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ABSTRACT

In South Africa earnings inequality between races still persists despite the convergence of educational attainment between races. There is a now a growing body of evidence which suggests that the quality of education received by South Africans differs markedly amongst and within race groups, and that schools differ substantially in their ability to impart cognitive skills. This difference in education quality between races is apparent to some extent in differing returns to the same levels of educational attainment between races. This paper reviews the international and South African literature which considers the role of education quality in improving labour market prospects. Education quality is considered from both from an input and output perspective. This paper concludes that education output quality, particularly the ability of a school system to impart cognitive skills, is a crucial determinant of labour market success.

Keywords: South Africa, Education, Earnings Functions, Education Quality, Cognitive Skills, Labour Market
JEL codes: I20, I21, I30, J30

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INTRODUCTION

Considerable evidence now exists that inequality between races is still particularly high in South Africa, despite the convergence of average educational levels between more recent cohorts of blacks and whites. Much of this inequality between races is believed to be rooted in the labour market, where employment and earnings prospects for white workers are considerably better than for their black counterparts. There is a now a growing body of evidence which suggests that the quality of education received by South Africans differs markedly amongst and within race groups, and that schools differ substantially in their ability to impart cognitive skills. Thus, years spent attending school is unlikely to be a reliable indicator of actual skills developed, rendering conventional Mincerian earnings functions (which considered years of education as the primary predictor of productivity and earnings) inappropriate for the examination of the true education-earnings relationship.

Economic growth literature in the past has also typically focused on quantity of schooling as a determinant of productivity which in turn would enable a country to access a higher economic growth plane. Here too there has been a growing realisation that the quantity of schooling is a poor indicator of skills within and between countries, with many cross-country growth regressions now being augmented by some standardised measure of cognitive skills.

This review first considers the theoretical and practical reasons for the use of simple education attainment measures in the modeling of individual earnings and aggregate economic growth. The evolution of the education-labour market empirical work since the 1970s is discussed, with much of the attention being devoted to empirical studies concentrating on the United States labour market. The inclusion of education-quality variables in Mincerian earnings functions is then discussed with reference to developed and developing countries, with a subsection focusing on recent South African empirical work by researchers who have attempted to uncover the relationship between cognitive skills and local labour market outcomes. Finally, the link between cognitive skills and growth is discussed before some tentative conclusions and recommendations are made.

1. EDUCATIONAL ATTAINMENT, EARNINGS AND ECONOMIC GROWTH

Arguably the most important role of educational attainment is its short-term impact on individual welfare through increased earnings and societal welfare via the individual's ability to integrate successfully into society. Microeconomists (for example Duflo, 2001; Psacharopolous, 1994) have typically focused on the link between education and improved earnings, but there are a number of other benefits to the individual which include better health outcomes and societal benefits such as reduced fertility and crime levels. The first subsection here briefly discusses the

more immediate benefits of education to the individual in the form of improved earnings and consequent poverty reduction.

The economic growth success stories of many South East Asian countries since the 1990s after following aggressive educational expansion policies may have led to an initial perception that more educational attainment would translate into more economic growth. The second subsection examines the education-growth literature and the realisation in recent years that it is education *quality* rather than simple measures of quantity of education which has an impact on economic growth.

2.1 Educational attainment and earnings

From the development economist's perspective, education not only provides the opportunity to escape deprivation through improved employment and earnings prospects, but also has non-pecuniary benefits such as improved health and the ability to function and integrate successfully into mainstream society, all factors which in themselves could promote better education and labour market outcomes (Van der Berg, 2008:7). The primary focus of research by labour economists has therefore been to determine how much educational attainment contributes to employment probabilities and subsequent earnings, and in which way educational attainment contributes to those earnings.

In its simplest form, human capital theory postulates that an individual makes investments in human capital which translate into later payoffs which matter to the individual. Simple human capital models such as those developed by Mincer (1974) specify earnings as a function of human capital which in its turn is a function of educational attainment and experience (both generally specified in years). The positive relationship between years of education and earnings could be as a result of more educated workers being more productive (Becker, 1964), but could also be attributed to the fact that years of education might signal ability to employers, making it possible for the better educated to be employed in more lucrative jobs.

A less conventional variant of human capital theory holds that formal schooling develops and promotes non-productive capabilities or behavior which employers find attractive (see for example Bowles and Gintis, 1976). These capacities include docility, which is desirable for lower-level workers, and self-direction, a trait which upper-level workers are rewarded for.

Research in the last three decades on the returns to education (for example Psacharopolous, 1994; Card, 1994) have all shown that more education translates into higher individual earnings. Hanushek and Woessman (2008: 615) estimate that the rate of return to a year's education is approximately 10 percent with expected variations based on the relative scarcity of individuals with different education levels. Previously it was widely believed that primary levels of

education yielded the highest returns, which prompted many developing countries to expand access to basic education (Psacharopolous and Patrinos, 2004). However, as countries develop the demand for skilled workers generally increases, and returns to investment in higher and tertiary education typically increase as well.

Education is not only instrumental in improving welfare of the currently-educated, but also improves the outcomes of subsequent generations. South African matriculants (those who complete grade 12) who have at one least one parent who had also matriculated, earn approximately twice as much their counterparts who do not have a matriculated parent (Van der Berg, 2007: 861). Parental education, possibly through parental social networks or the transfer of an unobservable human capital variable, appears to positively affect earnings of their children.

For the most part, the benefits of education are channeled through the labour market. The better-educated stand a higher chance of being employed, are generally more productive and are rewarded with higher earnings once employed. Some benefits of education such as improved health might also not explicitly be related to the labour market, but could enhance the pecuniary benefits associated with labour market participation. Although the benefits of education are more pronounced for the children of educated parents, upward social mobility is also possible for the poor who invest in education.

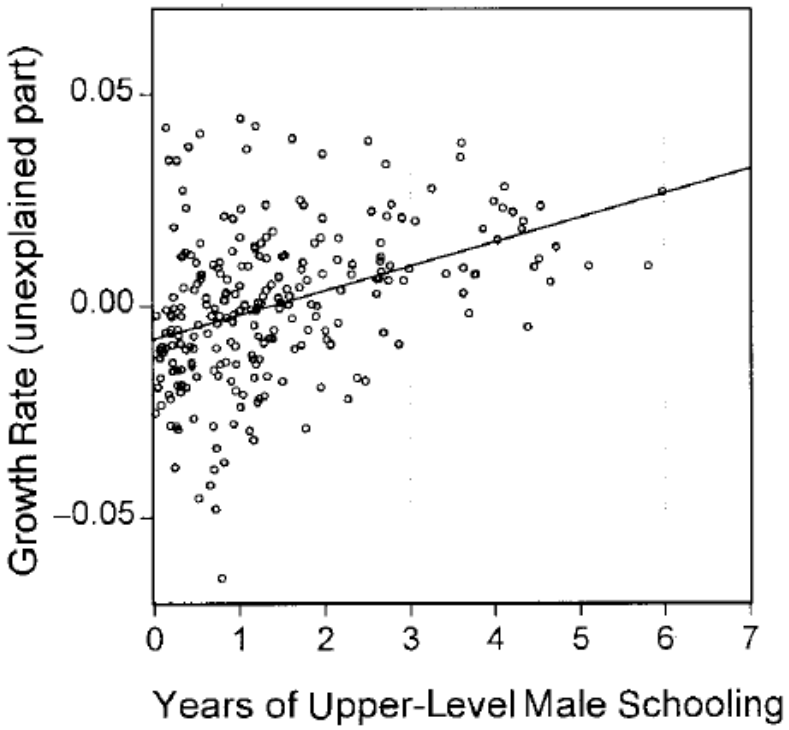
2.2 Educational attainment and economic growth

Economic growth research in the last two decades shifted to reasons why some nations prosper while others flounder. Given the microeconomic relationship between years of education and individual earnings growth, it was perhaps natural for macroeconomists to investigate the impact of average years of education on economic growth rates (for example Barro, 1997 and Mankiw *et al*, 1992). Measures of human capital were added as independent variables to cross-country regressions, with much of the work concentrating on formal years of education as a driver of economic growth. Theoretically human capital raises productivity and enhances a country's ability to absorb, implement and diffuse new knowledge and technology (Nelson and Phelps, 2005). Human capital could also have a second-round effect in that a country's ability to absorb new technology could also minimise the perceived risk of failure when investing in emerging countries.

Just as in microeconomic analysis of the education-income relationship, simple quantitative indicators of human capital, such as years of education, have been shown to be positively correlated with economic growth. Barro (2001) measures human capital in terms of years of education for males aged 25 years and older who have attained at least some secondary

education[2]. Panel regression analysis (for the periods 1965 – 75, 1975 – 85 and 1985 – 1995) reveals that each additional year of schooling contributes 0.44 percent to annual GDP growth (Barro, 2001: 14). The partial relationship between educational attainment and growth is depicted in Figure 1.

Figure 1 Years of education and economic growth



Source: Barro (2001: 15).

The seemingly robust relationship between average education levels and economic growth implied by Figure 1 seems to suggest that in order to promote economic growth, a country need only increase the average years of education. This is also insinuated by other authors such as Mankiw, Romer and Weil (1992) whose findings suggest that education improves labour productivity, which allows a country to access a higher economic growth plane. The simple education expansion strategy still seems to be the key strategy pursued by many developing countries and supporting institutions – perhaps driven in part by the economic success of East Asian countries after their education revolutions – and one which seems to be central to economic growth and the eradication of poverty (witness, for instance the Millenium Development Goals).

