wages in spite of increased school attainment partially because the reform decreased the returns to secondary schooling.

2.2 Summary of Literature on Financial Constraints

2.2.1 Financial Constraints and School Outcomes

One of the key issues in economic research on education is the extent to which financial constraints affect school outcomes of children from low-income families. Although there is clear evidence that family income is strongly correlated with school outcomes, there are different interpretations of what that correlation means. One interpretation

is that low-income families cannot afford to pay tuition and other costs of education, a problem that could potentially be solved through fee reductions or financial aid. Another interpretation is that there are long-term educational disadvantages from growing up in a low-income family and reduced tuition or financial aid will not be sufficient to compensate for the cumulative educational disadvantage faced by students from low-income families.

Summary of studies in the U.S.

Considerable research has analyzed the effects of financial constraints on educational outcomes in the United States, primarily focusing on attendance and drop-out decisions of individuals in post–secondary education. Studies based on the 1979 cohort of the National Longitudinal Survey of Youth (NLSY) generally suggest that financial constraints play a marginal role in explaining lower college attendance of individuals from low income families in the 1980s. Cameron and Heckman (1998, 1999), for instance, find a strong positive association between current family income and the probability of college attendance conditional on high school graduation, even after controlling for the effects of dynamic selection on unobservables. However, that association between family income and college attendance is becoming very small and statistically insignificant after controlling for adolescence Armed Forces Qualification Tests (AFQT), suggesting that skills and early life resource disadvantage and not short term liquidity constraints are driving the educational gap in college attendance between rich and poor in the U.S. Carneiro and Heckman (2002) also estimate small differences in college enrollment rates and other college-going outcomes by family income after accounting for differences in family background and AFQT scores.

These results are further corroborated by Cameron and Taber (2004) and Keane and Wolpin (2001). Cameron and Taber (2004) use the NLSY 1979 cohort to estimate

a lifecycle model with a discrete set of schooling options to test different discount rates in schooling choices. Evidence that some individuals face high interest rates relative to others would imply that borrowing constraints distort their education decisions. However, they find no evidence of discount rate heterogeneity in their sample. Keane and Wolpin (2001), on the other hand, suggest that financial constraints are tight (less than one-third the estimated cost of a single semester of post-secondary school) and are often binding for the NLSY 1979 cohort, but they too conclude that they do not distort schooling decisions. This surprising result is obtained because low-income students respond to their financial constraints by increasing their labor and reducing consumption. Simulating a policy that increases college loan limits, Keane and Wolpin (2001) find that such a policy will reduce work and increase consumption among previously constrained students, but will have a negligible effect on college attendance.

However, some research suggests that financial constraints have become more important in late 1990's and early 2000's.[2] Belley and Lochner (2007) use the NLSY 1997 cohort and find that family income has become much more strongly correlated with college attendance for recent cohorts. Youth from high income families in the NLSY97 are 16 percentage points more likely to attend college than are youth from low income families, conditional on AFQT scores, family composition, parental age and education, race/ethnicity, and urban/rural residence. Further evidence of financial constraints in the U.S. is provided by Lovenheim (2011). Lovenheim (2011) uses data from the Panel Survey of Income Dynamics to estimate the impacts of exogenous changes in housing wealth (driven by local housing booms and busts) on post-secondary enrollment decisions. He estimates that increases in house values

[2] Ellwood and Kane (2000) argue that college attendance differences by family income were already becoming more important by the early 1990s.

caused increased college attendance among families that would otherwise have been constrained. He also finds that the impacts of housing wealth have become more important in the 2000s.

Determining the effects of financial constraints on education is challenging because standard data do not provide a direct way of identifying which students are credit constrained. Stinebrickner and Stinebrickner (2008) overcome this problem by developing a survey to directly address these issues. Students at Berea College, a unique college in Kentucky that offers a full tuition subsidy and large room and board subsidies to all of its student, were asked if they would borrow more money (and how much) if a 'fair interest' loan was possible. Students are defined to be 'credit constrained' if they self-reported a desire to borrow more for college. The authors find that financial constraints have a non-trivial effect on students who are constrained. Their estimates indicate that between 40% and 48% of the drop-out rate of constrained students should be attributed to the constraint. However, they find that the relative number of credit constrained students is small. Their results thus suggest that the large majority of college attrition (which is significant at Berea) would remain even if students are given free access to loans (in addition to the current generous fee and board subsidies), and that factors other than borrowing constraints explain more than 85% of the dropout rate at Berea College. These results corroborate an earlier study that suggested that reasons unrelated to the direct cost of schooling are important in determining high attrition rates of students from low income families at Berea College (Stinebrickner and Stinebrickner 2003).[3] It should be noted, however,

[3]Stinebrickner and Stinebrickner (2003) analyze longitudinal data from Berea College, a unique liberal U.S college that provides a full tuition subsidy and large room and board subsidies to all entering students regardless of family background. They find that although the direct costs of schooling are approximately zero for all students in this college, a strong positive relationship remains between family income and the length of time that an individual remains at school, suggesting that reasons unrelated to the direct cost of schooling are important in determining high attrition rates of students from low income families.

that the study was conducted in one college which makes it difficult to extend the findings to other colleges in the U.S., and that the study is limited to examining the effects of financial constraints on drop-out decisions of students already enrolled in college, but not on college attendance decisions.

Brown, Scholz and Seshadri (2011) propose another way of identifying which youth may be credit constrained. They consider a model of intergenerational transfers with one-sided altruism: parents are assumed to care about their children and they are able to borrow freely. However, they cannot write enforceable loan contracts with their children, and, thus, may not want to transfer enough resources to satisfy the child's full demand for consumption and schooling at college ages. Their model assumes that youth would be borrowing constrained if they did not receive help from their parents, suggesting that one can distinguish between 'constrained' youth and 'unconstrained' youth based on the presence of post-secondary parental transfers. Using intergenerational data on educational attainment and family transfers for the U.S. during the 1970-1990, the authors find that a significant number - roughly 50% - of all youth in their sample are borrowing constrained. Moreover, they find that financial aid will have sharply different effects on parent-child pairs in the two regions of the model's equilibrium: for parents who make post-college transfers, additional financial aid should have negligible effect on educational attainment, because parents already make the efficient level of investment in their child's education. But children of parents who do not make post college transfers under-invest in education. For these children, an increase in financial aid will increase educational attainment; their estimates suggest that among 'constrained' youth, an additional $3,600 in aid increases average schooling levels by 0.2 years.

Surprisingly, despite extensive evidence that adolescent skill levels are important for subsequent schooling and lifetime earnings (see, e.g., Cameron and Heckman 1998,

Keane and Wolpin 1997, 2001, and Carneiro and Heckman 2002), very little research in the U.S. investigates the impact of financial constraints on educational outcomes other than for post-secondary education. Several recent studies show that exogenous increases in family income lead to improvements in early child development (e.g. Mogstad and Wiswall 2009, Duncan, Morris and Rodrigues 2011, Milligan and Stabile 2011). Financial constraints may play a crucial role explaining these findings. While generous government student loan programs are available for college education in the U.S., financial aid programs are typically not available for elementary or secondary education. Furthermore, even though elementary and secondary education is publicly provided, financial constrains may affect human capital not only via school attendance decisions, but via school quality choices, since the quality of public schools available to poor American families is often low, and high quality private schools and preschool programs are typically quite expensive.

This study has, therefore, implications beyond its specific context of South Africa. It contributes to the developing literature on financial constraints of school age children by explicitly investigating the impact of financial constraints on selection of children into secondary schools and into types of schools. I show that financial constraints are crucial at the secondary school level, not because they limit access to secondary education, but mainly because they force children from poor families to attend low quality schools. Moreover, I provide evidence that financial constraints at the secondary school level are more important than in the post-secondary education phase. Removal of school fees at the secondary school level will eliminate a substantial part of the racial gap in educational outcomes in post-apartheid South-Africa, but the effect of removal of fees at the post-secondary school level on schooling outcomes is very small.

Summary of Studies in Developing Countries

Developing countries often have large income inequalities and limited credit accessibility. Therefore, financial constraints may have strong implications on human capital accumulation in these countries. Nevertheless, most research on financial constraints in the developing world context has examined the link between financial constraints and child-labor, and direct evidence on the relevance of such constraints on schooling investment is limited.

Dehejia and Gatti (2002) use cross-country data on child labor to investigate the association between child labor and access to credit (as proxied by financial development) across countries. They find a significant negative and robust relationship between the two variables, which is particularly sizeable in poor countries. Guarcello *et al.* (2002) analyze the response of child labor to broadly defined income shocks (loss of employment, death in the family, droughts in the region, etc.) in Guatemala. They identify a sub-sample of credit-constrained households using information on denial of credit for households that applied and self-reported information on why a family was not able to apply for credit among non-applicants. They find that credit rationing is associated with higher child labor and that negative income shocks significantly increase the proportion of working children. Beegle *et al.* (2003) use panel data from Tanzania to identify the differential response of child labor to income shocks of households with credit access relative to those without. Their measure of credit access is collateralizable asset holdings, which they interact with income shocks in a household fixed-effects regression. The authors find that households protect themselves from adverse income shocks by varying their children's work hours, an effect which is mitigated when households have more collateralizable assets to secure access to credit. Among the most convincing empirical evidences of the impact of financial constraints on child labor is Edmonds (2006), who examines the change in child labor

in response to anticipated income changes. Theoretically, households that are not credit constrained should be able to borrow against known future increases in income and smooth child labor hours over time. Using the discontinuity introduced by the age-eligibility rule of a pension program in South Africa (which is large and highly anticipated), he finds that households with pension-eligible members decrease child work only after household members become eligible to receive the funds. His results suggest that households cannot borrow against even near guaranteed flows of future income to smooth child labor hours.

These results all point to child labor as one of the mechanisms that households use to smooth transitory income shocks and suggest that expanding access to credit might be effective in mitigating the prevalence of child labor. However, it is not obvious that there is a one-to-one trade-off between time spent in school and time spent working. Children who are not working are not necessarily enrolled in school and, in many cases, children combine schooling with work. Furthermore, hours in either activity may be sufficiently low on average that an increase in time spent in one activity will not crowd out time spent in another, as opposed to crowding out leisure time (Ravallion and Wodon 2000).

Several studies have directly investigated the impact of financial constraints on educational outcomes. Mimoun (2008) uses cross-country data on school enrolment, income inequality and credit accessibility from 19 OECD countries and 67 developing countries from 1970 – 2000. He finds that both income inequality and the development of credit markets are highly significant in explaining the international variance in school enrolment ratios in both secondary and post-secondary education.

Jacoby (1994) modifies a model developed by Ben–Porath (1967) to test the effects of credits constraints on grade completion in Peru. Grade repetition in Peru is tied directly to school attendance, because the country has instituted a grade pro-

motion policy where students were required to complete a given series of lessons to advance into the next grade rather than pass a set of exams. To obtain a test for borrowing constraints the sample was split to 'constrained' and 'not constrained' based on reported loan activities. The author finds that higher family income and durable goods holdings do not significantly enhance grade completion in households that are unconstrained, but they do in constrained households, supporting the hypothesis that unequal access to credit is indeed an important source of inequality in schooling investment.

Attanasio and Kaufman (2009) use data on subjective expectations to provide evidence on the importance of credit constraints in secondary and post-secondary schooling decisions in Mexico. They suggest that schooling should increase with expected returns. However, if the demand for schooling is constrained by some binding level of debt, then this relationship will no longer holds. Therefore, if one were to observe that the only youths for whom there is a positive relationship between expected returns and enrolment decisions, are those living with wealthier parents, then one would conclude that financial constraints might be playing an important role in determining who attends school. Their results points out towards the importance of financial constraints in college attendance decisions, but not in high school attendance decisions, which is consistent with higher costs for college and low availability of fellowships and loans at the higher education level in Mexico.

Solis (2011) exploits a natural experiment that produces random variation in credit access, to analyze the effects of financial constraints on enrollment and progress in college in Chile. Financing programs in Chile offer college tuition loans to students who: first, apply for benefits; second, belong to the lowest four income quintiles; and third, score above a certain cutoff in the national College Admission Test. Being barely above or below the cutoff is random in a small vicinity of the threshold.

