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THE IMPACT OF THE INTRODUCTION OF GRADE R ON LEARNING OUTCOMES

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Glossary

ASSA	Actuarial Society of South Africa
DBE	Department of Basic Education
DoE	Department of Education
ECD	Early Childhood Development
ECLS-K	Early Childhood Longitudinal Study-Kindergarten cohort
GER	Gross Enrolment Rate
Grade R	School reception year for five-year olds
NIP	National Integrated Plan
NIP for ECD	National Integrated Plan for Early Childhood Development
pre-K	pre-Kindergarten
SACMEQ	Southern and Eastern Africa Consortium for Monitoring Education Quality
SES	socioeconomic status
SD	standard deviations
SA	South Africa
UNESCO	United Nations Education and Science Organisation
USA	United States of America
US	United States (of America)
UK	United Kingdom

Policy summary

In December 2012 the Department of Performance Monitoring and Evaluation (DPME) in the Presidency in partnership with the Department of Basic Education (DBE) commissioned an Impact Evaluation of the Grade R programme. Through combining various data sources it was possible to create a very large dataset of 18102 schools, which allowed precise measurement of the impact of Grade R on test performance in mathematics and home language for Grades 1 to 6.

Key policy findings from the Impact Evaluation are:

- **There has been a massive expansion of the provision of Grade R.** Between 2001 and 2012 Grade R places in public and independent schools expanded more than threefold, from 242 000 to 768 000, meaning 45 000 additional learners and a thousand classrooms per year. A further 55 000 children attend Grade R in ECD centres meaning a total of 804 000 Grade Rs. 78% of 5-year olds were in some sort of education programme in 2009, up from 39% in 2002. More than 90% of all Grade Rs are in public schools, and 89% of public primary schools offer Grade R.
- **However, the impact of Grade R in South Africa is small and there is virtually no measurable impact for the poorest three school quintiles, while there are some impacts for the higher quintile schools. Thus, instead of reducing inequalities, Grade R further extends the advantage of more affluent schools.** Grade R impacts convert to only 12 days of normal learning gains in maths and 50 days in home language (for a school year of 200 days). Results are better in higher quintiles, better performing schools, and educationally stronger provinces (Gauteng, Northern Cape and Western Cape).
- **The cost per public ordinary school learner (excluding Grade R) in 2011/12 was R10 500, but for Grade R it was only R3 112 per year**. Actual spending may be higher, given inaccuracies in how Grade R spending is categoriseor recordedLow spending per learner suggests cross-subsidisation of Grade R from other programmesd. Even considering the low (and probably under-estimated) cost of providing Grade R places, Grade R is not cost-effective in terms of learning outcomes: A lot is spent on the programme but with fairly small resulting learning outcomes. However, the problem of weak outcomes despite high expenditure applies to the entire school system. Therefore, given the absence of known more cost-effective alternative forms of intervention and in the light of the potentially high impact of early interventions, it is recommended that the Grade R programme be continued and that ways to improve its impact be explored.
- The existing literature shows **poor quality** in many ECD and Grade R centres and that practitioners have limited understanding of their role in child development.
- **Poor quality may be part of a wider endemic failure of schools known to exist in SA schools rather than being specific to Grade R.** This may imply that impact is associated with the capacity (supportive framework, availability of good teachers and parental support) to deliver a quality programme in addition to specific factors that apply to Grade R only.
- Key **strategies** should be:
  - To measure success not by access alone, but by what is actually being **achieved** in order to narrow inequalities.
  - To pay more attention to the **quality** of Grade R. For teachers, quality issues include training and support, including qualifications, knowledge of *how* children learn and how to facilitate learning to achieve Grade R learning outcomes. Curriculum issues include clear spelling out of practical guidelines and standards for teachers and improving understanding of the curriculum.
  - To improve the **basic data** about Grade R enrolments and spending.
  - If government is to fund 90% of Grade R places, it may need to fund 212 000 more places. At R3 112 per place that will require R220 million per year extra over the next three years, but that may be an under-estimate.

Executive summary

Background to this study

This study entails a literature review of the impact of early learning, impact estimates of early learning on learning outcomes based on existing datasets, an impact evaluation using a new dataset that can attribute causation to the measured impact of Grade R, a short fiscal analysis, and a conclusion.