[2] Barro (2001: 14 – 15) finds that the proportions of males with primary schooling and females at all levels of schooling do not have statistically significant relationships with economic growth.

Yet questions remain about whether the simple interpretation of this relationship is entirely accurate. Many developing countries have not seen the economic growth rates predicted by these cross-country growth regressions, despite large-scale investments in expanding education access and attainment. One reason extended for the rather muted (or non-existent) impact of higher education levels on economic growth rates is that institutional frameworks are important to ensure that education expansion translates into economic growth (Pritchett, 2006). Those countries with strong institutions stand to gain the most from investment in education while those countries with poor institutions would be unable to mount an effective education programme or reap the benefits from that education once it is attained. There are also debates about whether it is educational levels at any given point in time or the *change* in education levels which matters more for economic growth (see for example Krueger and Lindahl, 2001). In addition using average years of schooling as a quantitative measure assumes that formal schooling is the only way in which productive human capital can be measured and that informal education does not contribute in any demonstrable way to economic growth.

The most important objection to the simple interpretation of the education level coefficient in recent times has been the fact that most cross-country regressions assume that one additional year of schooling imparts the same knowledge and skills to individuals in all countries (Hanushek and Woessman, 2008: 608). Even the casual observer would be hard pressed to believe that each additional year of education in Kenya would contribute to productivity in the same way that a year of schooling in Sweden would. Yet much of the labour market and economic growth literature has focused on years of education rather than what those years of education contribute to productivity (or the *quality* of that education) as the crucial determinant of individual and societal economic welfare. The following section of the paper deals with the impact of education quality on the labour market, both in terms of *inputs* (resources devoted to education) and *outputs* (what is produced using those inputs).

2. EDUCATION QUALITY AND THE LABOUR MARKET

Intuitively it seems reasonable to assume that the quality of education received should contribute positively to labour market outcomes. However, for a number of reasons the relationship between educational quality and the labour market is hitherto largely a descriptive one. The foremost reason is the paucity of reliable education quality data, regardless of the measure of quality used, a problem which is particularly prevalent in developing countries where the measurement of education quality (in terms of outcomes) should arguably be one of the more important indicators of policy success or failure.

Secondly, even though education quality data may be available, conceptual differences in how it should be measured have led to vastly different claims about the value of education quality in the labour market. The most common conceptual difference amongst researchers is whether

education quality should be measured by the *input* or *output* method. Should educational quality be measured by the inputs such as mean expenditure per pupil or the quality of its physical infrastructure? Or should educational quality be measured by the output method where the yardstick for education quality is student performance on nationally or internationally standardised achievement tests?

In the early years of education quality research, more often than not *input* measures of education quality such as average expenditure per pupil were used. Much of the early literature reflected the empirical uncertainty of the education quality-labour market relationship, with some researchers attributing wage premiums to higher school quality (see for example Card and Krueger, 1992) and more recent ones finding no significant effect of school quality on later earnings. Despite the contradictory results produced by education quality researchers, the input method continued to be the method of choice until it was realised that not all schools convert resources into outcomes with equal levels of efficiency (Hanushek, 1981).

The realisation that increasing school budgets did not necessarily translate into better performance provided impetus in the late 1980s for the compilation and administering of specially designed achievement tests which focused on student performance rather than school budgets as the definitive measure of education quality. Yet despite the realisation that the *output* method would provide a more informative measure of education quality than its input-based counterpart, much of the education quality literature is dominated by studies which use the latter measure as an indicator of education system performance. Hanushek and Woessman (2008) suggest that the omission of 'actual' education quality measures in favour of 'potential' quality measures is due to convention and convenience – policymakers and researchers design policies and assess their impacts using educational attainment and enrolment rates simply because these figures are readily available from government authorities and measured on a regular basis. The output method is also used less often because of the resource-intensive demands placed on those who design and administer achievement tests (Psacharopolous and Velez, 1993: 131).

Nevertheless, in recent times considerable effort has been made to ensure that the most comprehensive measure of educational quality is being used in the analysis of labour market outcomes. To this end much of the focus has shifted to the measurement of cognitive skills and their impact on subsequent and present-day labour market outcomes. Hanushek and Woessman (2008: 609) assert that cognitive skills rather than simple educational attainment are central to understanding wage differentials between individuals and the slowdown of growth convergence between developed and developing countries. Acquiring data on cognitive skills is therefore important when one considers its value in confirming how effective schools are at imparting or improving cognitive skills to students. A second, and more important, reason (for this study) for examining cognitive skills data is to clarify why the relationship between years of education and income is weak in general for some groups in South Africa and strong for others. Some studies have postulated that discrimination plays some sort of role in the determination of wages for South African workers (see for example Jafta and Burger, 2006; Chamberlain and Van der Berg,

2002). The investigation of a relationship between cognitive skills and labour market earnings (controlling at the very least for differences in geography, industry and years of education) could therefore also shed some light on whether wage discrimination is justifiable or not.

In developing countries with scarce resources, researching the relationship between cognitive skills and earnings could also be important to determine which types of cognitive skills to direct investment towards (Glewwe, 2002: 466). Different types of cognitive skills would have different impacts on earnings and a study of this sort could therefore make sure that those cognitive skills with the largest impact on wages are focused on. Such a study could also inform policymakers whether previous public investment in improving educational 'quality' contributed significantly to labour market outcomes or not. A study by Solmon (1986) indicates that education input quality has substantially greater effects on cognitive outcomes in developing countries than in developed countries. Heyemand and Loxley (1983) also find that small improvements in input quality lead to dramatic improvements in poorer communities. These papers seem to suggest that educational quality in terms of *outputs* is especially important for the poor, who generally have lower initial levels of cognitive skills than their more affluent counterparts.

Although there is general consensus that formal school attendance plays some role in the development of cognitive skills, there are also a number of other factors such as family and other environmental factors which also contribute to the development of cognitive skills and subsequent labour market outcomes. Sadly, most these factors are less malleable to government intervention and pressure than school quality factors such as physical infrastructure, teacher motivation and the efficient management of school resources, tools which government can use to overcome the cognitive skill development challenges faced by future labour market participants in developing countries. This section of the paper examines some of the empirical literature using both the input and output-based measures of education quality.

3.1 Education quality and the labour market: input-based approaches

Studies which concerned themselves with the relationship between education quality and earnings initially focused on school quality as measured by *inputs* such as expenditure per pupil, the pupil-teacher ratio and various teacher-quality measures such as experience, education levels and less commonly, teacher-test scores. Dearden et al (2002) use a representative sample from the National Child Development Survey (NCDS), a longitudinal survey of British subjects born in the first week of March 1958, to examine the effect of pupil-teacher ratios education and labour market outcomes. The survey has school-level information about a number of quality measures such as pupil-teacher ratios, type of school and scores on a number of ability tests undertaken at five follow-up surveys (at the ages of 7, 11, and 16 years while still at school and at the ages of 23 and 33 years old when in the labour market).

The focus of the Dearden et al (2002) paper is on eventual educational outcomes and earnings at the ages of 23 and 33. The advantage of being able to compare individuals' performance at two points in their earnings lifecycle is that the age-dependence of the school quality effect can also be tested for. Dearden et al (2002: 5) choose the school pupil-teacher ratio rather than the class pupil-teacher ratio as a school quality measure to circumvent the possible endogeneity problem which arises from the way in which pupils are allocated to classes[3]. Controlling for deprivation in the pupil's neighbourhood implicitly reduces the potential endogeneity as a result of rural schools having lower school-level pupil-teacher ratios. Family background variables are taken from the second and third waves of the survey (at the ages of 11 and 16), presumably because family background is most important just before adulthood. Real hourly wages in 1995 prices are constructed from labour market data when the respondents are aged 23 and 33 years. Quite often individuals work in areas away from where their schools were located, and Dearden et al (2002: 6) control for this by adding nine regional dummies. The impact of a number of education variables on male wages at the ages of 23 and 33 are shown in Table 1 overleaf.

Table 1 shows that the highest educational qualification obtained is more important at the age of 23 than at 33 years of age. Family background and ability as measured by test scores are insignificant at the age of 23, while type of school exerts no influence on the wage either.

Interestingly, the pupil-teacher ratio has a small and insignificant impact on the wage at the age of 23. The results are striking in the sense that it seems to suggest that better-quality education is important only in its capacity to promote further education (Dearden et al, 2002: 11). This resonates well with the signaling hypothesis. The specifications in column IV in Table 1, which excludes the education qualification variable, are unsuccessful in their attempts to tease out a relationship between school-quality and the wage.

At 33, the ability score at 7 years old and attendance of a private or grammar school (both selective schools) are significant and positive, while the pupil-teacher ratio has a very small impact as a predictor of wages. Dearden et al (2002: 11) suggest that those attending private or grammar schools might have better access to on-the-job training and a better ability to learn, which is illustrated by their acceptance into selective schools. This finding is consistent with an earlier study by Solmon (1981) which maintains that the quality of higher education affects individuals' later incomes more than it affects their initial incomes.

[3] In many developed countries, class size is dictated by pupil needs (Dearden et al, 2002: 5). Children with learning difficulties are often placed in smaller classes where attention can more readily be directed towards individual pupils, which would lead to the impact of the pupil-teacher ratio on education and labour market outcomes being negative.