Therefore, comparing college enrollment rates for the group just above (the treatment group) and the group just below (the control group) gives the causal effect of credit access on college enrollment. Using a regression discontinuity identification strategy, Solis (2011) finds that easing credit constraints by giving access to loans have tremendous impact on both enrollment in college and progress in college[4]. A Regression discontinuity identification approach is also used by Gurgand *et al.* (2011) to analyze the effects of loan access on college enrollment in South Africa in mid 2000's. They too find that financial constraints are substantial, as they decrease enrollment by more than 20 percentage points in a population of student loan applicants. Lam *et al.* (2010) on the other hand, use an indirect approach, similar to that of Carneiro and Heckman (2002) and show that controlling for scores on literacy and numeracy evaluation test reduces the apparent effect of baseline income on college enrollment, suggesting that reasons other than credits constraints explain the low enrollment level of individuals from poor families. The findings in this dissertation support those of Lam *et al.* (2010) for college attendance, though I suggest that financial constraints at the secondary school level are responsible for a substantial part of the racial gap in education in the sample.

[4]Students with loan access increase their enrollment probability by 21 percentage points, which is equivalent to a 133% increase in the enrollment rate of the group without access to loans. In addition, eligible students increase their probability of enrolling in a second year by 33 percentage points, and in a third year by 29 percentage points. Those numbers are equivalent to a 232% and 331% increase, respectively, when compared with the enrollment probability for the groups without access to loans.

2.3 South African School System and the Legacy of the Apartheid

During the apartheid, the provision of education was racially segregated. In Urban areas, four separate departments operated schools for each of the four main racial groups: white students were served by the House of Assembly (HOA), colored students by the House of Representatives (HOR), Indian students by the House of Delegates (HOD), and African students by the Department of Education and training (DET)[5]. In addition, there were ten departments operating schools for Africans in each of the ten homelands of South Africa. For most of the Apartheid era students were restricted to attending schools (including post-secondary schools) operated by their relevant department of education.

Not only were the education systems racially segregated, they were also very unequal. Although resources were lavished on schools serving white students, non-white (and in particular African) schools were systematically deprived of qualified teachers, physical resources and teaching aids. In addition, funds raising by parent bodies, including commercial sponsorships and school fees, enabled many white schools to add to their facilities, equipment and learning resources, and expand their range of cultural and sporting activities. At the peak of the apartheid, schools serving white students had more than 10 times the funding per student than schools serving African students (Fiske and Ladd 2005).

The government that won the first fully democratic election in 1994 quickly moved towards race-blind policies in both the structure and funding of public education.

[5]Due to the low percentage of individulas of Indian origin in the population, Indians are coded as 'colored' in CAPS. Consequentially, I consider three race groups - whites, colored and Africans and three types of school departments -former white, former colored and former African schools (that is, a colored school can be either HOR or HOD school).

South Africa's new constitution identified basic education as a right for all citizens and education was made compulsory up to age 15. It was the first time that any education had been compulsory for Africans.[6] Furthermore, the racially defined departments of education were replaced with a single national race-blind system that included nine newly established provinces that shared responsibility for primary and secondary education with the national government. Responsibility for post-secondary education was assigned exclusively to the national government. The national government also retained the responsibility to set national norms and standards related to the distribution of teacher slots and non-personnel spending across schools within provinces and to negotiate teacher salaries.

Under the new system, the federal government provides race-blind and 'equitable' shares of funding to all provinces based on a weighted formula computed from actual school enrollments and school-age children to ensure that "each province, regardless of its wealth, will be able to spend the same amount on education per student as any other province" (Fiske and Ladd 2004, p. 103).[7] Furthermore, the national norms regarding teacher slots and salaries and non-personnel spending have contributed greatly to reduced differences in public spending across schools serving students of different race within provinces. In 2001, for instance, spending on behalf of students in the former white schools in the Western Cape was about 28 percent higher than that for students in former African schools and about 6-7 percent higher than that for students in formerly colored schools (Fiske and Ladd 2005), compared with two and a half fold differential observed at the end of the apartheid period between white

[6] Nontheless, in the model, individuals younger than 15 are allowed not to attend school, since this is observed in the data.

[7] Data on public spending per learner show that although great progress was made between 1995 and 2001 in equalizing public spending across the country's nine new provinces, disparities still remain. In 2001, average per learner spending in the Western Cape province exceeded the national average by 30 percent, and by contrast, spending in Eastern Cape and Limpopo, South Africa's two most impoverished provinces, fell short the national average by 25 percent or more.

and African schools.

Nonetheless, the apartheid heritage is enduring and there are still striking differences between the qualities of the facilities of schools in the former white, colored and African schools. Yamauchi (2005) finds that even though most provinces took steps between 1996 and 2002 to increase the number of classrooms in the former African and colored schools, major shortfalls remain which translate to high student-teacher ratio in these schools. Colored and especially African schools also fall short in basic amenities such as water, telephone, electricity, libraries, media centers and computers (Fiske and Ladd 2005). Even more important are the striking differences in the qualification of teachers. By the end of the Apartheid, more than one in three teachers in schools serving non-whites was under-qualified. Although the proportions of under-qualified teachers dropped to one in five in 2001, this figure understates the disparities among schools, because many African and colored teachers received their training in low quality teacher colleges that have since been shut down because of their poor quality (Fiske and Ladd 2004).

Further complicating its quest for equality, in 1996, South Africa enacted the South African Schools Act – 1996, mandating that all schools elect school governing bodies that, by design, are dominated by parents. School governing bodies were given significant authority, from the setting of admissions policy and making admission decisions (subject to nondiscrimination requirements) to making recommendations to the provincial department of education regarding the appointment of teachers and staff. This act was a result of a political compromise; as apartheid began to wane in the late 1980's and early 1990's, the white government transferred ownership of the physical property of all white schools to the parents in these schools and granted them significant authority to run their schools as a means to preserve white privilege. Seeking the support of the minority white population, the new government decided

not to roll back control from these schools and, instead, granted local control to all schools in the country. The case was also made that local school control would benefit the non-white communities as well, because it would ameliorate the rooted distrust of non-whites towards the South African school system, traditionally viewed by them as an instrument of the apartheid.

The biggest controversy has risen around the provision that allowed school governing bodies to augment public funds by charging fees to parents:[8]

> "A governing body of a public school must take all reasonable measures within its means to supplement the resources supplied by the State in order to improve the quality of education provided by the schools to all learners at the school."

In other words, at the same time that public funds were being distributed more equally across schools, schools serving affluent communities were able to use revenues generated from parents to augment their public resources. Since 1996, when such schools were required to down-size their staff establishments, many have been able to recruit additional staff on governing body contracts, paid from the school fund. For instance, Fiske and Ladd (2004) find that in 2000, fee revenue permitted the former white schools in the Western Cape to augment their state-paid teaching staff by about 30 percent on average, and in some cases by more than 100 percent. By contrast, former African schools were able to augment their state-paid teaching staffs on average by less than 1 percent.

The fee policy was justified at the time on the ground that by helping to maintain school quality, school fees would keep the children of middle class families – regardless of their race – from leaving the public schools, thus providing continuing political

[8] South African Schools Act, 1996, p. 21.

support for the public education system and avoiding the creation of yet another segregated educational system in South Africa. Indeed, the policy achieved this goal. Private schools serve less than 3% of the student population in South Africa, and even in the richer province of Western Cape the figure is 3.1% (Fiske and Ladd 2004).

However, the policy failed to decrease segregation in the public school system, despite an additional policy adopted in 1998 that exempted qualified low-income families from fees. Although schools cannot lawfully discriminate against students based on their race, test scores or ability to pay fees, the fee policy gave incentives to schools to minimize the admission of low-income students to avoid substantial cross subsidies of such students by the more affluent parents (Selod and Zenou 2003). In 2001, only 2.5% of primary school students and 3.7% of secondary school students in South Africa received a partial or a full fee exemption, figures that rise to 4.1% and 5.7%, respectively, in historically white schools (Fiske and Ladd 2004). Consequently, African students continue to account for nearly 100 percent of the enrollment in the former African schools in the Western Cape, Colored - for 93% of the students in the former colored schools in the Western Cape, and white students - for 66% of the students in the former white schools in the Western Cape (Fisk and Ladd 2004).

Another evidence of lingering legacy of educational inequities from the apartheid era is the racial disparities in school outcomes. A series of cross-national standardized tests have shown that South African students are not internationally competitive (Van der Berg 2005, Crouch and Vinjevold 2005), and they are shown to have performed poorly even within Africa. However, in the midst of South Africa's poor performance on these international tests, there are pockets of international excellence that are strongly correlated with race. Similar disparities emerge from work analyzing matriculation exam results, in particular scores in mathematics and science (Van der Berg 2005, Bhorat and Oosthuisen 2006). Moreover, the post-apartheid school system is

characterized by high rates of grade repetition and lengthy school careers for African and colored youth (Lam, Ardington and Leibbrandt 2011), while African also experience low transitions from school to employment with only 37% of African males aged 21-22 reporting ever obtaining employment (Lam, Leibbrandt and Mlatsheni 2009).

Chapter 3

Model

I formulate a finite horizon dynamic discrete choice model of school decisions and labor market participation, where individuals choose every year from a finite set of mutually exclusive alternatives in order to maximize their discounted expected lifetime utility.

Every year, beginning at the age (a) of twelve, each individual makes a decision whether to attend school or not. If he attends school, he passes the school grade and accumulates the associated human capital with a probability that depends on his current state variables. It is assumed that individuals do not drop out of school if they do not attend school in a given year. The model allows for re-enrollment in school after spans of no enrollment as this behavior is observed in the data.

I consider three levels of education: primary education (pr), secondary education (sec) and post-secondary education (col). Individuals complete their primary education after passing eight years of schooling, secondary education after passing twelve years of schooling, and post-secondary education after passing sixteen years of schooling. Once individuals graduate from college, they can either work or stay at home.

I consider three types of primary schools: former African schools (det), former

colored schools (hor), and former white schools (hoa), i.e., $pr \in \{det, hor, hoa\}$. The type of primary school is an initial condition in the model as all individuals in the sample attended primary schools prior to age 12. Individuals are not allowed to change their school type during primary school (as this is very rare in the data). Once individuals complete their primary education, they can choose a secondary school, with the same three options as before, i.e., $sec \in \{det, hor, hoa\}$. School type decision is made only once, upon attending the first year of secondary education and it cannot be changed in the following years. Individuals incur a cost of transitioning from primary to secondary school that depends on the type of secondary school in relation to the type of primary school they attended. This cost can be thought of as capturing costs of transferring from one school system to another, facing a new environment, and traveling longer distances to get to a secondary school (since det, hor and hoa schools are geographically segregated). Let $s_a^{pr,j} = 1$ if individuals attend type j of primary school at age a, and $s_a^{sec,j} = 1$ if individuals attend type j of secondary school at age a, $j \in \{det, hor, hoa\}$. Similarly, let $s_a^{col} = 1$ if individuals attend college at age a (else the indicator variable is 0).

In addition to school choices, each individual makes a yearly decision whether to work or not at a given wage (w) offered to him. I assume that individuals can only work full time (i.e., 160 hours per month) and that the (ln) hourly wage offer is given by:

$$\begin{aligned} \ln w_a \;=\; & \alpha_0 + \alpha_1 * I\{type = high\} + \alpha_2 * colored + \alpha_3 * white + \\ & \alpha_4 * S_a^{pr} + \alpha_5 * S_a^{sec} + \\ & \alpha_6 * S_a^{sec} * I\{sec = hor\} + \alpha_7 * S_a^{sec} * I\{sec = hoa\} + \\ & \alpha_8 * S_a^{col} + \alpha_9 * H_a + \alpha_{10} * h_{a-1} + \alpha_{11} * a_a + \varepsilon_a^w \end{aligned} \tag{3.1}$$

I allow the wage to depend on unobserved type (*type*) to capture unobservable heterogeneity in human capital. Wage also depends on race (*colored* and *white* are race indicators that equal one if the individual is colored or white, respectively) to capture labor market discrimination or other differences in age 12 endowments that are correlated with race but are independent of type. This wage equation extends the standard Mincer equation as I allow the return from schooling to differ among human capital accumulated in primary (S^{pr}), secondary (S^{sec}) and post-secondary (S^{col}) school levels, as well as to differ among the three former school departments at the secondary school level. Furthermore, I allow for an additional sources of human capital for individuals who worked in the previous year ($h_{a-1} = 1$). At the beginning of each year, individuals observe the realization of the their wage shock, ε_a^w, and make a decision (h) whether to work at this given wage or not. Let $h_a = 1$ if individuals work at age a (else the indicator variable is 0). Work experience is accumulated endogenously according to the following rule:

$$H_{a+1} = H_a + h_a. \tag{3.2}$$

Individuals cannot simultaneously attend school and work during their primary and secondary education levels, but they can simultaneously work and attend college. Individuals who do not work and do not attend school at a given age are assumed to be at home and receive one unit of leisure. Individuals receive no leisure if they attend school or work.