Literature review: the evidence on early learning

The first few years of a child's life lay a foundation for cognitive functioning, behavioural, social and self-regulatory capacities, and physical health. These early determinants reinforce each other. Early interventions could shift these trajectories. Our scientific knowledge base is however constrained. The difficulty is to distinguish impact from self-selection: children who attend preschool may perform better in school simply because their families value education. Returns on investment are greatest for the young as they have a longer horizon over which to recover investments, and because "skill begets skill." Early investment in disadvantaged young children reduces inequality and raises productivity.

Most quantitative studies draw from a few US studies, with recent evaluations in Argentina and Uruguay providing further evidence that early interventions improve later cognitive outcomes. Studies on the impact of ECD services in South Africa report mainly on health benefits. The Sobambisana programme found mixed impacts of various programmes aimed at improving children's readiness for Grade R.

The developmental trajectory of most children is well established at school entry: schooling reinforces developmental trends and usually widens gaps. The key question is how much educational interventions *before* primary school can reduce gaps. Opportunity for language learning is greatest *before* children enter school. A South African study found that language delays remained stable between Grades R to 3, suggesting that education was not powerful enough to overcome an entrenched problem (Klop, 2005). Emergent literacy in preschool (including ability to manipulate phonemes and to recognise letters and letter sounds) predicts later reading achievement.

Grade R should be aligned with ECD pedagogical practice and not be a "watered-down" Grade 1. The curriculum must be clear about foundations for literacy to be laid in Grade R. It requires active, child-centred, participatory methods that are difficult to assimilate into the school system. Opportunities for emergent literacy development through exposure to reading, pictures and mediated explanations of text are especially important. A South African study found that 65% of Grade R learners enter Grade 1 without the necessary skills or concepts to master reading.

Impacts for preschool are more consistent and stronger than other remedial strategies, especially for children from poor home environments. The benefits of early education need to be maintained through subsequent school experiences. Though Grade R cannot overcome deeply rooted economic problems and social pathologies, a quality programme can be a powerful equaliser to reduce disadvantages. Importantly, the evidence stresses that good quality ECD produces good outcomes, but weak provision could foster worrying outcomes such as aggressive behaviour and poor language development. Quality is key: a quality curriculum, a quality teacher, and a quality response to developmental needs.

Exploring existing datasets for evidence of the impact of Grade R

The re-estimation of models using NIDS, SACMEQ and GHS data confirmed findings of a DBE study, that the association of ECD with learning outcomes provides only *suggestive* and no *causal* evidence of an impact on learning.

An impact evaluation using a new dataset

A new dataset was created by merging the EMIS masterlist of schools, the SNAP data on learners in each grade, and the Annual National Assessments (ANA) of 2011 and 2012 that provide test performance in mathematics and home language for Grades 1 to 6. This large dataset of 18102 schools allows precise measurement of impact.

A (proxy) measure of "treatment" is the percentage of learners of a given cohort in a given school that had attended Grade R. Treatment for a cohort (exposure to school-based Grade R) is calculated as the number of children in Grade R as proportion of those in Grade 2 two years later. Some schools serve a wider catchment of Grade R learners who may later attend other schools, thus influencing the treatment measure. Also, some learners may have attended Grade R at non-school based facilities. This may under-estimate treatment in such schools.

Better managed schools may have introduced Grade R earlier, or a focus on poor schools may have increased treatment in schools where performance lagged. This confounds the relationship between treatment and performance in ANA tests. Fixed effects models at school level (i.e. observing the relationship *within* rather than *between* schools) remove such bias. Having a number of observations in each school of both treatment by cohort and of test performance (ANA results from Grade 1 to 6) makes it possible to use a fixed effects structure. Impact is measured as the *proportion of a standard deviation* change in test scores as a result of full treatment, i.e. full exposure to Grade R.