Table 1 The Impact of School Input Quality on Earnings for Males aged 23

	Specification							
	I		II		III		IV	
Age	**23**	**33**	**23**	**33**	**23**	**33**	**23**	**33**
Dependent variable log of wage								
Pupil-teacher ratio (1974)	0.004	-0.005	0.003	-0.004	0.004	0.002	0.003	-0.0013
	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)	(0.006)	(0.005)	(0.006)
Single-sex school	-0.0029	-0.019	-0.020	-0.035	-0.026	-0.069	-0.027	-0.069
	(0.021)	(0.024)	(0.020)	(0.024)	(0.022)	(0.026)	(0.022)	(0.028)
Secondary modern school					-0.002	0.003	-0.001	-0.013
					(0.021)	(0.026)	(0.022)	(0.027)
Grammar school					0.029	0.058	0.024	0.086
					(0.029)	(0.035)	(0.028)	(0.036)
Private school					-0.006	0.195	-0.010	0.22
					(0.043)	(0.052)	(0.044)	(0.054)
Highest educational qualification by 1981								
Other	0.060	0.048	0.046	0.007	0.047	0.010		
	(0.033)	(0.056)	(0.033)	(0.054)	(0.033)	(0.054)		
Lower vocational	0.122	0.195	0.101	0.121	0.102	0.121		
	(0.030)	(0.053)	(0.032)	(0.052)	(0.032)	(0.052)		
Middle vocational	0.160	0.231	0.132	0.142	0.133	0.143		
	(0.029)	(0.054)	(0.320)	(0.054)	(0.032)	(0.054)		
A levels	0.106	0.393	0.085	0.270	0.082	0.253		
	(0.038)	(0.068)	(0.041)	(0.068)	(0.041)	(0.068)		
Higher vocational	0.182	0.421	0.158	0.316	0.158	0.321		
	(0.035)	(0.056)	(0.037)	(0.056)	(0.037)	(0.056)		
Degree	0.126	0.566	0.098	0.433	0.096	0.422		
	(0.041)	(0.057)	(0.043)	(0.058)	(0.044)	(0.058)		
P-value: local area characteristics	0.000	0.36	0.000	0.30	0.000	0.31	0.000	0.20
P-value: family background	0.37	0.52	0.41	0.53	0.44	0.53	0.21	0.12
P-value: test scores at age 7			0.23	0.003	0.25	0.007	0.15	0.000
P-value: test scores at age 11			0.68	0.12	0.69	0.09	0.32	0.000
P-value: test scores at age 7 and 11			0.34	0.000	0.40	0.000	0.017	0.000
R^2	0.1096	0.309	0.119	0.334	0.120	0.341	0.106	0.277
Number of observations	1700	1523	1700	1523	1700	1523	1700	1523

* standard deviations in parentheses.

Source: Dearden et al (2002: 10).

Although many of the earlier studies assert that educational inputs are instrumental in determining labour market outcomes[4], once cannot confidently state that these findings are conclusive. Many other studies (such as Morgan and Duncan, 1979) have also found a weak to non-existent relationship between education quality (as measured by the input method) and labour market outcomes. These seemingly contradictory findings could simply be because of methodological differences and the fact that the nature of datasets used differed substantially in most cases. The developing country literature has not produced much evidence related to input-based educational quality and the labour market, in large part because the measurement of even the most basic indicators is weak and quite possibly because linking labour market participants to the schools they attended is nigh on impossible due to confidentiality concerns. As a result of inconclusive findings surrounding education input quality, poor data and the realisation that not all schools convert education inputs equally successfully to the desired *outputs*, the debate has now shifted to the impact of education *output* quality (as measured by standardised test scores or pass rates) on individual labour market outcomes and economic growth.

3.2 Education quality and the labour market: cognitive skills as a measure of education quality

Since the 1990s, there has been a burgeoning body of evidence from developed countries such as the United States and the United Kingdom in support of the impact of cognitive skills (or education *outputs*) on individual labour market prospects. The evidence from developed countries is quite clear – the earnings premium associated with higher scores on standardised tests is considerable. The first subsection here deals with recent empirical work by Murnane et al (1995) and Tyler et al (1992) who both use a Mincerian function augmented by a measure of cognitive skills as the focal point of their discussion, but differ slightly in their approaches to determine the impact of cognitive skills on individual earnings in the United States.

It is questionable whether the clear relationship between cognitive skills and earnings in developed countries such as the United States is generalisable to developing countries as well. The second subsection discusses some of the recent empirical work done in developing countries, with a particular emphasis on African countries and the attendant challenges of reliably estimating the impact of cognitive skills on labour market outcomes.

The third subsection discusses two South African attempts by Moll (1998) and Chamberlain and Van der Berg (2002) to uncover the relationship between cognitive skills and labour market outcomes. The studies differ slightly in motivation, but both hypothesise (and show to varying degrees) that cognitive skills are a key determinant of labour market success.

[4] See for example Card and Krueger (1990) who find that the pupil-teacher ratio, average length of the school term and average teacher salaries matter for future earnings.

3.2.1 Cognitive skills and the labour market: developed countries

In the early 1990s a number of studies asserted that competitive pressures had forced many manufacturing firms to restructure their staff complements and acquire more advanced technology in a bid to cut costs and maximise revenues (e.g. Marshall and Tucker, 1992). The restructuring resulted in a rapidly increasing demand for more advanced occupational skills which had consequences for U.S. schools as well. Although the increase of the within-group (race, age category, gender, education levels) wage dispersion between the 1970s and 1990s insinuated that there was a growing demand for skilled workers (Katz and Murphy, 1992), there was surprisingly little empirical research indicating *which* skills were responsible for the wage inequality within groups.

Murnane et al (1995) examine two longitudinal studies, the National Longitudinal Study of the High School Class in 1972 (NLS72) and High School and Beyond (HS & B), to determine how important basic cognitive skills (distinct from formal schooling) were in the determination of within-group wage differentials. Both studies administered tests which assessed vocabulary, reading and mathematics skills which were then scaled using an Item Response Theory model to ensure comparability within and across the two datasets (Murnane et al, 1995: 253). The IRT-scaled mathematics scores proved to be most consistent across datasets and were therefore used as a primary measure of cognitive skill levels. Both longitudinal studies provide labour market information about respondents six years after high school graduation, which would allow most of the high school graduates to have some experience of the labour market.

Conventional earnings functions which include educational attainment, family background and other control variables as regressors are shown separately for males and females in Tables 2 and 3 (column I and III). Column II and IV present the same earnings function, but add the IRT-scaled mathematical score as an independent variable. The reference group consists of white high school graduates who were in families with both parents present and who did not attend school in the South at the time of the initial survey.

For the most part, the family background variables are consistent with other labour market literature. The number of siblings negatively affects the logarithm of wages for both genders, while mother's and father's education levels affect only females' wages positively. Living in a single-parent household would intuitively have a negative impact on wages, but here it is statistically significant and does not have the expected sign in some instances. It is possible that this family structure variable is specified too simplistically; the variable reflects family structure in the senior high school year and gives no indication of how long the household had been one with a single parent or in the case of a two-parent household, whether both parents were biologically related to the student.

Table 2 The estimated impact of various education variables on the logarithm of wage: 6 years after graduation for males

	NLS72		HS & B	
	I	II	III	IV
Education				
Years of schooling completed after grade 12	0.022	0.013	0.044	0.021
	(3.63)	(1.85)	(5.72)	(2.22)
Mathematics Score		0.004		0.011
		(3.13)		(5.06)
Family Background				
Single Parent Household	-0.018	-0.017	-0.030	-0.031
	(-0.913)	(-0.082)	(-1.19)	(-1.25)
Number of siblings	-0.006	-0.006	-0.011	-0.010
	(-1.95)	(-1.97)	(-1.97)	(-1.84)
Mother's Highest Grade Completed	-0.006	-0.007	0.006	0.004
	(-1.62)	(-1.81)	(1.10)	(0.777)
Father's Highest Grade Completed	0.002	0.001	-0.008	-0.007
	(0.572)	(0.288)	(-1.50)	(-1.43)
Controls				
Attended High School in the South	-0.071	-0.071	-0.045	-0.028
	(-5.49)	(-5.44)	(-2.22)	(-1.38)
Black	-0.066	-0.042	-0.116	-0.056
	(-2.97)	(-1.78)	(-4.48)	(-1.98)
Hispanic	-0.048	-0.031	0.015	0.062
	(-1.62)	(-1.02)	(0.640)	(2.46)
Years full-time work experience	0.045	0.043	0.022	0.020
	(8.08)	(7.68)	(2.89)	(2.63)
Years part-time work experience	-0.001	-0.002	0.017	0.015
	(-0.107)	(-0.218)	(1.55)	(1.37)
Wage for part-time work	-0.067	-0.066	-0.032	-0.032
	(-1.84)	(-1.80)	(-0.572)	(-0.576)
Intercept	1.92	2.01	1.52	1.69
R^2	0.038	0.041	0.061	0.078
Number of observations	4114	4114	1980	1980

* t-values in parentheses.

Source: Murnane et al (1995: 257).