Individuals accumulate human capital if they pass the grade they attended. The probability that they pass the school grade is given by:

$$prob(pass_a = 1) = \frac{\exp(X\tau_a)}{1 + \exp(X\tau_a)} \tag{3.3}$$

where for primary school:

$$X\tau_a = \tau_0^{pr} + \tau_1^{pr} * I\{type = high\} + \tau_2^{pr} * colored + \tau_3^{pr} * white + \tau_4^{pr} * House_a + \tau_5^{pr} * I\{NF_a = 1\} + \tau_6^{pr} * I\{NF_a \geq 2\} \quad (3.4)$$

for secondary school:

$$X\tau_a = \tau_0^{sec} + \tau_1^{sec} * I\{type = high\} + \tau_2^{sec} * colored + \tau_3^{sec} * white + \tau_4^{sec} * House_a + \tau_5^{sec} * I\{sec = hor\} + \tau_6^{sec} * I\{sec = hoa\} + \tau_7^{sec} * I\{NF_a = 1\} + \tau_8^{sec} * I\{NF_a \geq 2\} \quad (3.5)$$

and for college:

$$X\tau_a = \tau_0^{col} + \tau_1^{col} * I\{type = high\} + \tau_2^{col} * colored + \tau_3^{col} * white + \tau_4^{col} * House_a + \tau_5^{col} * I\{sec = hor\} + \tau_6^{col} * I\{sec = hoa\} + \tau_7^{col} * I\{h_a = 1\} + \tau_8^{col} * I\{NF_a = 1\} + \tau_9^{col} * I\{NF_a \geq 2\} \quad (3.6)$$

I denote NF the accumulated number of grades failed since age 12, and $House$ an indicator equals 1 if individuals co-reside with both biological parents. I allow the probability to pass a school grade to depend on parental co-residence to account for differences in household investment in young adult's education. For college students, I further allow the probability to pass a school grade to depend on whether the individuals work in parallel (and thus may have less time available to invest in their schooling), and on the type of secondary school they attended (because different types of secondary school may reflect different school skills and knowledge).

Parental co-residence is not a choice. Individuals reside with two biological parents

according to a draw from an exogenous probability rule. I assume that the probability of co-residing with two biological parents depends on individual's race, age and his lagged co-residence status:

$$prob(House_a = 1) = \frac{\exp(X\psi)}{1 + \exp(X\psi)} \tag{3.7}$$

where,

$$\begin{aligned} \exp(X\psi) &= \psi_0 + \psi_1 * I\{a \geq 17\} + \psi_2 * I\{a \geq 20\} + \psi_3 * House_{a-1} + \\ &\quad \psi_4 * colored + \psi_5 * white \end{aligned} \tag{3.8}$$

Conditional on school attendance, individuals receive positive school transfers (tr) from their households during their secondary and college schooling. School transfers depend on individuals' school level, their race and the characteristics of their households (co-residence status and schooling of household's head). The (ln) transfer equations for individuals at their secondary and college level are given by:

$$\begin{aligned} \ln tr_a^j &= \delta_0^j + \delta_1^j * s_a^j + \delta_2^j * House_a + \delta_3^j * colored + \delta_4^j * white + \\ &\quad \delta_5^j * I\{edu_z \geq 12\} + \varepsilon_a^{tr,j}, \quad \forall j = sec, col \end{aligned} \tag{3.9}$$

where edu_z is the schooling of the head of the household at age 12 and ε^{tr} is an age varying transfer shock.

I assume that individuals use the conditional transfers they receive from their households to pay their school tuitions and that they cannot borrow additional funds to pay towards tuitions. In college, individuals can supplement their conditional

school transfers with their work earnings. This implies that individuals in the model cannot attend secondary schools for which tuition fees are higher than the school transfers they receive from their households, and they cannot attend college schools for which college tuition exceeds the combined size of school transfers and wage earnings.

Individuals face the following budget constraint, which is assumed to be satisfied every year:

$$C_a = 12 * 160 * w_a * h_a + (tr_a^{col} - Tu_{col}) * s_a^{col} + \sum_{j=det,hor,hoa} (tr_a^{sec} - Tu_{sec}^j) * s_a^{sec,j} \quad (3.10)$$

where C is consumption, Tu_{sec}^j is tuition in type j secondary school, and Tu_{col} is college tuition. For primary school, tuition costs and school transfers cannot be identified separately from the utility parameter γ_0^{pr} in equation 3.12, so γ_0^{pr} represents utility net of tuition cost and school transfers.

Individuals derive utility from consumption, school attendance and leisure (L). Assuming the linearity of the preferences, I can write the periodic utility, u_a, as:

$$u_a = C_a + U_a^{pr} * \sum_j s_a^{pr,j} + U_a^{sec} * \sum_j s_a^{sec,j} + U_a^{col} * s_a^{col} + U_a^L * L_a \quad (3.11)$$

where the periodic utility from primary school U_a^{pr} is:

$$U_a^{pr} = \gamma_0^{pr} + \gamma_1^{pr} * I\{type = high\} + \gamma_2^{pr} * s_{a-1} \quad (3.12)$$

The periodic utility from secondary school, U_a^{sec}, is:

$$\begin{aligned} U_a^{sec} &= \gamma_0^{sec} + \gamma_1^{sec} * I\{type = high\} + \gamma_2^{sec} * colored + \gamma_3^{sec} * white + \\ & \gamma_4^{sec} * I\{sec = hor\} + \gamma_5^{sec} * I\{sec = hoa\} + \gamma_6^{sec} * s_{a-1} + \\ & \gamma_7^{sec} * I\{a \geq 18\} + \gamma_8^{sec} * I\{a \geq 20\} + \\ & \rho_1 * I\{pr = det\} * I\{sec = hor\} + \rho_2 * I\{pr = det\} * I\{sec = hoa\} + \\ & \rho_3 * I\{pr = hor\} * I\{sec = hoa\} + \varepsilon_a^{sec} \end{aligned} \tag{3.13}$$

where ρ-s represent transition costs from one type of primary schools to a different type of secondary school.

The periodic utility from college U_a^{col} is:

$$\begin{aligned} U_a^{col} &= \gamma_0^{col} + \gamma_1^{col} * I\{type = high\} + \gamma_2^{col} * colored + \gamma_3^{col} * white + \\ & \gamma_4^{col} * h_a + \gamma_5^{col} * s_{a-1} + \varepsilon_a^{col} \end{aligned} \tag{3.14}$$

and the periodic utility from leisure is:

$$U_a^L = \gamma_0^L + \gamma_1^L * I\{type = high\} + \gamma_2^L * colored + \gamma_3^L * white + + \varepsilon_a^L \tag{3.15}$$

where $\varepsilon_a = [\varepsilon_a^{pr}, \varepsilon_a^{sec}, \varepsilon_a^{col}, \varepsilon_a^L]$ are age varying preference shocks to primary schooling, secondary schooling, college and leisure, respectively.

The individual is assumed to maximize the present discounted value of lifetime utility from age twelve to sixty (A), which is the retirement age in South Africa. The choice set in each year consists of a subset of the discrete alternatives given by the Cartesian product $s\ X\ h$. Denoting the choice of the k^{th} element of this set as $d_a^k = 1$ (and the choice of any other element as $d_a^k = 0$), $k = 1, ..., K$, and the utility

associated with that choice as u_a^k, the maximized objective function at any age $a \geq 12$, $V_a(\Omega_a)$, is given by:

$$V_a(\Omega_a) = \max_{d_a^k} E\left[\sum_{\tau=a}^{A} \beta^{A-\tau} \sum_{k=1}^{K} u_\tau^k d_\tau^k | \Omega_a\right] \tag{3.16}$$

where E is the expectations operator, Ω_a is the state space at age a (the relevant information set with which the individual enters decision age a), and β is the subjective discount factor. The state variables include the level of human capital, work experience, primary and secondary school types, co-residence status, household head's schooling, race, accumulated number of school grades failed and the contemporaneous shocks:

$$\Omega_a = \{S_a^{pr}, S_a^{sec}, S_a^{col}, H_a, pr, sec, House_a, edu_z, colored, white, NF_a, \varepsilon_a\} \tag{3.17}$$

I assume that the shocks $\varepsilon_a = [\varepsilon_a^w, \varepsilon_a^{tr,sec}, \varepsilon_a^{tr,col}, \varepsilon_a^{pr}, \varepsilon_a^{sec}, \varepsilon_a^{col}, \varepsilon_a^L]$ are serially independent and uncorrelated, such that $\varepsilon_a \backsim N(0, \Sigma)$ where all non-diagonal elements of Σ are 0. Initial conditions consist of race, household head's schooling, type of primary school, parental co-residence (at age 12), and accumulated human capital (at age 12). As individuals in the sample do not work prior to age 12, work experience at age 12 is 0 for all individuals:

$$\Omega_{12} = \{colored, white, edu_z, pr, House_{12}, S_{12}^{pr}, H_{12} = 0\} \tag{3.18}$$

3.1 Solution Method

The maximization problem can be recast in a dynamic programming framework. In particular, the value function, $V_a(\Omega_a)$, can be written as the maximum over

alternative-specific value functions, denoted as $V_a^k(\Omega_a)$ for $k = 1, ...K$, that satisfy the Bellman (1957) equation; namely

$$V_a(\Omega_a) = \max(V_a^1(\Omega_a), ..., V_a^K(\Omega_a)) \tag{3.19}$$

where,

$$V_a^k(\Omega_a) = \begin{cases} u_a^k + \beta E\left[V_{a+1}(\Omega_{a+1})|d_a^k = 1, \Omega_a\right] & \text{if} \quad a < A \\ u_A^k & \text{if} \quad a = A \end{cases} \tag{3.20}$$

where the expectation is taken over the joint distribution of the stochastic shocks ε_{a+1}, grade pass/fail states and $a+1$ household type.

In each period the individual chooses an element from the choice set that is feasible for him for which the value function is maximized. As seen in (21), future decisions are assumed to be made optimally for any current choice k. The model does not admit an analytical solution, but it can be numerically solved in a recursive way from the last period back to the first. To solve the model, for every a, I need to first calculate the value of $E\left[V_{a+1}(\Omega_{a+1})|d_a^k = 1, \Omega_a\right]$. This needs to be done for every possible k and for every possible element of Ω_a. I refer to these functions as the Emax. Full numerical computation of the Emax functions requires high dimensional integration. Following Keane and Wolpin (1994), I use Monte Carlo integration to numerically approximate the Emax functions. That is, I take M draws from the normal distribution of ε and calculate for each draw the maximum of the value functions. The maximum values are averaged, implying:

$$\begin{aligned} E\max\{V_{a+1}^1(\Omega_{a+1}), ..., V_{a+1}^K(\Omega_{a+1})|d_a^k &= 1, \Omega_a\} = \\ \frac{1}{M}\sum_{m=1}^{M}\max\{(V_{a+1}^1(\Omega_{a+1}), ..., V_{a+1}^K(\Omega_{a+1})|d_a^k &= 1, \Omega_a\} \end{aligned} \tag{3.21}$$

Since I only follow individuals up to age 22, I split the horizon to two sub periods. For ages 12 to 22, the model is solved explicitly, as described above. The value function for age 23, $V_{23}(\Omega_{23})$, is assumed to be a parameterized function of the state space at age 22. In particular, I assume the following terminal value function:

$$\begin{aligned} V_{23}(\Omega_{23}) &= \theta_1 * I\{S_{23}^{pr} = 8\} + \\ &\quad \theta_2 * S_{23}^{sec} + \theta_3 * S_{23}^{sec} * I\{sec = hor\} + \theta_4 * S_{23}^{sec} * I\{sec = hoa\} + \\ &\quad \theta_5 * S_{23}^{col} + \theta_6 * H_{23} \end{aligned} \tag{3.22}$$

3.2 Estimation Method

The numerical solution to the individuals' maximization problem provides approximations to the Emax functions as indicated in (22). The alternative-specific value functions, $V_a^1, ..., V_a^K$ for $k = 1, .., K$, are known up to the random vector of shocks, and the implicit shock that determines age a parental co-residence status. Conditional on the deterministic part of the state space, the probability that an individual is observed to choose option k takes the form of an integral over the region of the several dimensional error space (depends on what is observed at each period) such that k is the preferred option.