Table 3 The estimated impact of various education variables on the logarithm of wage: 6 years after graduation for females

	NLS72		HS & B	
	I	II	III	IV
Education				
Years of schooling completed after grade 12	0.054	0.037	0.065	0.037
	(11.07)	(6.74)	(10.63)	(5.32)
Mathematics Score		0.009		0.017
		(7.18)		(8.57)
Family Background				
Single Parent Household	-0.017	-0.007	0.014	0.004
	(-1.07)	(-0.448)	(0.640)	(0.198)
Number of siblings	-0.002	0.002	-0.007	-0.007
	(-0.792)	(-0.744)	(-1.42)	(-1.55)
Mother's Highest Grade Completed	0.008	0.006	0.015	0.014
	(2.40)	(1.86)	(3.20)	(2.97)
Father's Highest Grade Completed	0.007	0.005	0.005	0.003
	(2.40)	(1.88)	(1.23)	(0.697)
Controls				
Attended High School in the South	-0.041	-0.039	-0.094	-0.077
	(-3.47)	(-3.30)	(-5.51)	(-4.57)
Black	0.002	0.052	-0.025	0.057
	(0.086)	(2.67)	(-1.15)	(2.42)
Hispanic	0.008	0.045	0.047	0.105
	(0.291)	(1.57)	(2.26)	(4.91)
Years full-time work experience	0.026	0.023	0.049	0.042
	(5.25)	(4.57)	(7.44)	(6.57)
Years part-time work experience	-0.003	-0.005	0.022	0.013
	(-0.360)	(-0.579)	(2.66)	(1.60)
Wage for part-time work	-0.041	-0.045	0.010	0.030
	(-2.26)	(-2.49)	(0.288)	(0.870)
Intercept	1.05	1.21	0.720	0.940
R^2	0.078	0.094	0.131	0.171
Number of observations	3925	3925	2163	2163

* t-values in parentheses.

Source: Murnane et al (1995: 257).

Educational attainment (years of schooling after high school) seems to have become more important over time. Columns I and III (not explicitly accounting for cognitive skill) show that each additional year of post-secondary education accounted for a moderate wage premium for the class of 1972 while the class of 1980, shown by columns III in Tables 2 and 3 respectively, saw a 4.4% increase in the male wage and a 6.5% increase in the female wage for each additional year of tertiary education completed. The relatively small sise of the college education coefficient is explained by the fact that 24 year olds (the age of most of the respondents) who graduate from college would not yet have experienced the steep increase in the earnings trajectory associated with college education so early in their careers (Murnane et al, 1995: 257).

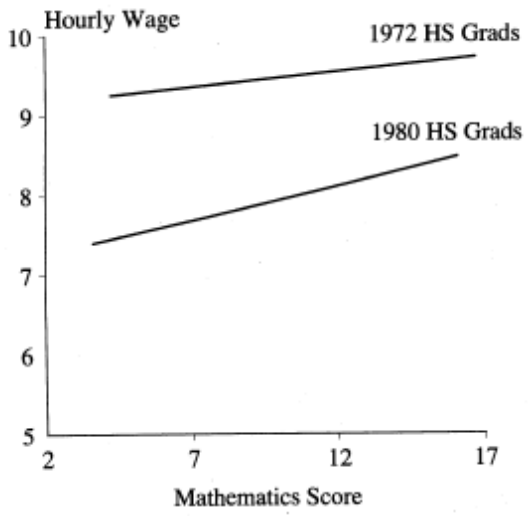
The most striking result from Murnane et al (1995) is the fact that once the mathematics score variable is included, it reduces the impact of the educational attainment variable by 41% for males who graduated in 1972 and 52% for those who graduated in 1980. For females the educational attainment coefficient is reduced by 31% and 43% respectively for the 1972 and 1980 high school graduates. Remarkably, when comparing the female wage premium for each additional year of college education in 1972 and 1980, it seems as if the increase in the return to college education is entirely explained by the increase in the return to cognitive skills (educational attainment coefficients unchanged in columns b and d in Table 3).

Murnane et al (1995: 259) then use the mathematics score coefficient to predict the relationship between the mathematics score and the hourly wage for 1972 and 1980 high school graduates. The analysis is restricted to individuals with no post-secondary education to reduce the bias associated with more mathematically able individuals being more likely to start attending colleges. Figures 2 and 3 illustrate the relationship between the wage and the mathematical score for males and females respectively. The endpoints of each line represent the predicted wage based on mathematical scores points 6.25 points (one standard deviation) above and below the mean.

Both graphs above show that the wage premium associated with higher mathematical scores increased between 1972 and 1980. For 1972 graduates the wage differential associated with a 6.25 point difference is $0.24[5] per hour for males and $0.39 for females. For 1980 graduates the same mathematical score differential translates into a wage that is $0.57 per hour higher for males and $0.74 higher for females. Males who graduated in 1980 and had weak math skills (at the lower endpoint in Figure 3) at the time of testing would earn approximately $7.40 per hour, which would translate into just under $13 000 per year, which is barely above the 1988 poverty line for a three-person family. This, coupled with the increase in the skill-related premium for both genders between 1972 and 1980, lead Murnane et al (1995: 260) to advocate the mastery of basic mathematical (cognitive) skills as imperative to poverty reduction and economic growth.

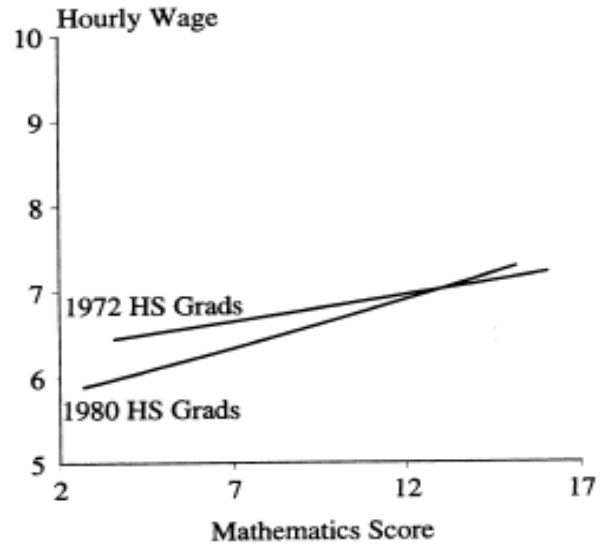
[5] All values in this section are expressed in 1988 dollars.

Figure 2 Fitted relationship between the mathematics score in the graduation year and earnings at age 24 for males



Source: Murnane et al (1995: 259).

Figure 3 Fitted relationship between the mathematics score in the graduation year and earnings at age 24 for females



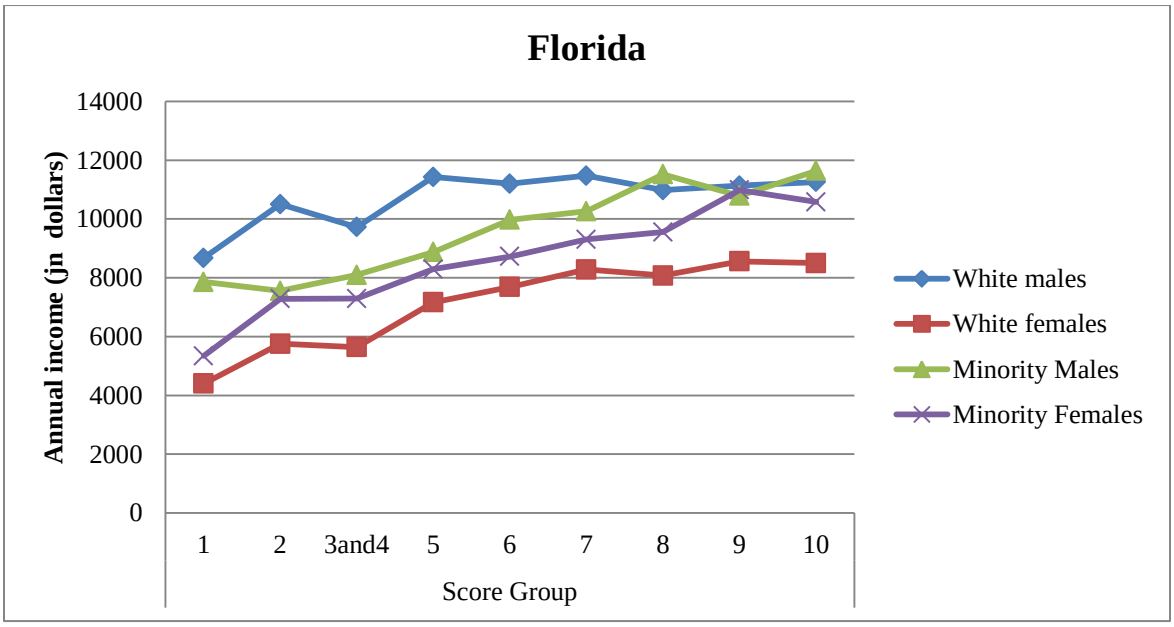
Source: Murnane et al (1995: 260).

There are a number of problems which could impede attempts to investigate the impact of cognitive skills on labour market productivity and earnings (Tyler et al, 2000: 749). Firstly, the tests which are designed to capture cognitive skill data may be inconsequential to the test-taker;

for example, it is not inconceivable that a clothing sales assistant might not score as high on an algebraic test as his educational attainment might suggest simply because the questions might test proficiency in areas which are irrelevant to the individual's daily life. The scores would therefore be exposed to some measurement error, which would be more likely if many individuals find test-taking unpleasant. Differing levels of motivation, which are generally not accounted for by tests, could also lead to biased results if the test-taker is reluctant to take the test.

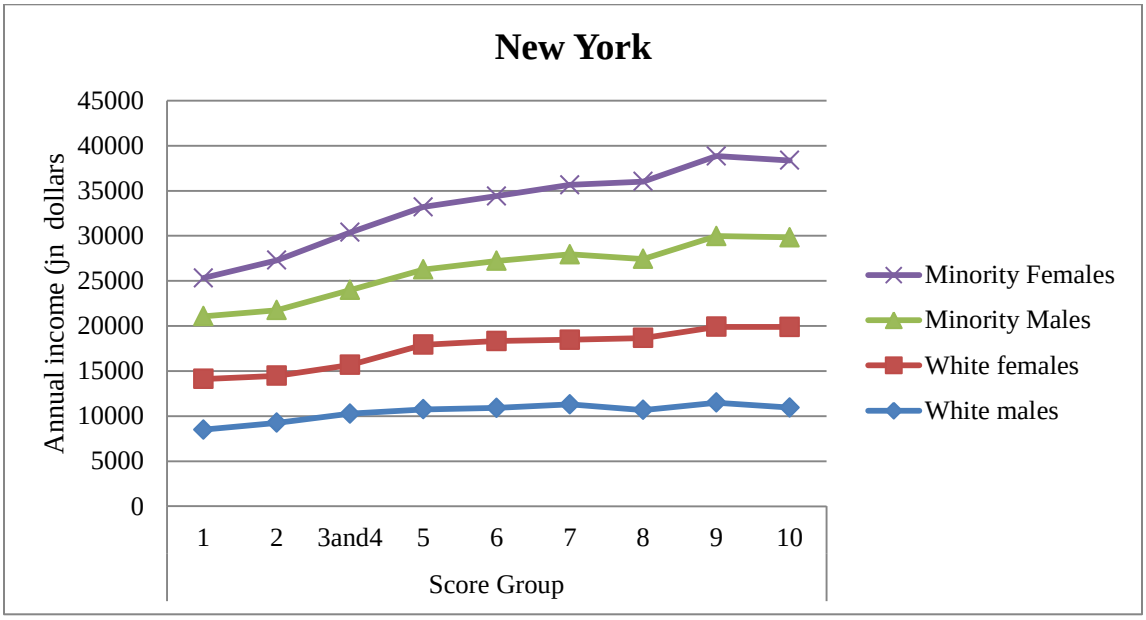
Tyler *et al* (2000) avoid some of the motivation bias issues which often are part and parcel of data collected from adults who voluntarily submit themselves to cognitive skills tests. They examine the impact of cognitive skills on wages for high school dropouts in New York and Florida who write the GED examination. The approach is defensible in that it only considers those individuals who are motivated to perform well (the stakes are markedly higher for a GED-examinee than for a respondent who needs to volunteer for a cognitive skills test). Figures 4 and 5 show the relationship between GED scores and wages five years later.

Figure 4 Wage data 1994 to 1995 for 24 to 26 year olds who had written the GED examination in 1989 or 1990 (Florida)



Source: Graph constructed from GED data presented in Tyler et al (2000: 752).

Figure 5 **Wage data 1994 to 1995 for 24 to 26 year olds who had written the GED examination in 1989 or 1990 (New York)**



Source: Graph constructed from GED data presented in Tyler et al (2000: 752).

The results in Figures 5 and 6 clearly show that for the most part the higher the GED score, the higher individual earnings are five years after the examination. The same is true of individuals who pass or fail the GED examinations – higher scores are positively correlated with higher average annual earnings.

3.2.2 Cognitive skills and the labour market in developing countries

In developed and developing countries the acquisition of cognitive skills by children while still at school plays a crucial role in determining their living standards later in life. Earlier literature emphasised the importance of educational attainment in wage determination, which many economists believed to be synonymous with cognitive skill acquisition. Mincerian earnings regressions often yielded the same results – better-educated individuals experienced better labour market outcomes than their less-educated peers.

The apparent and ongoing failure of developing countries to catch up to developed countries in terms of economic growth and societal welfare is well-documented. Development strategies in these countries have typically concentrated on increasing educational attainment in order to improve productivity and economic well-being, with many countries making significant strides in improving access to education and average educational attainment. Despite these improvements in schooling opportunities and education levels, quite often the desired individual

and societal outcomes have not been realised. Unfortunately, for large parts of the population in most developing countries, education levels and cognitive skills are not synonymous. Many of these countries are plagued by deficiencies and inefficiencies on the demand and supply sides of education and labour markets.

The largest impediment to rigorously investigating the impact of education on labour market outcomes in developing countries is the scarcity of datasets which include some measure of cognitive skill and a reliable welfare indicator such as income at the individual level. Further estimation problems arise in developing countries due to the high rates of unemployment and self-employment while developed countries have relatively low rates of unemployment and large proportions of the labour force which are wage earners. Additionally, where there are a small number of wage earners a large proportion of those workers may be employed by government. Since very few incentives exist for government to pay employees their marginal product, returns to education for the employed could be driven largely by government salary scales rather than market-related rewards for education. Nevertheless there are a number of studies in developing countries where valiant attempts have been made to uncover the relationship. This section of the paper considers some of the empirical literature on developing countries, with particular attention being paid to sub-Saharan African countries.

Much of the work in developing countries has focused on the wage-earning segment of the population. One of the first investigations of its kind was conducted by Boissiere et al (1985) who focused on wage earners in urban Tanzania and Kenya. Two comparable surveys, which were dedicated to understanding urban wages, were used to determine the impact of work experience, educational attainment in years, native ability (measured by the Raven's abstract thinking ability test) and the sum of literacy and reading tests. A large proportion of Tanzania's workers were employed by government at the time (Boissiere et al, 1985: 1017), thus the primary aim was to determine whether the positive education-earnings relationship was driven by credentialism[6] or whether actual productive characteristics accounted for wage differentials. The results from earnings regressions in both countries are shown below, where the regressors are years of experience (years after completion of school education), a dichotomous variable indicating whether an individual had completed high school or not, cognitive skills (the combined score on reading and literacy tests) and reasoning ability as measured by the Raven's test. The earnings functions for different types of workers in Kenya and Tanzania are shown in Table 4.

[6] Credentialism is defined as 'the undue emphasis on credentials (as college degrees) as prerequisites to employment (Merriam-Webster, 2011) .

Table 4 Human capital earnings functions with and without measures of ability and cognitive skills in Kenya and Tanzania

Kenya	Whole Subsample (1)	Whole Subsample (2)	Primary Leavers (3)	Secondary Leavers (4)	Manual Workers (5)	White-Collar workers (6)
Year of experience	0.042	0.045	0.031	0.062	0.036	0.049
	(8.40)	(9.84)	(4.49)	(10.20)	(6.02)	(8.64)
Completed high school or not	0.476	0.192			0.065	0.030
	(6.70)	(2.47)			(0.650)	(0.23)
Cognitive skills		0.020	0.019	0.023	0.013	0.017
		(6.18)	(3.98)	(5.40)	(3.21)	(3.55)
Reasoning ability		0.006	-0.000	0.014	0.003	0.011
		(1.32)	(0.02)	(2.17)	(0.50)	(1.46)
Constant	6.297	5.459	5.811	5.171	5.866	5.705
R^2	0.29	0.44	0.39	0.50	0.32	0.49
Number of observations	205	205	71	134	116	88
Tanzania						
Year of experience	0.054	0.055	0.049	0.066	0.044	0.061
	(9.70)	(10.10)	(7.13)	(7.06)	(4.88)	(7.82)
Completed high school or not	0.280	0.112			0.141	0.068
	(4.30)	(1.42)			(0.85)	(0.58)
Cognitive skills		0.013	0.009	0.013	0.008	0.012
		(3.22)	(1.66)	(2.29)	(1.16)	(2.25)
Reasoning ability		0.001	-0.001	0.010	-0.004	0.013
		(0.15)	(0.21)	(1.01)	(0.64)	(1.51)
Constant		5.752	5.908	5.476	5.027	5.423
R^2	0.38	0.43	0.34	0.47	0.24	0.46
Number of observations	179	179	107	72	87	88

*t-values in parentheses
Source: Boissiere et al (1985: 1021).

In Kenya each year of employment experience equates to a 4.2 percent increase in annual earnings while Tanzanian workers are paid a premium of 5.4 percent for each additional year of work experience. The schooling coefficient in column 1 suggests that high school graduates who complete high school earn 61 percent more than primary school graduates who drop outin Kenya, while high school graduates in Tanzania earn a premium of 32 percent. The dissimilarity in the education coefficients between the two countries is attributed to the compression of wages in the public sector which is the dominant employer in Tanzania (Boissiere et al, 1985: 1020).

Column 2 adds reasoning ability and cognitive skill levels to the regression. The addition of these two variables does not reduce the impact of experience, but the premium associated with secondary school attendance is diminished substantially. The impact of cognitive skills on wages is large relative to the ability coefficient and significant for workers, irrespective of highest level of education and occupational complexity (Boissiere et al, 1985: 1020).

Boisierre *et al*'s (1985) findings are encouraging (at least for Tanzania and Kenya) in that it implies that even in countries where government is the largest employer, educational attainment is more important for workers to develop productive characteristics (cognitive skills) than as a signal to *imply* productivity. For the reasons mentioned previously in this paper, significant bias in tests which measure ability and cognitive skills are quite probable in developing countries, but Boisierre *et al's* (1985) work is instructive nonetheless.