Specifically, in the decision model presented above, the observed outcomes at each period include: (a) the choice (from the feasible set) made by the individual of whether or not to attend school, the type of school and whether or not to work (b) the wages received by the individuals who work (c) the success or failure of individuals who attend school to complete the school grade (d) parental co-residence status, and (e) the transfers provided to individuals who attend school.

Let $O_a(n)$ represent the vector of outcomes of individual n at age a:

$$O_a(n) = \{d_a^k(n), w_a(n), pass_a(n), House_a(n), tr_a(n)\} \tag{3.23}$$

Also, let $I(n)$ denote the set of initial conditions for this individual (race, head's schooling, parental co-residence status at age 11, type of primary school, years of primary school completed by age 12 and whether failed a grade prior to age 12). Suppose that this individual is observed from age 12 (a_0) up to some age $a = \bar{a}_n$, then the contribution to the likelihood of individual n is given by:

$$L_n = \Pr(O_{\bar{a}_n}(n), O_{\bar{a}_n - 1}(n), ..., O_{a_0}(n); I(n)) \tag{3.24}$$

Given the assumption of joint serial independence among the vector of shocks, the likelihood function can be written as the product of within-period outcome probabilities:

$$L_n = \Pi_{a=a_0}^{\bar{a}_n} \Pr(O_a(n) | O_{a-1}(n), ..., O_{a_0}(n); I(n)) \tag{3.25}$$

To complete the description of the model, I need to specify the functional form for the unobservable type probabilities. I estimate the model with two unobserved types (high type and low type). I assume that the unobserved type is known to the individual but not to the econometrician. The probability that an individual is a high type depends on a subset of his initial conditions - head's schooling and whether the individual completed at least six years of schooling by age 12.

$$prob(type = high) = \frac{\exp(X\phi_{12})}{1 + \exp(X\phi_{12})} \tag{3.26}$$

where,

$$X\phi_{12} = \phi_0 + \phi_1 * I\{edu_z \geq 12\} + \phi_2 * I\{S_{12}^{pr} \geq 6\}$$

Integrating over the type probabilities, the likelihood function can be written as:

$$L_n = \sum_{k=1}^{2} \Pi_{a=a_0}^{\bar{a}_n} \Pr(O_a(n)|O_{a-1}(n), ..., O_{a_0}(n); type = k, I(n)) * \Pr(type = k; I(n)) \tag{3.27}$$

The overall likelihood for the sample $n = 1, .., N$ is the product over the individual likelihoods:

$$L = \Pi_{n=1}^{N} L_n \tag{3.28}$$

To illustrate the calculation of the likelihood, suppose that the alternative chosen by individual n is to work without attending school, so that I observe a wage and a co-residence status at age a. The probability of observing that choice, the wage and co-residence status outcome conditional on the state space which includes $(O_a(n), O_{a-1}(n), ..., O_{a_a}(n), I)$ is:

$$\begin{aligned} \Pr(h_a &= 1, w_a, House_a|\Omega_a, I) = \\ \Pr(h_a &= 1|w_a, House_a, \Omega_a, I) f(w_a|\Omega_a, I) \Pr(House_a|\Omega_a, I) \end{aligned} \tag{3.29}$$

where $f(w_a|\Omega_a, I)$ is the wage density.

Similarly, for an individual who chooses to attend primary school of type j at a given age a, I observe the co-residence status, the school transfer and the school outcome:

$$\begin{aligned} \Pr(s_a^{pr,j} &= 1, tr_a, pass_a, House_a|\Omega_a, I) = \\ & \Pr(pass_a|s_a^{pr,j}, House_a, \Omega_a, I) \Pr(s_a^{pr,j} = 1|tr_a, House_a, \Omega_a, I) \\ & f(tr_a|House_a, \Omega_a, I) \Pr(House_a|\Omega_a, I) \end{aligned} \tag{3.30}$$

Probability statements for all other outcomes are obtained in the same manner. Calculation of the conditional probabilities of observing a choice $k, (k = 1, ..., K)$ in the right hand side of (31) and (32) requires integrating over the preference shocks of all feasible choices as well as the shocks of feasible outcomes that I do not observe. Instead, I use the kernel smoothed frequency simulator proposed by McFadden (1989). For each set of error term draws, I calculate:

$$\frac{\exp\{\frac{V^k(a)-\max(V^j(a))}{\tau}\}}{\sum_i \exp\{\frac{V^i(a)-\max(V^j(a))}{\tau}\}} \tag{3.31}$$

where $V^k(a)$ is the value function associated with the choice made, $\max(V^j(a))$ is the value function associated with the maximal choice, and τ is a smoothing parameter.

Notice that the entire set of model parameters enter the likelihood through the choice probabilities that are computed from the solution of the dynamic programming problem. Subsets of the parameters also enter through other structural relationships - wage offer function, transfer functions, parental co-residence function, and grade passing probability functions. The estimation procedure, i.e., the maximization of the likelihood function, iterates between the solution of the dynamic program and the calculation of the likelihood.

Chapter 4

Data

I use data from the Cape Area Panel Study (CAPS), a longitudinal study of youth in metropolitan Cape Town, South Africa. CAPS covers a wide range of outcomes, including schooling, employment, health, family formation, and intergenerational support systems. The study was designed as a stratified two-stage clustered sample with stratification on the predominant population group living in each sample cluster. Cape Town population in the 2001 census was 48% colored, 32% African, 19% white and the remaining classified as Indian or other. CAPS oversampled areas classified as predominantly African and white in order to produce larger samples of African and white respondents than would be present in a simple random sample.[1]

CAPS sampled 4,752 youth aged 14-22 from 3,304 households in Wave 1 (2002). The study currently includes four publicly available waves, the most recent conducted

[1]However, the percentage of white respndents in the first wave of CAPS (2002) is only 16%. CAPS failed to produce a larger sample of whites due to a very low response rate amongst white respondents. Household response rates were 89% in African areas, 83% in colored areas, and 46% in white areas. Young adult response rates, conditional on participation of the household, were quite high, even in white areas. Given household participation, response rates for young adults were 93% in African areas, 88% in colored areas, and 86% in white areas (Lam, Seekings, and Sparks 2006). It should be noted that low response rates for white respondents are common in households surveys in South Africa.

in 2006. Each of these waves contains a young adult questionnaire and three of them (waves 1, 3 and 4) also contain household surveys. Crucial to this dissertation, wave 1 further contains retrospective life histories for each year stretching back to birth. This includes information on school enrollment, school advancement, household arrangements and employment. Wave 3 further contains retrospective life history on the schools young adults attended back to the beginning of their schooling career. In addition, CAPS contains school-level data, derived from The School Register of Needs Survey - 2000. This is a survey of nearly 30,000 schools through the secondary level throughout all South Africa. The survey instrument asks questions relating to school infrastructure, available equipment and resources, and relevant to this dissertation – data on the department that served each school during the apartheid regime. Details about the design of CAPS are provided in Lam et al. (2008).

In this dissertation I make several restrictions to the original sample. First, I restrict the sample to male youth. Second, I only keep those youth who were 12 years old or less when the apartheid ended (1994). Older individuals might have already been attending secondary schools when the apartheid ended, and thus, were not free to choose a secondary school. Third, I drop individuals who attended private primary or secondary institutions, individuals who attended new secondary institutions (i.e., schools that were founded post-apartheid), and individuals whose school history was missing or could not be matched to a school department. Fourth, I keep only those individuals who are observed until at least age 18. Lastly, I drop individuals with inconsistent histories, individuals who advance two or more grades in a given year, and individuals without continuous enrolment and/or work histories. With these constraints the sample size drops to 1420 individuals who I follow from age 12 continuously up to a maximum age of 24. The sample size drops sharply at later ages due to both the young ages of entry into the panel (i.e., right-censoring) and attrition in

later waves.[2] Since the number of point observations for ages 23 and 24 in the sample is fairly low, I drop these observations and I only follow individuals up to a maximum age of 22.

Most relevant to this dissertation is data collected on school choices and outcomes, employment and wages, conditional school transfers and living arrangements. I use the retrospective wave 1 data updated with information from waves 2-4 to build the history of school enrolment, school advancement, employment and parental co-residence. For each year respondents reported whether they were enrolled in school, and whether they passed the grade, failed the grade or withdrew before completing the school year. I define 'failure' as an event in which respondents did not pass a school grade, which may include events such as withdrawal (for any reason) rather than outright academic failure. Enrollment for individuals with less than 12 years of schooling supersedes labor market participation when these are reported to occur simultaneously at a given age, in order to keep these choices consistent with their treatment as mutually exclusive in the model. Work while enrolled never exceeds 2% during grades 1-12, making me confident that modeling enrollment as distinct from labor force participation is reasonable.

To construct school department variables, I use data from each wave as well as the retrospective school history from wave 3 (2005). School names were assigned codes which I could match to educational school departments in The Register of Needs Survey (2000). Transition from one school department to another typically occurs during the transition from primary to secondary school. Consequentially, the model

[2] The overall rate of attrition in the sample was 17%, with significant differences across population groups. The African attrition rate is 21%, with most of the attrition resulting from migration back to the rural Eastern Cape province that is the main sending region for Africans living in Cape Town. The colored population has its roots primarily in Cape Town, a factor contributing to its lower 10% attrition rate. The 23% attrition rate for whites includes both migration out of Cape Town (including migration out of South Africa) and a significant number of refusals.

allows transition from one school department to another to occur only during this time. Individuals who switched school departments during their primary or secondary school education were assigned the department of the school they attended for most years.

Information on wages is included in the young adult questionnaire in each wave. Wages are full-time annual equivalent based on 160 working hours per month. Hourly wages are calculated from actual number of hours reported. Individuals are considered to be working if they report working more than 20 hours per-week. Intergenerational school transfers are included in each household questionnaire. Education of the head of the household is the schooling of the father, if the father was a member of the household when young adult was 12 years old. It is the schooling of the mother, if the mother, but not the father, was a member of the household when young adult was 12 years old. It is the schooling of a grandparent if young adult co-resided with this grandparent, but without biological parents, when he was 12 years old. Otherwise, schooling of the head of the household is 'missing'.

4.1 Data Description

Table 1 presents summary statistics for the sample. The close number of African and colored respondents is the result of the intentional over-sampling of African areas, while the under-representation of white respondents is the result of a low response rate and the higher attrition rates of whites. Striking differences amongst races are already evident at age 12. While more than 80% of the whites had completed 6 years of schooling by this age, this is true for only 61% of the coloreds and 24% of the Africans. These differences translate into a large racial gap in age 12 completed schooling, with Africans lagging about 1.5 grades behind whites, and coloreds lagging about 0.3 grades

behind whites. Youth from different races also differ in the characteristics of their households. Whites, on average, live in households whose heads are significantly more educated than coloreds and Africans, and while 73% of the whites live in households with two biological parents, this is only true for 59% of the coloreds and 40% of the Africans in the sample.

Table 1 further shows striking racial differences in schooling outcomes at age 23. While 93% of the whites complete 12 years of schooling by this age, this is only true for 42% of the coloreds and 38% of the African respondents. Table 1 also suggests a difficult transition from school to work for African men. While 81% of the colored and 77% of the white respondents had worked by age 23, this is only true for 29% of the Africans. Also, age 22 mean wage for whites is about 150% higher than that of Africans, and about 80% higher than that of coloreds.

Figure 1 shows the proportions of African, colored and white respondents who were enrolled in school or post-secondary institution at each age from 12 to 22. Up to age 15, enrollment rates are close to or above 90% for all three race groups. Colored enrollment rates begin to fall above age 15, with Africans having higher enrollment rates than colored youth at all ages above 15. African enrollment rates are still high in their late teens with enrollment rates around 85% at age 17 and 70% at age 18. White enrollment drops sharply at age 18 when the vast majority of whites complete 12 years of schooling.

Figure 2 shows the proportions of African, colored and white respondents attending each of the three types of secondary school departments. The vast majority of youth who are in secondary school attend schools that are predominately of their race, with 97% of the whites attending former-white secondary schools, 84% of the coloreds attending former-colored secondary schools, and 86% of the Africans attending former-African secondary schools.

Figure 3 shows the mean grades completed by African, colored and white respondents at each age from 12 to 23. The figure shows that whites advance, on average, almost one grade of school per year up to age 18. Grade advancement for Africans is slower. By age 16, the schooling gap between whites and Africans is close to two full grades, and by age 20 - 2.5 grades. Coloreds have the slowest grade advancement of all three races. Largely due to the high enrollment rates for Africans in their late teens, African grade attainment almost catches up with colored grade attainment by age 21. By age 23, both Africans and coloreds lag about 2.8 grades behind whites.