A more recent study by Alderman *et al*. (1996) which focuses on Pakistan directly confronts the estimation issues often faced by researchers in developing countries by controlling for sample selectivity issues and using instrumental variables for years of education, work experience and cognitive skill levels. The inclusion of health variables as regressors, although statistically insignificant, is interesting as most studies in developing countries ignore the impact of health on test scores and labour market outcomes. The findings are remarkably similar to those by Boissierre et al (1985); ability has no statistically significant influence on earnings and when cognitive skills are added to years of education as an explanatory variable, years of education becomes insignificant while cognitive skills remains statistically significant.

Although the positive sign of the cognitive skills coefficient in developing country wage regressions is encouraging, one should be cautious about interpreting the precise magnitude of the coefficient. Estimated returns to a standard deviation increase in cognitive skills in Ghana (Glewwe, 2002), for instance, range from 5 to 30 percent depending on the data being examined and the methodology used. Nevertheless, the overwhelming message from the developing country data is that cognitive skills development is critical to ensure labour market success.

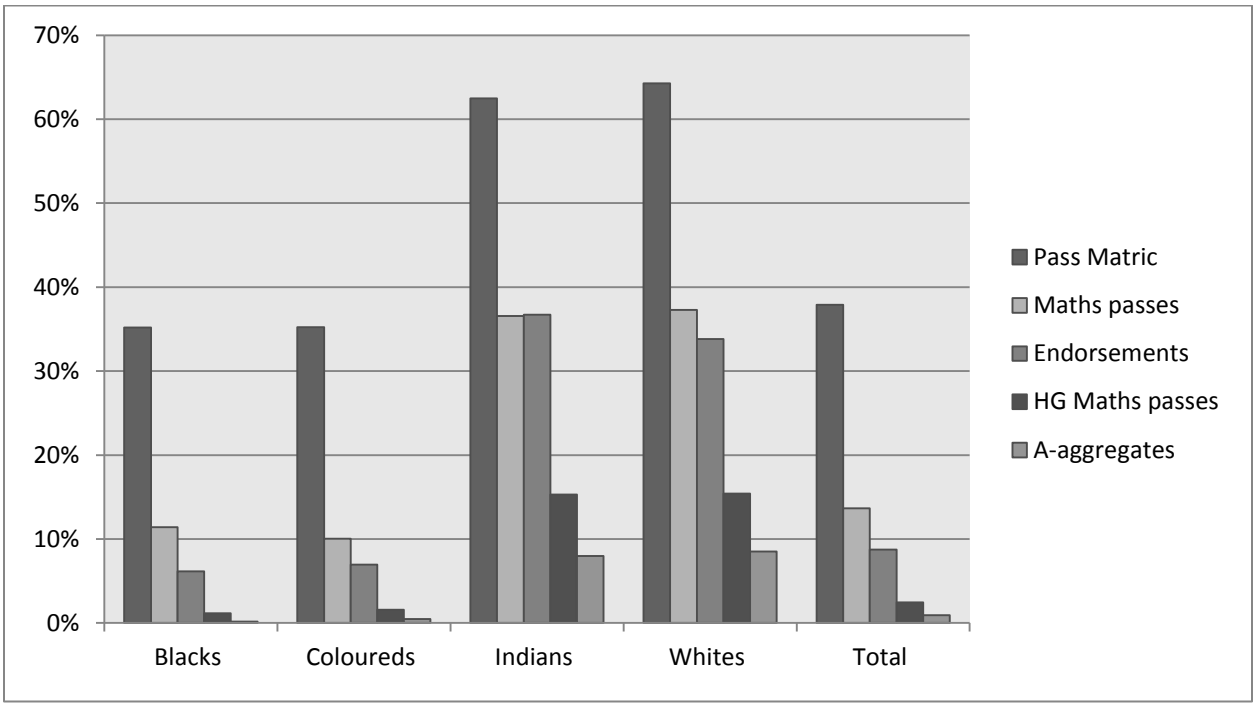
3.2.3 Cognitive skills and the labour market in South Africa: recent empirical research

The enduring impact of South Africa's previously racially segregated education system is still apparent in the large differentials in education quantity and quality as well as labour market outcomes between race groups today. Previous inequities in education spending and outcomes, along with a discriminatory labour market, manifested themselves in poor labour market outcomes for previous generations of non-whites. Less-than-desirable labour market outcomes for previous generations, along with an enduring apartheid-inspired geographical hierarchy, contributed and still contribute significantly to inequitable educational and labour market opportunities for many non-whites in South Africa.

Resource shifts to black schools and less attrition from the 1970s onwards had the desired effect of creating a more educated labour force. Mean educational attainment differentials between whites and blacks born in 1970 was only 3.6 years while for those born in 1980 that differential had decreased to a mere 2.3 years (Louw *et al*, 2005). Although this was a marked improvement on the 7.2 year differential between whites and blacks born in 1920, extreme earnings inequality persisted even after the demise of apartheid, due in part to past discriminatory labour market practices and in more recent times due to perceived differentials in the quality between whites and blacks with the same years of education.

Figure 6 provides some insight into the possible reasons for unequal earnings prospects between blacks and whites.

Figure 6 Matriculation pass rates and broad results by race: South Africa 2007



Source: Graph constructed using data from Van der Berg (2010).

The performance of black matriculants compared dismally to the performance of white students. Although 83 percent of all 2007 matric candidates were black, they only accounted for 59 percent of those students who passed with endorsements and could apply for university admission. Just over 1 percent of all black matric candidates qualified for admission to mathematical and scientific degree programmes, while 15 percent of their white counterparts satisfied the academic requirements for admission into these degree programmes.

Because of data availability and compatibility issues, much of the South African research has looked at the effects of education input quality on educational outcomes. However, there have

been some attempts at uncovering the relationship between education quality and labour market outcomes, two of which will be discussed here. Due largely to data constraints, neither of the attempts by Moll (1998) and Chamberlain and Van der Berg (2004) are wholly successful at revealing the impact of education quality on labour market earnings, but both are instructive.

Moll (1998) investigates the impact of pre-labour market discrimination on wages by testing whether the inferior education offered to blacks was successful in imparting cognitive skills to its pupils and whether those skills were equitably rewarded by the labour market. The basic model which underpins the investigation is guided by the theory of returns to formal education (Becker, 1975). The model is specified as:

$$Y = \mu_i \exp(\beta S + \alpha A + \alpha C + u_i),$$

where Y represents the wage, S years of schooling, A the measure of innate ability and C a cognitive skills measure which is driven by S and A.

Moll (1998) uses the 1993 Project for Statistics on Living Standards and Development (PSLSD) dataset to test his hypothesis that the apartheid education system had contributed little to the cognitive skill development of blacks in South Africa. The PSLSD surveyed 8800 urban and rural households on weekdays and generated data in wages, years of schooling, demographics and employment. In addition two members between the ages of 18 and 59 years in every six households was asked to completed a literacy test where six of the questions assessed language comprehension, six assessed computational ability and a further two questions were not strictly defined as fitting into the latter two categories. The fact that the test was conducted on weekdays might have contributed to some attrition of possible test-takers, resulting in a sub-sample of 2407 individuals who took the literacy test. Table 5 shows three of the questions from the PSLSD literacy test.

Table 5 Extract from the PSLSD Literacy Test, 1993

Comprehension

A. Question 3: 'When Mbaya was a child, he got very excited when his mother, Corfu, asked if he would like to go to the meat market with her. As they walked into the centre of town, the wondereful odours of meat – both fresh and spoiled – could be smelled up to 1 kilometre away. The hundreds of market stalls formed a row of 1 ½ kilometres long. It took almost one hour to walk slowly from one end of the meat market to the other.'

How long was the row of meat stalls, from one end to the other end? Tick one:

a) 1 ½ kilometres long
b) 1 kilometre long
c) It was very close from one end to the other end
d) Hundreds of stalls were lined up

B. Computation

Question 5: 103kg – 37kg = _____ kg
Question 6: R35.50 x 7 = R _____

Source: Project for Statistics on Living Standards and Development, 1993.

The literacy test was administered in the respondent's preferred vernacular and was intended to be comparable in complexity to examinations set for white and black Grade 7 students (Moll, 1993: 272). However, subsequent re-evaluation of the test by its compilers revealed that the the literacy test complexity was actually between Grade 3 and Grade 4. The mean literacy scores by educational attainment and race are shown in Table 6.

The combined results from the computational ability and comprehension test were scored out of 14. The average Asian and white passed the test (answered 7 or more questions correctly) comfortably at all levels of education (even those with less than a Grade 8 education) while coloureds with Grade 7 or higher were also able to accomplish the same feat. Blacks performed poorly, with the average black test-taker with less than Grade 12 education failing the test with a score of 5.7 or less. Blacks with 12 or more years of formal education barely passed the literacy test.

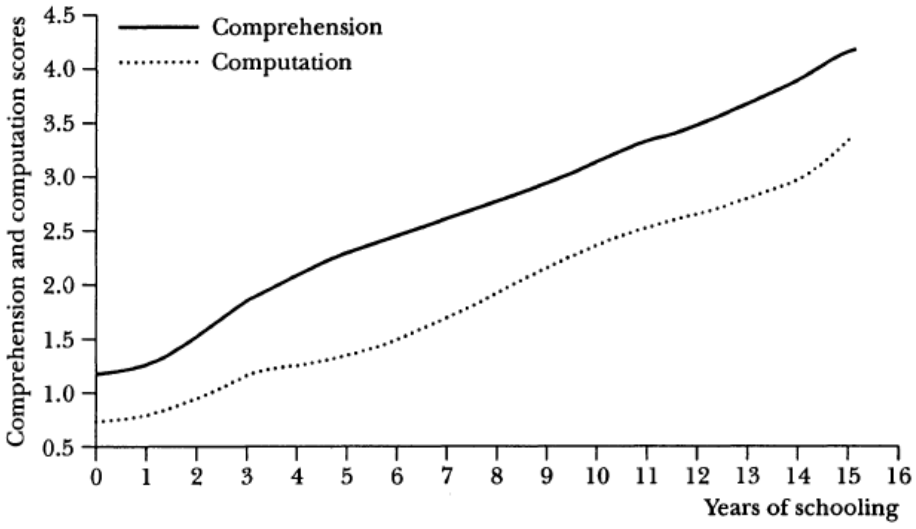
Table 6 Mean literacy test scores by race and highest educational attainment category

Population group	No schooling to grade 6	Grades 7 to 11	Grade 12 and tertiary
Black	3.1	5.7	7.5
(s.e. of mean)	(0.1)	(0.1)	(0.2)
N	470	768	109
Asian	9.5	10.0	10.7
(s.e. of mean)	(1.5)	(0.7)	(0.6)
N	2	27	15
Coloured	2.5	8.2	10.9
(s.e. of mean)	(1.2)	(0.5)	1.1)
N	12	37	7
White	9.4	9.0	11.3
(s.e. of mean)	(1.3)	(0.4)	(0.3)
N	10	48	41

Source: Moll (1998: 273).

The results of the computational and comprehension sections of the test (which were scored out of 6) for blacks are shown in figure 7.

Figure 7 Comprehension and computational ability scores for blacks by educational attainment, PSLSD 1993



Source: Moll (1998: 274).

Figure 7 illustrates just how dysfunctional the education system was which black individuals were exposed to. The average black person who had completed 12 years of education, or in other words achieved 50 percent or more for each school grade, only scored 2.5 out of a possible 6 points in a computational test which was designed for grade 5 or 6 learners. Figure 7 lends credence to Moll's (1998: 275) claim that the average black students were being promoted to secondary school despite being functionally illiterate. Those students who had completed 7 years of schooling scored 25 percent and 40 percent on computational and comprehension tests respectively. In addition students in the primary school grades were being promoted to high school to make space for new students. As dysfunctional as it appeared, the black education system was not entirely unable to develop cognitive skills, as Table 7 illustrates.

Column 1 reveals that home background (proxied by mother's education) is important for educational attainment, female benefit from 0.7 years more education than males and household durables (a proxy for access to credit) matter for years of schooling. Transport costs and distance to school negatively affect years of education, with distance to school affecting primary school students more profoundly than high school students. Column 2, where the overall test score is the dependent variable, shows that female test scores are not very different to male test scores.

The strongest determinant of the test score is years of schooling. Each additional year of schooling contributes 0.55 points to the test score. Despite low levels of public spending, dwindling teacher morale and frequent disruptions due to an explosive political situation, simply attending school for 12 years would ensure that black test-takers would achieve 6.6 more conditional points out of a possible 14. Of course this assertion does not account for the impact of innate ability, but it does make the point that the black education system contributed extensively to the development of human capital. The computational score coefficients in column 5 are 0.11 and 0.31 for the primary and secondary school spline respectively, indicating that much of the computational ability needed to pass a test aimed at Grade 7 pupils is only developed in the high school years.

Regressing the computational and comprehension test scores on the log wages reveals that although the comprehension score coefficient is insignificant, the computation score coefficient is relatively large and significant at 0.21 (Moll, 1998: 275). The coefficient on years of schooling is reduced from 0.15 to 0.10 (but not to zero) once test scores are included as regressors, indicating that there is some value in school attendance which is not reflected in test scores.

Table 7 Cognitive skills production functions for blacks, PSLSD 1993

Independent variables	Years' schooling OLS (1)	Total Score IV (2)	Comprehension OLS (3)	Comprehension OLS (4)	Computation OLS (5)	Computation OLS (6)	Means of vars. (std deviation)
Intercept	-1.8	2.6	1.6	1.6	1.9	2.3	
	(2.5)	(3.1)	(3.3)	(3.3)	(4.0)	(4.8)	
Urban Dummy	0.50	-0.53	-0.30		-0.17		0.39
	(1.8)	(1.5)	(1.8)		(1.0)		(0.49)
Female Dummy	0.72	-0.080	-0.050	00007	-0.090	-0.15	0.56
	(3.9)	(0.3)	(0.5)	(0.1)	(0.8)	(1.2)	(0.50)
Age	0.41	-0.062	0.0014	-0.014	-0.046	0.083	17.3
	(14)	(0.7)	(0.1)	(0.6)	(2.1)	(3.4)	(3.0)
Schooling		0.55					7.7
		(2.8)					(2.8)
Schooling splines							
Primary			0.19	0.17	0.11	0.068	6.2
			(4.9)	(3.9)	(2.7)	(1.5)	(1.6)
Secondary			0.19	0.17	0.31	0.37	1.5
			(4.2)	(3.5)	(6.8)	(7.3)	(1.6)
Tertiary			0.56	0.64	-0.014	-0.20	0.03
			(2.3)	(2.6)	(0.1)	(0.7)	(0.2)
Mother's education	0.17	0.084	0.041	0.031	0.043	0.030	4.9
	(6.6)	(1.7)	(2.7)	(1.6)	(2.7)	(1.5)	(3.9)
Pupil-classroom ratios							
Primary	-0.001	-0.012	-0.0038		-0.0081		46
	(0.2)	(2.1)	(1.3)		(2.8)		(20)
Secondary	0.0058	-0.011	-0.0067		-0.0037		49
	(1.4)	(2.1)	(2.5)		(1.4)		(21)
Distance to school (km)							
Primary	-0.14						0.94
	(2.9)						(1.9)
Secondary	-0.027						2.5
	(1.6)						(5.6)
Transport costs (R/week)							
Primary	-0.13						0.26
	(3.0)						(2.1)
Secondary	0.013						1.1
	(1.1)						(7.3)
Durables in Household	0.16						6.0
	(3.4)						(2.1
City dummies	Yes	Yes	Yes	No	Yes	No	
Cluster dummies	No	No	No	Yes	No	Yes	
Mean of dependent variable	7.8	5.3	2.8	2.8	1.9	1.9	

* t-values in parentheses

Source: Moll (1998: 279).

The results of the South African study by Moll (1998) are compromised to some degree by the fact the same test (which was designed for Grade 7 pupils) was administered to all respondents regardless of their educational attainment and thus could not be an adequate measure of ability for those who had completed at least some high school or tertiary education. Glewwe (2002: 470) also questions whether wages closely reflect actual productivity as it is unclear how many of the respondents were government workers. Despite these criticisms the work by Moll (1998) offers an interesting, well-structured look at the reasons behind and the eventual labour outcomes associated with poor education quality for black South Africans.

Chamberlain and Van der Berg (2002) hypothesise that once education quality differences between blacks and whites are accounted for, the unexplained part of the wage gap (residual) normally referred to as labour market discrimination will be reduced. This is not to imply that labour market discrimination does not exist, but rather to determine how much of that discrimination is rooted in the labour market itself and how much of it stems from factors affecting human capital before entering the labour market. The authors use test scores obtained from the Project for Statistics and Living Standards and Development 1993 (PSLSD) to predict the test scores for respondents to the October Household Survey 1995 (OHS95) and eventually construct an educational quality variable from these test scores. A three-phased approach is used to account for differences in the impact of labour market variables when (1) individuals decide whether or not to enter the labour market, (2) what their employment probabilities are once they decide to participate and (3) their earnings if they are actually employed. The final results of their paper are shown below in Table 8 which shows how wages would differ for blacks if white characteristics were applied to the black population.

Table 8 Accounting for the wage gap by applying white characteristics to the black population

Level of educational quality (1)	Average black wage (2)	Average white wage (3)	Wage gap accounted for by white characteristics (4)	Wage gap unaccounted for even with white characteristics applied (5)	Residual as a % of the white wage (6)
0%	R1589	R 6989	R 2150	R 3250	46.5%
10%	R1589	R 6989	R 2161	R 3239	46.3%
20%	R1589	R 6989	R 2206	R 3194	45.7%
40%	R1589	R 6989	R 2341	R 3059	43.8%
80%	R1589	R 6989	R 3335	R 2064	29.5%

Source: Chamberlain and Van der Berg, 2002.

Table 8 shows that if one does not adjust for educational quality and if the average black wage earner had the same characteristics as his white counterpart, he would earn R 3739. Therefore R3250 or 46.5 percent of the white wage remains unexplained, which would generally be

attributed to discrimination within the labour market. However, once education quality differences between blacks and whites are accounted for, the size of the residual in relation to the white wage decreases in accordance with the 'strength' of the education quality adjustment applied. Although the residual decreases with each incremental adjustment for quality, it is not until the weight of the quality adjustment reaches 80 percent or more that the wage gap between blacks and whites is reduced substantially to 29.5 percent of the white wage.