One of the valuable features of CAPS is that it provides direct measures of grade repetition. Figure 4 shows the cumulative number of grades failed in school or post-secondary institutions for Africans, coloreds and whites at each age from 12 to 23. Despite higher enrolment rates for Africans at each age above 13, coloreds fail, on average, more grades than Africans up to age 18. Above age 18, Africans have a higher cumulative number of grades failed than colored because school enrolment for coloreds is significantly lower than that of Africans at these ages. For whites, the cumulative number of grades failed is significantly lower than that of Africans and coloreds. By age 23, whites fail, on average, 0.4 school grades, coloreds fail, on average, 1.05 school grades, and Africans fail, on average, 1.45 school grades.

Figure 5 shows the proportions of African, colored and white respondents who are employed at each age from 12 to 22. Employment rates are negligible for all races up to age 15 because enrolment is almost universal at these ages. For ages 16 and above colored employment rates are always above those of whites, though this mainly reflects right-censoring of school careers for whites rather than failure in the job search. At age 22, about 70% of the coloreds and 60% of the whites are employed. Africans experience an arduous transition from school to work. They have extremely low rates of work, with employment rates never exceeding 10% below age

20. Moreover, their employment rate is lower than 30% at age 22, although only 13% of the Africans are still enrolled in school at this age.

Chapter 5

Estimation Results

I estimate a model with 99 parameters. The parameter estimates and standard errors are displayed in Table 2. In this section I discuss the parameters that are of greatest interest, highlighting those related to apartheid school departments and race that are informative for the counterfactual experiments I perform later. Other parameters have obvious signs and reasonable magnitudes.

5.1 School Quality Related Parameters

The estimates show that utility flow from attending secondary school is highest for former white schools and lowest for former African schools. The consumption value of Individuals attending former white (colored) secondary schools is 17,316 (7,107) rand higher than for individuals attending former African secondary schools. In addition, individuals attending better quality secondary schools are also more likely to pass their current grade in school, and they are more likely to pass a grade in college. The logistic functions imply, for instance, that the probability of a "typical" African, that is a low type who lives without at least one biological parent, and failed one grade in

school since age 12, to pass a grade in a former African, a former colored or a former white secondary school is 59%, 64% and 67%, respectively, and his probability to pass a grade in college is 68%, 79% and 81%, respectively.

The estimates also report higher return to schooling for former white and former colored secondary schools. An additional year in a former white (colored) secondary school increases the offered wage by about 6% (5%), whereas an additional year in a former African secondary school increases the offered wage by about 3%.

Consistent with the literature, the estimates also show large differences in secondary school tuitions by school department. Estimated tuitions are 84 rand for former African secondary schools, 269 rand for former colored secondary schools, and 1300 rand for former white secondary schools. Ladd and Fiske (2004) report similar average annual school tuitions for former African and former colored secondary schools in the Western Cape province based on actual tuition data obtained from the South African Ministry of Education (105 rand for former African schools, and 333 rand for former colored schools). However, they calculate that the average annual school fees in former white secondary schools in the Western Cape province is 2701, which is substantially higher than the value I estimate. It is likely that the low participation rates of whites in the survey, and in particular the low response rates of whites in the wealthier neighborhoods of Cape Town contributed to this outcome.

5.2 Race-related Parameters

Utility function parameters: The estimates report substantial differences in utility flows from leisure and school attendance amongst races. Whites receive the highest utility flow from leisure while coloreds receive the lowest utility flow from leisure (consumption utility from leisure for whites is 3,950 rand higher than that of Africans,

and consumption utility from leisure for coloreds is 1,393 rand lower than that of Africans). The estimates further show that Africans receive the highest utility flow from attending secondary school and college, while whites receive the lowest utility flow from attending secondary school (14,727 rand lower than coloreds and 30,794 lower than Africans), and coloreds receive the lowest utility flow from attending college (13,483 rand lower than coloreds and 18,395 rand lower than Africans).

Labor market parameters: The estimates imply that Africans and coloreds, ceteris paribus, receive wage offers that are 50% and 8% lower than those of whites. This may reflect discrimination in the labor market, that is, lower skill rental prices for Africans and (to much lesser extent) for coloreds and/or that African and (to much lesser extent) colored youth have lower skill endowments at age 12 independent of type.

School progress: The estimates show that whites have the highest probability to pass a grade in secondary school, and Africans - the lowest. For example, while a white young man who is a low type, attends a former white secondary school, did not fail a grade in school since age 12, and co-resides with two biological parents, passes a grade with a probability of 97%, the probabilities of comparable colored and African men to pass a grade in a former white secondary school are 87% and 85%, respectively. Differences amongst races at the college level are marginal.

Unobserved heterogeneity, initial endowments and race: I estimate a model with two latent types, finding this number is sufficient for the model to provide a reasonable fit to all the key features of the data that I am interested in. In the model, unobserved heterogeneity affects behavior through its effect on preferences to schooling and labor and through its effect on school and labor skill endowments. The estimates show that high type young adults receive higher utility from school attendance during primary school (33,516 rand more than comparable low type individuals), secondary school

(6475 rand more than comparable low type individuals), and college (3,059 rand more than comparable low type individuals). High type young adults also receive higher utility from leisure (18,038 rand more than otherwise identical low type individuals). High type individuals are further estimated to have offer wages about 55% higher than comparable low type youth, and to have higher school skill endowments (i.e., higher probability to pass a grade in school conditional on attendance) in all phases of education. For instance while the probability of an African who is a low type who lives without at least one biological parent, and failed one grade in school since age 12, to pass a grade in a former African, a former colored or a former white secondary school is 59%, 64% and 67%, respectively, the probability of a comparable high type individual to pass a grade in school is 88%, 91%, 92%, respectively.

The logit function expresses type probabilities as a function of (a) initial schooling endowment - whether the individual completed at least 6 years of schooling by age 12, and, (b) schooling of the head of the household - whether the head of the household completed at least 12 years of schooling. Simulating the model, I find that 23% of the individuals who completed at least 6 years of schooling by age 12 are high type, while only 11% of those who completed less than 6 years of schooling by age 12 are high type. Similarly, the estimates imply that 30% of the individuals whose head of the household has schooling level of 12 years or above are high type, while this is true for only 13% of the individuals whose head of the household has less than 12 years of schooling.

Since initial endowments are highly correlated with race, colored and African young men are under-represented amongst the high skill endowment type. Simulating the model I find that 29% of the whites, 17% of the coloreds, and 13% of the Africans are high endowment type.

5.3 Model Fit

Model fit is displayed in Tables 3 to 8. The model captures fairly well all the main features of the data.

School Enrolment: Fit for enrolment rates by age is displayed in Table 3. The model fits well the enrolment patterns for all three races. It captures the high enrolment levels (above 90%) for Africans at ages younger than 16, and the gradual decline in enrolment for Africans from age 17. The model predicts that enrolment rates for Africans at ages 18, 20 and 22 are 72%, 43% and 19%, respectively, while the actual enrolment rates at these ages are 71%, 39% and 14%. The model also fits well the enrolment patterns for coloreds, with enrolment levels below those of Africans at every age from 13 to 22, and it captures the steep drop in colored enrollment above age 16. The model further predicts well the enrolment patterns for whites with enrollment rates above 90% for all whites younger than 17, and it captures the steep decline in enrollment for whites from age 18. The model predicts that enrolment levels for whites at ages 18, 20 and 22 are 68%, 39% and 25%, respectively, while the actual enrolment rates at these ages are 64%, 43% and 26%, respectively.

Choice of Secondary School Department: Fit for the proportions of African, colored and white youth attending former African, former colored and former white secondary schools is displayed in Table 4. The model captures well the racial persistence in choices of secondary school departments. The model predicts that 85% of the Africans attend former African secondary schools, 81% of the coloreds attend former colored secondary schools, and 100% of the whites attend former white secondary schools, while the actual proportions are 86%, 85%, and 97%, respectively.

Employment. Fit for employment rates by age is displayed in Table 5. The model fits well the employment patterns for all three races. The model captures well the

very low employment rates for Africans at all ages below 18 (1% or less). It further captures that the proportions of employed Africans never exceed 10% before age 20. At age 22, the model predicts that 24% of the Africans are employed, while the actual proportions of Africans working at this age is 28%. The model also captures very well the employment patterns for coloreds. The model predicts that the proportions of coloreds working is 10% or less below age 17, and it captures the sharp increase in employment rates from age 18 and above. At age 22, the model predicts that 70% of the coloreds are employed, which is also the actual rate of coloreds employed at this age. Similarly, the model captures fairly well the proportions of whites employed at each age from 12 to 22, and it captures that colored employment rates exceed those of whites at each age from 12 to 22.

School Advancement and Completion: Fit for mean years of completed schooling by age, and school attainment distribution at age 23 are displayed in Tables 6 and 7, respectively. Table 6 shows that the model captures well the mean years of completed schooling at every age from 12 to 22 for all three races. Mean school attainment at age 23 predicted by the model is 10.47 years for Africans, 10.48 years for coloreds, and 13.30 years for whites, while actual mean completed schooling at this age is 10.43, 10.47, and 13.25 years for Africans, coloreds and whites, respectively. Table 7 shows that while the model fits well the school attainment distribution of Africans, it does not fit those of coloreds and whites as well as it fits the mean. The model under-estimates colored school graduation rates by about 9 percent-points, and while it predicts fairly well white school graduation rates, it over-predicts the percentage of whites who complete more than 12 years of schooling by about 12 percent-points.

Chapter 6

Counterfactual Experiments

6.1 Accounting for Racial Differences in Schooling Outcomes

§5.2 show that Africans, colored and white youth differ in their initial endowments, as well as in their structural parameters. In this section, I address whether and to what extent these differences account for racial differences in schooling outcomes. Specifically, I perform two set of counterfactual experiments. The first, involves altering initial endowments distributions, and the second, involves altering race parameters related to labor market and preferences to schooling and leisure. Each experiment reveals how close the outcomes for Africans and coloreds would be to those of whites if each category of parameters, taken one at a time, were set equal to those of white men.

6.1.1 The Role of Initial Endowments

Table 8 shows what would have happened, according to the model's predictions, to racial gaps in schooling outcomes at age 23 if age 12 endowment distributions were equalized to those of whites. The first column presents the (simulated) baseline situation: by age 23, 96% of the whites are school graduates while this is true for 35% of the Africans and 33% of the coloreds. In addition, mean educational attainment at age 23 for both Africans and coloreds is about 2.8 years less than that of whites.

Column (ii) reports an experiment in which Africans and coloreds had the same age 12 parental co-residence distribution as whites. With this experiments age 23 mean schooling attainment increases by 0.1 years for Africans and by 0.04 years for coloreds. The experiment also reports an increase of about 3 percent-points in school graduation rates for Africans and of about 1 percent-point for coloreds.

The second experiment (column iii) assumes that Africans and coloreds have the same parent-education distributions as whites. I find that mean age 23 school attainment increases by about 0.2 years for both Africans and coloreds. This represents a decrease of about 7% in the original African-white and colored-white school attainment gap.

The third experiment (column iv) assumes that Africans and coloreds have the same age 12 initial schooling distributions as whites. I find that equalizing initial schooling distributions would cause the mean schooling difference between whites and Africans to fall by 29%. Furthermore, the percentage of Africans who graduate from school increases by 15 percent-points. The impact of this experiment on colored youth is much smaller: mean schooling difference between whites and coloreds falls by 8%, and the percentage of school graduates increases by about 3 percent-points.

The last experiment (column v) combines all previous experiments, that is, this experiment shows what would have happened, according to the model's predictions,

to racial gaps in schooling outcomes at age 23, if all age 12 endowment distributions of Africans and coloreds were equalized to those of whites. I find that with this experiment, the percentage of Africans (coloreds) who graduate from school by age 23 increases by 20 (6) percent-points. The experiment leads to a reduction in the mean schooling differential of 40% for Africans and 16% for coloreds. This reduction in mean schooling differentials, though significant, is still smaller than the 70% reduction found for black males in the U.S. (Keane and Wolpin 2000).

6.1.2 Equalizing Race Parameters

Table 9 shows what would have happened according to the model's predictions, to race differences in schooling outcomes at age 23, if race parameters of African and colored youth were equalized to those of whites. As before, the first column presents the (simulated) baseline situation.