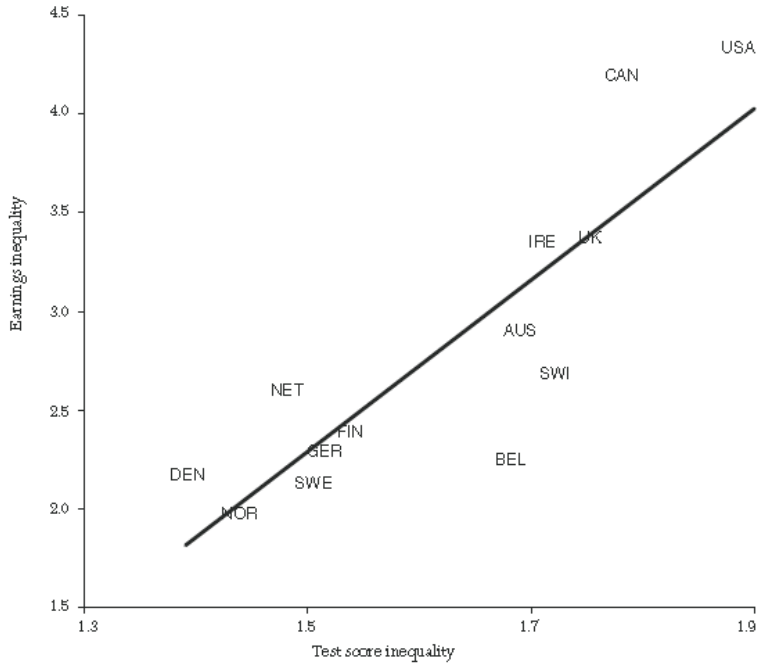
In the absence of clear measures of quality or reliable indicators of income in one dataset, Chamberlain and Van der Berg (2002) use a novel approach of combining datasets to tease out a relationship between education output quality (as measured by PSLSD test scores) and labour market outcomes. This solution, although crude, at least confirms the results of international studies on the same topic and highlights the importance of cognitive skills in predicting labour market earnings.

3. COGNITIVE SKILLS AND ECONOMIC GROWTH

Much of the focus of this review has been on the importance of cognitive skills on individual productive characteristics and earnings prospects. Economic growth is indicative of improvements in overall standards of living – educated individuals make others better by sharing their knowledge, more skilled societies are more likely to be innovative and firms could become more productive when individuals are better educated because they could seamlessly introduce new technology (Hanushek, 2008: 43). These externalities associated with a better-educated society are by no means exhaustive, but illustrate the possible avenues through which a society could access a higher economic growth plane.

The distribution of earnings within countries is also determined by the prevailing distribution of cognitive skills. Figure 8 shows the earnings inequality associated with the International Adult Literacy Survey test score inequality. The y-axis measures inequality as the earnings of the 90^{th} percentile divided by the earnings of the 10^{th} percentile while the x-axis measures test score inequality in the same way.

Figure 8 The relationship between prose test score inequality and earnings inequality by country



Source: Hanushek and Woessmann (2007: 628).

The correlation between test score inequality and earnings inequality is 0.85, testament to the fact that the distribution of cognitive skills is closely associated with the distribution of earnings. Although the figure is silent on the direction of causality, it does communicate the relationship between earnings and cognitive skills quite powerfully.

Initial research by Hanushek and Kimko (2000) revealed that labour force quality (as measured by mathematics and science tests administered by the IEA[7]) is a key determinant of economic growth. Their approach is to combine all of the IEA test scores into indexes of education quality which vary by country. Basic statistical models which include the initial gross domestic product, average years of schooling and population growth rates are used to explain the reasons for differing growth rates between countries for the period 1960 to 1990. Their main finding is that a one standard deviation difference in the education quality index would lead to a 1.1 percent change in annual per capita GDP growth rates.

Hanushek and Woessmann (2007: 36) distinguish between countries based on membership of the OECD and their initial level of GDP. Columns 1 and 2 classify countries as developing countries or OECD members while columns 3 and 4 classify those countries earning less than the sample

[7] The International Association for the Evaluation of Educational Achievement (IEA) started administering cognitive skills tests in 1963. Although the initial tests were crude in design, they did prove the importance and feasibility of cognitive skill testing.

mean of GDP as low-income countries and those earning more as high-income countries. The impacts of years of education and a measure of cognitive skills are shown in Table 9.

Table 9 The impact of education on per capita GDP growth rates: 1960 to 2000

	Developing countries (1)	OECD sample (2)	Low-income countries (3)	High-income countries (4)
GDP per capita	-0.262	-0.301	-0.063	-0.294
	(1.77)	(5.81)	(0.28)	(6.38)
Years of schooling	0.025	0.025	0.006	0.152
	(0.20	(0.26)	(0.05)	(1.70)
Test score (mean)	2.056	1.736	2.286	1.287
	(6.10)	(4.17)	(6.98)	(5.37)
Constant	-5.139	-3.539	-6.412	-2.489
	(3.63)	(1.96)	(4.52)	(2.86)
N	27	23	25	25
R^2 (adj.)	0.676	0.830	0.707	0.783

*t-values in parentheses

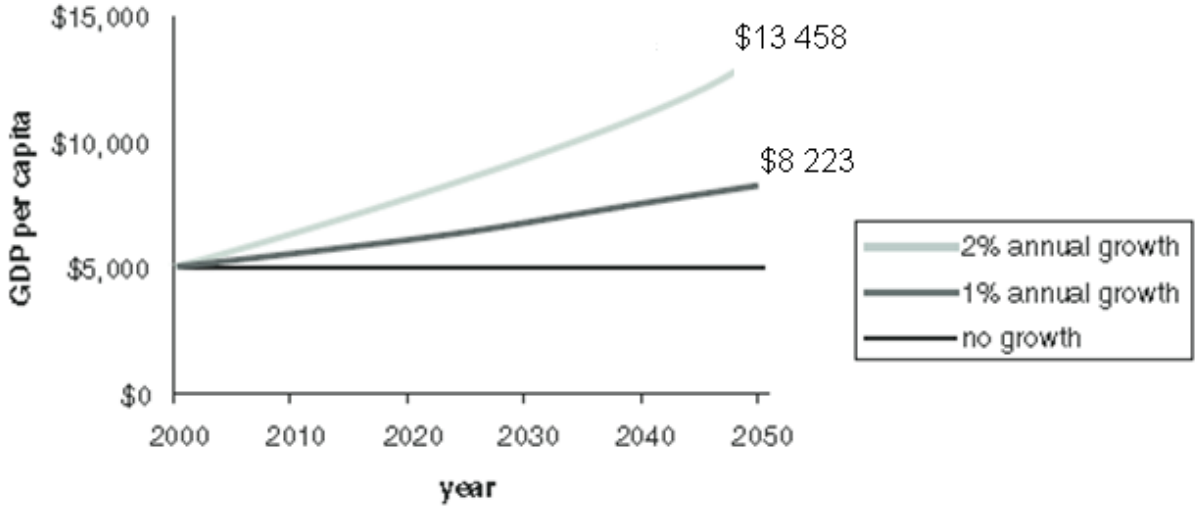
Source: Hanushek and Woessmann (2008).

Table 9 clearly illustrates the importance of cognitive skills in promoting economic growth. The effects of cognitive skills on growth rates of GDP per capita are much more profound in low-income countries, underlining the urgency of improving cognitive skills in developing countries.

Although the impact of labour force quality on economic growth appears small in the short-term, the long-term benefits are quite substantial. Figure 9 (Hanushek, 2008: 44) illustrates how GDP per capita for a medium-income country would increase in the long-term at differing growth rates.

If Hanushek's (2008) projections are to be believed, the potential long-term benefits of labor force quality are quite substantial. Cognitive skills on its own could increase per capita income by more than 60 percent for those countries growing at a rate of 1 percent. Earlier papers also stressed the importance of cognitive skills in promoting economic growth with some even finding that cognitive skills outdoes simple quantitative measures of education in explaining economic growth rates (see for example Bosworth and Collins, 2003). Although there is some doubt that these findings on economic growth are plausible for developing countries (due to their limited participation in the International Adult Literacy Survey), the microeconomic studies conducted in developing countries thus far seem to support the notion that improving cognitive skills would be in the best interests of economic growth as well.

Figure 9 The effects of different economic growth rates on long-term GDP per capita



Source: Hanushek (2008).

4. CONCLUSION

The studies discussed in this literature review yield a number of interesting conclusions. Firstly, more education *inputs* do not necessarily translate better education *output quality*. Secondly, formal education is valued quite highly for its perceived role in imparting cognitive skills to school-going individuals, particularly in developing countries. Thus wages are determined to a large extent by the cognitive skills developed while at school which increase productivity or signal productivity to prospective employers. In developing countries much of the population cannot provide the complementary resources required to ensure that optimal learning takes place, thus it is largely up to the state to ensure that publicly provided education is of such a quality that family background variables do not affect labour market prospects much.

Many of the datasets used in the research discussed here rely on simple mathematics and comprehension tests as measures of cognitive skill which could be problematic in that these tests might not be representative of the actual skills rewarded in the labour market. In order to credibly uncover the relationship between cognitive skills and labour market outcomes and economic growth in developing countries, new household surveys expressly designed for that purpose need to be designed and administered. Although the initial planning and implementation of such household surveys are likely to be costly, the long-term benefits of being able to quantify the benefits and outcomes of attempts to improve education quality should far outweigh the costs.

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