Column (ii) reports an experiment in which wage equation race parameters are equalized to that of whites. With this intervention, African experience a dramatic surge in employment - employment rates at age 22 increase by 30 percent-points Consequentially, high-school graduation rates of Africans drop by 8 percent-points, and age 23 mean schooling drops substantially - a drop of 0.56 years. The impact of this intervention on colored youth is more modest: employment rates increase by about 6 percent-points, graduation rates decrease by about 1.5 percent-points, and mean schooling at age 23 decreases by 0.08 years. This experiment suggests that though counter-intuitive, labor market discrimination helps in this case to mitigate racial differences in education, especially for Africans, because with less attractive labor market opportunities individuals stay longer in school.

Column (iii) reports an experiment in which preferences to schooling and leisure of Africans and coloreds are equalized to those of whites. Since the estimates report

that the utility of whites from secondary school is substantially lower than that of Africans and coloreds, this intervention has a substantial adverse effect on schooling of both Africans and coloreds: African mean schooling at age 23 drops by 2.6 years and colored mean schooling at age 23 drops by 1.6 years. African and colored employment rates, too, drop dramatically - 10 percent-point and 37 percent-points, respectively. This is because the estimates report that utility from leisure is highest for whites and lowest for coloreds.

Column (iv) reports an experiment in which Africans and coloreds have the same probability to complete a grade in school (all else equal). This experiment has a very large impact on schooling outcomes for both Africans and coloreds, as it eliminates 45% of the African-white gap in years of schooling and 35% of the colored-white gap in years of schooling. With this experiment 66% of Africans and 60% of the coloreds graduate from school, and 31% of the Africans and 24% of the coloreds complete at least some college.

6.2 Policy Interventions

I next use the estimated model to explore whether financial constraints enhance racial disparities in education by analyzing how different school tuition policies affect schooling outcomes and the racial gap in education. To perform these policy interventions, I use the model to simulate choices and outcomes with a modified budget constraint as implied by the intervention I consider.

Tables 10-13 summarize the effects of four school tuition interventions on schooling outcomes of African, colored and whites. The first column in each table presents the (simulated) baseline situation, and columns (ii) to (v) in each table present the results for the four interventions I consider: abolishing tuitions in all secondary schools,

abolishing tuitions only in former colored and former African secondary schools, abolishing tuitions only in former African secondary schools, and abolishing tuitions in post-secondary schools (but not at earlier phases of education). Table 10 presents the results for mean completed schooling by age, Table 11 presents the results for enrollment rates by age, Table 12 presents the results for secondary school department choices, and Table 13 presents the results for school attainment distribution at age 23.

Abolishing tuitions in all secondary schools (column ii): This policy has a dramatic impact on schooling outcomes for Africans and coloreds, and a relatively small impact on schooling outcomes for whites. The policy dramatically alters the choices Africans and coloreds make regarding the school department they attend at secondary school (Table 12). With this intervention all Africans and coloreds attending secondary schools choose to attend former white schools. Table 11 reveals a substantial increase in African and colored school enrolment at every age from 12 to 22. Table 10 reveals a substantial increase in mean completed years of schooling for both Africans and coloreds. By age 23, mean school attainment for Africans and coloreds are 11.86 and 11.67, respectively, which represents a reduction of 49% and 42%, respectively, in the original schooling gap. This policy has also pronounced effect on school graduation rates for Africans and coloreds (Table 13). By age 23, their secondary school completion rates double (rates are now 69% and 67%, respectively), and 30% of the Africans and 24% of the coloreds complete at least some college. However, removal of secondary school tuitions has a relatively small effect on schooling outcomes for whites, as whites have high enrollment rates and high school completion rates already prior to the intervention. With this intervention, school completion rates for whites increase by 2 percent-points (Table 13), and mean schooling at age 23 increases by 0.08 years (Table 10). This policy is, thus, effective in substantially reducing racial

disparities in education.

Abolishing tuitions in former African and colored schools (column iii): This policy has a substantial impact on school outcomes for Africans (though lesser than in the previous experiment where no tuitions are charged in all secondary schools), a small impact on school outcomes for coloreds, and no impact on school outcomes for whites. With this intervention 98% of the Africans attending secondary schools choose to attend former colored schools (Table 12). For coloreds, too, school choice distribution is more concentrated in former colored schools than in the baseline model, with no coloreds attending African schools and a lower percentage of coloreds attending former white secondary schools. Table 11 reports an increase in African and colored school enrolment at each age from 12 to 22 (compared with the baseline model). The increase in enrollment for Africans is more substantial than for coloreds, but in both cases, the effects are lesser than in the experiment where no tuitions are charged in all secondary schools. Table 10 reveals a substantial increase in mean completed years of schooling for Africans and a smaller increase for coloreds. By age 23, mean school attainment for Africans and coloreds are 11.10 and 10.74, respectively, which represents a reduction of 22% and 9%, respectively, in the schooling gap. By age 23, 50% of the Africans and 40% of the coloreds complete at least 12 years of schooling, an increase of 17 percent-points and 6 percent-points, respectively (Table 13).

Abolishing tuitions in former African secondary schools (column iv): This intervention has a small impact on school outcomes for Africans, and no impact on school outcomes for coloreds and whites. With this intervention, age 23 mean schooling attainment for Africans increases by 0.09 years (Table 10), and the percentage of Africans who complete at least 12 years of schooling increases by about 2 percent-points (Table 13). This policy, thus, yields a small reduction in the schooling gap between Africans and whites, and no improvement in the schooling gap between col-

oreds and whites.

Abolishing post-secondary school tuitions, while secondary school tuitions remain unchanged (column v): This policy has a very small effect on the percentage of school graduates for all three races (an increase of less than 1 percent-point), but it increases the proportions of those completing more than 12 years of schooling within the school graduates (Table 13). The percentage of Africans completing more than 12 years of schooling increases by 2.6 percent-points, and the percentage of coloreds completing more than 12 years of schooling increases by 1.4 percent-points. The percentage of whites completing more than 12 years of schooling increases by about 3.3 percent-points. With this intervention, by age 23, mean completed schooling of Africans increases by 0.07 years and mean completed schooling of coloreds - by 0.04 years (Table 10).The impact on whites is bigger (0.13 years). Because whites benefit more from removal of tuitions at the college level, this policy ends increasing racial disparities in schooling, though not by much.

Chapter 7

Conclusions

Racial disparities in education in South-Africa are large and well documented in the literature. However, moving beyond simple descriptions of these disparities to a more detailed explanation has proven to be elusive. This paper develops and estimates a dynamic model of schooling and labor supply of youth in South-Africa, and uses it to study several potential explanations for racial disparities in education, and policies aimed to ameliorate them.

I find that Africans, coloreds, and whites differ substantially in their structural parameters, but that these differences do not necessarily translate into a bigger schooling gap. For example, whites receive wage offers that are 50% higher than those of comparable Africans, and 8% higher than those of comparable coloreds. Nontheless, wage discrimination is found to mitigate racial disparities in schooling, in particular for African men. I find that if African and colored wage offers were equalized to those of whites, school enrollment would decrease, and age 23 schooling would drop by 0.56 years for Africans and by 0.08 years for coloreds. This is because with inferior labor market opportunities, coloreds and, in particular, Africans increase their school enrollment. Similarly, I find that although African, colored and white South-Africans

differ substantially in their preferences to schooling and leisure, these differences do not contribute to racial disparities in schooling, rather, they mitigate them. On the other hand, I find that apartheid heritage explains 40% of the African-white gap in years of schooling, and 16% of the colored-white gap in years of schooling.

My findings further highlight the role of financial constraints as major contributors to racial disparities in education. I find that abolishing secondary school fees in all secondary schools will eliminate 49% of the schooling gap between African and whites and 42% of the schooling gap between coloreds and whites. Moreover, with this intervention, secondary school completion rates double. On the other hand, eliminating school fees only in former African secondary schools will have a small effect on African enrollment and school completion (an increase of 0.09 years of schooling), and will have no effect on colored schooling. This finding suggests that financial constrains in this case affect human capital primarily via school quality choices and not via school attendance decisions. This linkage, that has rarely been addressed in previous research casts serious doubts on the effectiveness of policies aimed to reduce tuitions in low quality schools in mitigating racial disparities in education. The findings further suggest that financial constraints are more important at the secondary school level than they are in college. Abolishing school fees at the post-secondary school level without altering secondary school fees will mostly benefit the white population (average increase of 0.13 years of schooling), and will have a smaller effect on Africans and coloreds, suggesting that intervention at post-secondary school level will only reinforce the already overwhelming racial gap in education, while intervention at the secondary school level can dramatically decrease racial gaps in education.

Appendix A

Tables

Table A.1: Descriptive Statistics (Std. Deviation in Parentheses)

	African	Colored	White
Number of individuals	600	668	152
At Age 12			
Mean schooling (yrs)	4.41	5.56	5.88
	(1.44)	(1.02)	(0.51)
Completed at least 6 years (%)	23.83	61.07	80.26
	(42.64)	(48.79)	(39.93)
Co-reside with 2 biological parents (%)	39.83	58.68	73.02
	(48.99)	(49.27)	(44.52)
Household head's schooling ≥ 12 (%)	9.99	13.91	79.59
At Age 23			
Mean schooling (yrs)	10.43	10.48	13.25
	(2.19)	(2.35)	(1.47)
Schooling Distribution (%):	1.40	0.98	0.40
	(1.06)	(0.90)	(0.79)
< 9 yrs	16.80	19.81	0
9 - 11 yrs	45.10	38.21	7.09
12 yrs	26.85	30.19	36.33
> 12 yrs	11.25	11.79	56.58
Cumulative grades failed (yrs)	1.40	0.98	0.40
	(1.06)	(0.90)	(0.79)
Ever worked (%)	29.2	81.1	77.2
	(40.7)	(39.2)	(42.8)
Hourly wage (Rand)	11.44	15.61	28.39
	(13.07)	(8.36)	(21.02)

Table A.2: Estimated Parameter Values

Prob. to Pass a Grade - Primary School	Estimate	S.E.
constant (τ_0^{pr})	2.131	0.362
High Type (τ_1^{pr})	0.615	0.281
Colored (τ_2^{pr})	0.31	0.243
White (τ_3^{pr})	1.333	0.473
Co-reside with two parents (τ_4^{pr})	0.173	0.042
Failed one grade (τ_5^{pr})	-0.474	0.159
Failed two or more grades (τ_6^{pr})	-1	0.278
Prob. to Pass a Grade - Secondary School		
constant (τ_0^{sec})	1.231	0.265
High Type (τ_1^{sec})	1.673	0.495
Colored (τ_2^{sec})	0.126	0.171
White (τ_3^{sec})	1.679	0.637
Co-reside with two parents (τ_4^{sec})	0.211	0.069
Secondary School - Former Colored (τ_5^{sec})	0.221	0.039
Secondary School - Former White (τ_6^{sec})	0.355	0.110
Failed one grade (τ_7^{sec})	-0.864	0.266
Failed two or more grades (τ_8^{sec})	-1.744	0.311
Prob. to Pass a Grade - College		
constant (τ_0^{col})	0.826	0.369
High Type (τ_1^{col})	0.023	0.036
Colored (τ_2^{col})	0.034	0.013
White (τ_3^{col})	0.042	0.014
Co-reside with two parents (τ_4^{col})	0.488	0.144
Secondary School - Former Colored (τ_5^{col})	0.608	0.218
Secondary School - Former White (τ_6^{col})	0.705	0.304
Work while in school (τ_7^{col})	-0.589	0.132
Failed one grade or more (τ_8^{col})	-0.085	0.031
Failed two or more grades (τ_9^{col})	-1.572	0.351

Table A.2 - continued		
Probability to Reside with two parents	Estimate	S.E
constant (ψ_0)	-4.12	0.11
Age 17 to 20 (ψ_1)	-0.38	0.09
Age $\geq$ 21 (ψ_2)	-0.66	0.16
Co-resided with two parents in the previous year (ψ_3)	6.84	0.11
Colored (ψ_4)	0.41	0.10
White (ψ_5)	0.23	0.15
Ln. Wage		
constant (α_0)	0.538	0.154
High Type (α_1)	0.438	0.221
Colored (α_2)	0.348	0.082
White (α_3)	0.403	0.09
Year in Primary School (α_4)	0.025	0.012
Year in Secondary School (α_5)	0.031	0.011
Year in Secondary School - Former Colored (α_6)	0.017	0.005
Year in Secondary School - Former White (α_7)	0.031	0.013
Year in College (α_8)	0.093	0.034
Work Experience (α_9)	0.056	0.031
Worked in previous year (α_{10})	-0.37	0.112
Age (α_{11})	0.048	0.012
wage S.E	0.522	0.214
Type Probabilities		
constant (ϕ_0)	-2.272	0.631
Parent schooling: $\geq$12 yrs (ϕ_1)	0.895	0.271
Completed 6 yrs or more(ϕ_2)	0.732	0.238

Table A.2 - continued		
Utility Parameters - Leisure	Estimate	S.E.
constant (γ_0^L)	33,568	6,412
High Type (γ_1^L)	18,038	10,183
Colored (γ_2^L)	-1,392	2,721
White (γ_3^L)	3,949	2,220
Error S.E.	8,148	3,403
Utility Parameters - Primary School		
constant (γ_0^{pr})	1,971	660
High Type (γ_1^{pr})	33,515	815
Enrolled in previous year (γ_2^{pr})	33,765	5,547
Error S.E.	8,875	5,099
Utility Parameters - Secondary School		
constant (γ_0^{sec})	17,309	3,782
High Type (γ_1^{sec})	6,474	1,845
Colored (γ_2^{sec})	-16,067	6,827
White (γ_3^{sec})	-30,794	658
Secondary: Former Colored (γ_4^{sec})	7,107	3,927
Secondary: Former White (γ_5^{sec})	17,316	5,446
Age $\geq$ 18 (γ_6^{sec})	-6,519	2,863
Age $\geq$ 20 (γ_7^{sec})	-1,461	1,200
Enrolled in previous year (γ_8^{sec})	22,948	6,178
Switching cost: DET to HOR ($-\rho_1$)	-10,595	6,384
Switching cost: DET to HOA ($-\rho_2$)	-19,369	5,479
Switching cost: HOR to HOA ($-\rho_3$)	-12,720	1,054
Error S.E.	8,346	3,885
Utility Parameters - College		
constant (γ_0^{col})	-20,859	8,485
High Type (γ_1^{col})	3,059	1,524
Colored (γ_2^{col})	-18,394	5,797
White (γ_3^{col})	-4,911	942
Work while in school (γ_4^{col})	-40,493	1,599
Enrolled in previous year (γ_5^{col})	18,874	5,591
Error S.E	25,111	7,058

Table A.2 - continued		
Ln. Transfer, Secondary School	Estimate	S.E.
constant (δ_0)	5.798	0.047
Co-reside with two parents (δ_1)	0.068	0.063
Parent schooling: $\geq$ 12 yrs (δ_2)	0.564	0.088
Colored (δ_3)	0.852	0.068
White (δ_4)	2.309	0.124
Error S.E	0.759	
Ln. Tranfer, College		
constant (δ_5)	8.21	0.175
Co-reside with two parents (δ_6)	0.244	0.181
Parent schooling: $\geq$ 12 yrs (δ_7)	0.347	0.211
Colored (δ_8)	0.526	0.237
White (δ_9)	0.626	0.284
Error S.E.	0.908	
Secondary School Tuitions		
DET	85	65
HOR	269	24
HOA	1300	98
College Tuition	1690	19
Terminal Values		
completed 8 years of schooling (θ_1)	235	210
Year in Secondary School (θ_5)	10,120	1,803
Year in Secondary School - Former Colored (θ_6)	8,580	1,806
Year in Secondary School - Former White (θ_7)	24,775	3,084
Year in College (θ_8)	38,057	5,817
Year of work experience (θ_8)	18,946	9,005

Table A.3: Model Fit - Enrollment Rates by Age (%)

Age	African		Colored		White	
	Data	Model	Data	Model	Data	Model
12	98.50	98.80	98.80	98.98	100	99.71
13	98.33	97.93	98.50	97.16	100	99.23
14	97.50	95.78	96.25	91.84	100	96.32
15	95.33	93.20	89.56	85.04	99.34	94.89
16	90.66	90.05	79.64	78.81	99.34	95.23
17	84.83	84.56	57.33	65.20	89.47	91.84
18	71.00	72.40	35.83	39.58	63.81	67.82
19	54.66	57.87	18.96	19.23	52.58	48.98
20	38.37	42.68	14.01	9.95	43.34	38.51
21	21.57	30.86	9.06	6.56	33.33	33.90
22	13.52	18.68	7.54	4.98	26.27	25.34

Table A.4: Model Fit - Secondary School Department Choice (%)

School Department	African		Colored		White	
	Data	Model	Data	Model	Data	Model
DET (Former African)	86.17	85.39	1.42	0.84	0	0
HOR (Former Colored)	11.42	12.76	84.68	81.05	2.76	0.02
HOA (Former White)	2.41	1.83	13.90	18.10	97.24	99.98

Table A.5: Model Fit - Employment Rates by Age (%)

Age	African		Colored		White	
	Data	Model	Data	Model	Data	Model
12	0	0	0	0.04	0	0
13	0	0.02	0.15	0.16	0	0.05
14	0	0.08	0.9	0.98	0	0.1
15	0	0.16	2.10	2.89	0	0.56
16	0	0.36	7.69	5.91	0.66	0.71
17	1.0	0.81	16.92	13.42	6.58	3.55
18	3.24	2.52	34.58	30.32	26.32	26.81
19	6.29	6.81	46.41	52.31	40.51	49.57
20	11.63	11.50	60.57	61.07	52.33	56.17
21	19.83	19.65	64.40	62.68	57.41	57.23
22	27.69	23.59	69.89	69.55	60.09	59.18

Table A.6: Model Fit - Mean Completed Shooling by Age (yrs)

Age	African		Colored		White	
	Data	Model	Data	Model	Data	Model
12	4.41	4.41	5.56	5.56	5.88	5.88
13	5.31	5.30	6.49	6.44	6.85	6.85
14	6.21	6.18	7.37	7.29	7.84	7.82
15	7.07	7.02	8.17	8.07	8.80	8.76
16	7.88	7.80	8.89	8.78	9.76	9.69
17	8.62	8.51	9.46	9.40	10.71	10.61
18	9.24	9.13	9.87	9.90	11.61	11.50
19	9.69	9.61	10.14	10.19	12.20	12.11
20	10.07	9.96	10.31	10.32	12.63	12.51
21	10.35	10.20	10.45	10.40	12.9	12.83
22	10.40	10.37	10.48	10.45	13.09	13.10
23	10.43	10.47	10.48	10.49	13.25	13.30

Table A.7: Model Fit - School Attainment at age 23 (%)

Completed	African		Colored		White	
Schooling	Data	Model	Data	Model	Data	Model
$<$ 9 yrs	16.8	14.43	19.81	13.69	0	0
9 - 11 yrs	45.10	49.64	38.21	52.93	6.09	3.55
12 yrs	26.85	21.95	30.19	20.38	36.33	26.19
$>$12 yrs.	11.25	13.98	11.79	13.0	57.58	70.26

Table A.8: Accounting for Race Differences in Schooling Outcomes Equalizing Initial Conditions

	Baseline model			Whites' parent co-residence distribution		Whites' parent education distributions		Whites' initial schooling distributions		total impact of (ii)-(iv)	
	(i)			(ii)		(iii)		(iv)		(v)	
	Africn	Colord	White	Africn	Colord	Africn	Colrd	Africn	Colord	Africn	Colord
Mean Education (yrs)	10.47	10.49	13.30	10.57	10.53	10.66	10.69	11.29	10.71	11.59	10.93
% < 12 yrs of schooling	64.87	66.62	3.55	62.03	65.8	61.78	64.88	50.02	63.63	44.93	60.73
% 12 yrs of schooling	21.95	20.38	26.19	22.27	20.58	20.32	19.99	28.82	22.02	25.19	21.60
% >12 yrs of schooling	13.18	13.00	70.26	15.70	13.62	17.90	15.13	21.16	14.35	29.88	17.67
% employed at age 22	23.59	69.55	59.18	23.64	69.52	22.36	65.03	25.86	70.15	24.76	65.97
Hourly wage at age 22 (Rand)	9.77	15.74	23.29	9.82	15.76	10.63	16.84	10.39	16.02	11.81	17.28

Table A.9: Accounting for Race Differences in Schooling Outcomes - Equalizing Race Parameters

	Baseline model			Equalizing wages		Equalizing prefrences		Equalizing Prob to pass a grade	
	(i)			(ii)		(iii)		(iv)	
	African	Colored	White	African	Colored	African	Colored	African	Colored
Mean Education (yrs)	10.47	10.49	13.30	9.91	10.41	7.89	8.90	11.75	11.54
% < 12 yrs of schooling	64.87	66.62	3.55	72.61	68.06	90.68	83.62	33.87	39.71
% 12 yrs of schooling	21.95	20.38	26.19	16.19	19.42	6.83	10.11	35.05	35.86
% >12 yrs of schooling	13.18	13.00	70.26	11.20	12.52	2.49	6.27	31.08	24.43
% employed at age 22	23.59	69.55	59.18	54.09	75.11	13.78	32.87	26.71	71.35
Hourly wage at age 22 (Rand)	9.77	15.74	28.56	15.25	16.80	8.71	13.62	10.31	16.59

Table A.10: Removal of Tuitions - Mean Completed Schooling by Age

	Age	Baseline Model (i)	All Sec. (ii)	African & Colored Sec. (iii)	African Sec. (iv)	College (v)
African	12	4.41	4.41	4.41	4.41	4.41
	13	5.30	5.31	5.31	5.30	5.30
	14	6.18	6.21	6.20	6.19	6.18
	15	7.02	7.09	7.05	7.03	7.02
	16	7.80	7.94	7.88	7.82	7.81
	17	8.51	8.77	8.66	8.54	8.52
	18	9.13	9.54	9.36	9.17	9.14
	19	9.61	10.21	9.94	9.66	9.62
	20	9.96	10.78	10.39	10.03	9.99
	21	10.20	11.23	10.71	10.28	10.24
	22	10.37	11.59	10.95	10.45	10.42
	23	10.47	11.86	11.10	10.56	10.54
Colored	12	5.56	5.56	5.56	5.56	5.56
	13	6.44	6.45	6.44	6.44	6.44
	14	7.29	7.32	7.29	7.29	7.29
	15	8.07	8.17	8.10	8.07	8.07
	16	8.78	9.00	8.85	8.78	8.78
	17	9.40	9.81	9.54	9.40	9.41
	18	9.90	10.52	10.10	9.90	9.91
	19	10.19	11.01	10.41	10.19	10.21
	20	10.32	11.30	10.57	10.32	10.35
	21	10.40	11.48	10.65	10.40	10.43
	22	10.45	11.59	10.70	10.45	10.48
	23	10.49	11.67	10.74	10.49	10.53
White	12	5.88	5.88	5.88	5.88	5.88
	13	6.85	6.85	6.85	6.85	6.85
	14	7.82	7.83	7.82	7.82	7.82
	15	8.76	8.78	8.76	8.76	8.77
	16	9.69	9.74	9.69	9.69	9.69
	17	10.61	10.69	10.61	10.61	10.62
	18	11.50	11.61	11.50	11.50	11.52
	19	12.11	12.21	12.11	12.11	12.14
	20	12.51	12.60	12.51	12.51	12.58
	21	12.83	12.91	12.83	12.83	12.92
	22	13.10	13.18	13.10	13.10	13.21
	23	13.30	13.38	13.30	13.30	13.43

Table A.11: Removal of Tuitions - Enrollment Rates by Age (%)

Age	Baseline Model (i)	All Secondary (ii)	African & Colored Secondary (iii)	African Secondary (iv)	College (v)
African					
12	98.80	99.88	99.31	98.88	98.85
13	97.93	99.76	98.82	98.17	98.02
14	95.78	99.42	97.67	96.34	95.92
15	93.20	99.13	96.42	94.24	93.27
16	90.05	99.10	95.08	91.72	90.14
17	84.56	97.18	91.50	86.69	84.92
18	72.40	90.53	80.92	74.83	73.33
19	57.87	80.98	67.10	60.36	59.34
20	42.68	69.92	51.57	44.79	44.89
21	30.86	58.62	38.48	32.56	33.03
22	18.68	43.82	24.51	19.69	20.41
Colored					
12	98.98	99.78	99.18	98.98	99.00
13	97.16	99.56	97.94	97.16	97.19
14	91.84	98.93	94.51	91.84	91.94
15	85.04	98.44	90.55	85.04	85.21
16	78.81	97.85	85.85	78.81	79.09
17	65.20	90.76	72.91	65.20	65.85
18	39.58	67.48	44.99	39.58	40.52
19	19.23	43.14	21.88	19.23	20.16
20	9.95	27.13	11.18	9.95	10.71
21	6.56	17.83	7.19	6.56	7.16
22	4.98	11.86	5.36	4.98	5.45
White					
12	99.71	99.77	99.71	99.71	99.75
13	99.23	99.50	99.23	99.23	99.34
14	96.32	98.26	96.32	96.32	96.61
15	94.89	97.84	94.89	94.89	95.30
16	95.23	98.09	95.23	95.23	95.60
17	91.84	94.72	91.84	91.84	92.48
18	67.82	68.25	67.82	67.82	70.25
19	48.98	48.02	48.98	48.98	52.10
20	38.51	37.82	38.51	38.51	41.71
21	33.90	33.63	33.90	33.90	36.92
22	25.34	25.13	25.34	25.34	27.32

Table A.12: Removal of Tuitions - Secondary School Depatment Choices (%)

Sec. School Dept.	Baseline Model (i)	All Secondary (ii)	African & Colored Secondary (iii)	African Secondary (iv)	College (v)
African					
DET	85.40	0	1.25	85.88	84.55
HOR	12.77	0	97.99	12.37	13.62
HOA	1.83	100	0.76	1.75	1.83
Colored					
DET	0.85	0	0	0.88	0.84
HOR	81.05	0	85.98	81.03	81.13
HOA	18.10	100	14.02	18.09	18.03
White					
DET	0	0	0	0	0
HOR	0.02	0	0.02	0.02	0.01
HOA	99.98	100	99.98	99.98	99.99

Table A.13: Removal of Tuitions - School Attainment at age 23 (%)

School Attainment	Baseline Model (i)	All Secondary (ii)	African & Colored Secondary (iii)	African Secondary (iv)	College (v)
African					
<12	64.07	30.63	49.95	61.95	63.01
=12	21.95	38.92	26.29	23.41	20.43
>12	13.98	30.45	23.76	14.64	16.56
Colored					
<12	66.62	33.38	60.13	66.63	65.84
=12	20.38	42.48	24.43	20.37	19.74
>12	13.0	24.14	15.44	13.0	14.42
White					
<12	3.55	1.88	3.55	3.55	2.91
=12	26.19	25.72	26.19	26.19	23.55
>12	70.26	72.40	70.26	70.26	73.54

Appendix B

Figures

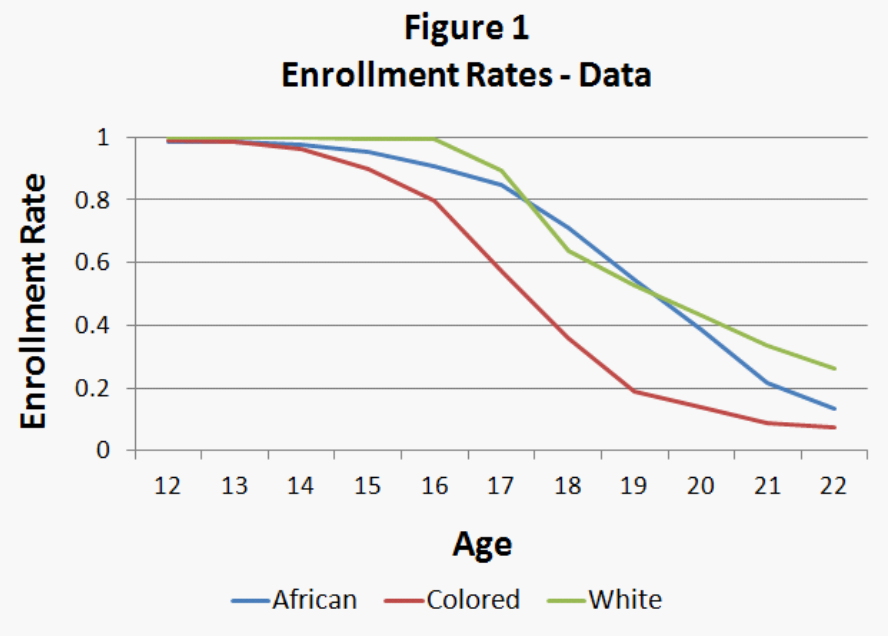

Figure B.1: Enrollment Rates - Data

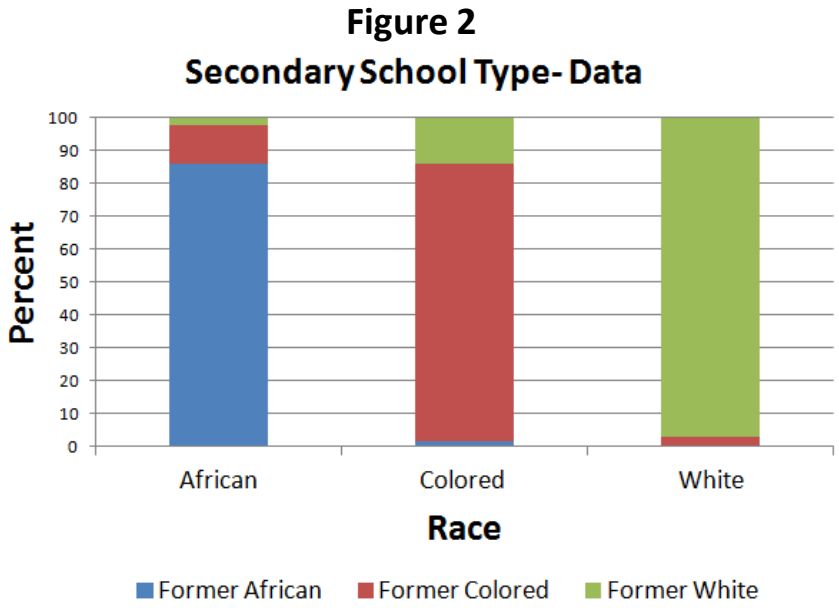

Figure B.2: Secondary School Type - Data

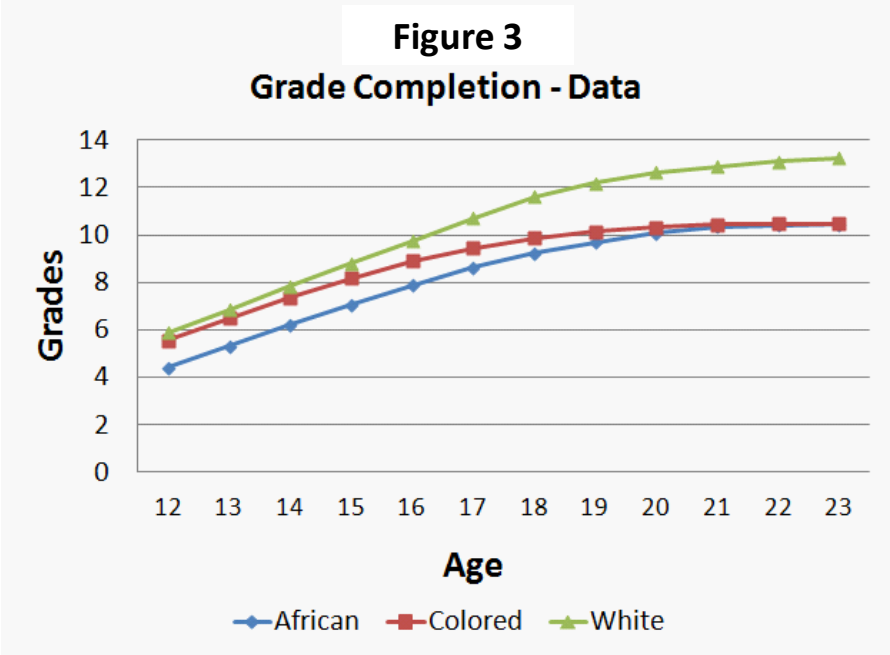

Figure B.3: Grade Completion - Data

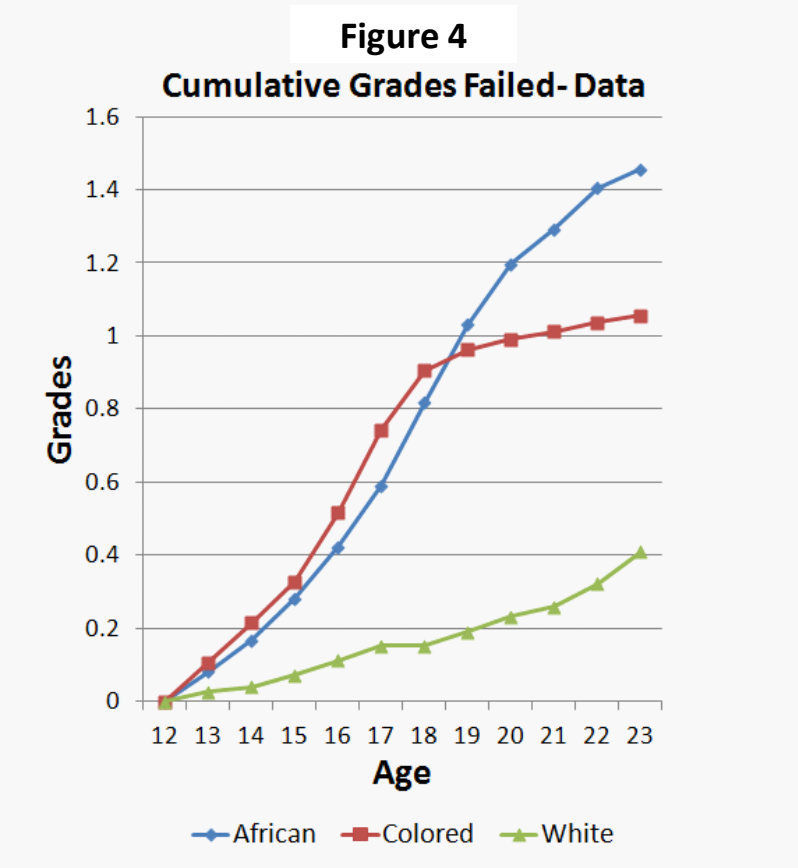

Figure B.4: Cumulative Grades Failed - Data

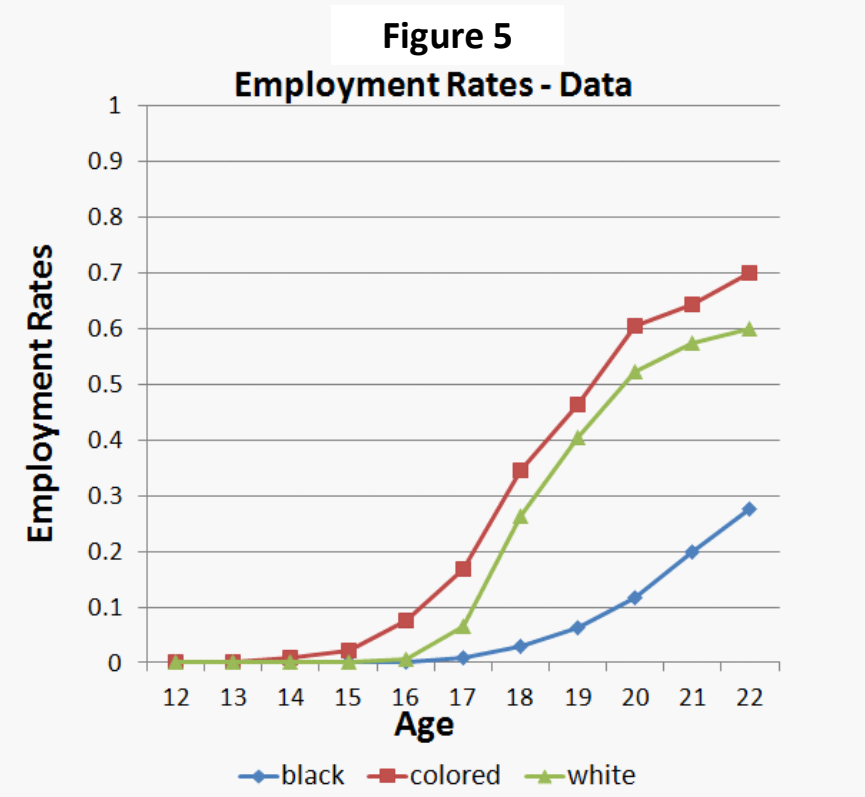

Figure B.5: Employment Rates - Data

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