For the 2012 sample, exposure to Grade R increased mathematics scores in subsequent years by 2.5% of a standard deviation, and home language scores by 10.2% of a standard deviation. Assuming 40% of a standard deviation to be equivalent to one grade level in school and a school year to be 200 days of instruction, this is equivalent to what the average learner should learn in 12 days or in 50 days for mathematics and home language respectively. These are quite small effects. A review of preschool programmes in the US found average effects on cognitive outcomes to be 42% of a standard deviation at or near school entry. Oklahoma's universal preschool programme for 4-year olds, a high quality programme, saw an 80% of a standard deviation gain in pre-reading and reading skills, a 65% of a standard deviation gain in pre-writing and spelling skills, and a 38% of a standard deviation gain in early math reasoning and problem-solving. In Argentina, one year of pre-primary education increased average third grade test marks in standardised mathematics and Spanish tests by 23% of a standard deviation.

Treatment has no statistically significant effect in lower quintiles, while a significant effect of approximately 10% and 20% of a standard deviation is estimated for Quintile 4 and Quintile 5 schools respectively in both maths and language. Thus provision of Grade R to all will improve results in the wealthiest quintile by about half a year's learning, with almost no benefits for lower quintiles.

To capture differences in school functioning, two provincial groupings were distinguished: weaker performing and top performing provinces, the latter being Gauteng, Northern Cape and Western Cape. Top performing provinces may face fewer constraints with functioning of school based programs and quality of Grade R teachers. For home language test scores, there are no major differences across the provincial groupings for similar school quintiles: Quintile 5 gained 13-14% and Quintiles 1-4 only 3-4% of a standard deviation in both provincial groupings. For mathematics, treatment had a statistically significant effect across all four sub-samples: in the weaker provinces only 1.8% of a standard deviation in poorer schools and 9.6% of a standard deviation for Quintile 5 schools. Poorer schools in top performing provinces experienced a similar impact (10.4% of a standard deviation) while wealthy schools in these provinces experienced the largest impact, at 16% of a standard deviation. This suggests that Grade R provision provides greater benefits for mathematics learning when implemented within a well-functioning education system.

Quantile regressions allow investigation of differences in impact between schools that over- or under-perform. Results are best interpreted for fixed effects versions, which investigate *differences* in tests and treatment between 2011 and 2012. The impact is statistically larger amongst better performing schools in both mathematics and home language.

This unique and exceedingly large dataset makes it possible to estimate effects quite accurately and with high levels of confidence, even for small effect sizes. It demonstrates that Grade R indeed improves learning in mathematics and home language. However, impacts are larger in stronger provinces, higher quintiles and among top performers. Thus Grade R further extends the advantage of more affluent schools, rather than reducing inequalities. This may have much to do with quality of interventions and may suggest that impact relates to capacity, an issue returned to later. Importantly, the impact measured in this study was only in terms of learning (cognitive) outcomes. As Section 2 shows, good early childhood development programmes can also contribute to non-cognitive outcomes, which were not measured here.

Grade R – Coverage, cost and cost-effectiveness

Between 2001 and 2012 the numbers of Grade R places in public and independent schools expanded more than threefold from just under a quarter of a million (242 000) to more than three-quarters of a million (768 000), an average annual growth rate of 11% per year, or 45 000 additional learners or a thousand classrooms per year. A further 55 000 children attend Grade R in ECD centres. This total of 804 000 is 80% of the just over 1 million 5-year olds, though many Grade Rs are under-age. The General Household Surveys confirm the rapid expansion: in 2009 78% of 5-year olds were in some sort of education programme, up from 39% in 2002. More than 90% of all Grade Rs are in public schools, and 89% of public primary schools offer Grade R. Numbers of 5-year olds will remain stable at just over 1 million over the next 20 years, reducing pressure on new provision.

Cost per public school Grade R learner in 2011/12 was calculated as R3 112 per year, ranging from R845 in Limpopo to R7 823 in Gauteng, compared to about R10 500 in public ordinary schools (excluding Grade R), thus well below the 70% benchmark set in the funding norms and standards. However, the data appear suspect and on average probably under-estimate costs, as inaccuracies in accounting procedures are more likely to record Grade R spending as general school spending than the other way round. If government were to fund 90% of Grade R places, another 212 000 places may be necessary in the public system. At R3 112 per place that will require about R220 million per year extra over the next three years, but this may be an under-estimate.

Despite the remarkable progress in providing access, questions remain about coverage and quality. Getting an accurate picture is complicated by weak administrative data and population projections, and extremely low estimated spending in some provinces suggest cross-subsidisation of Grade R from other programmes or data inaccuracies due to how Grade R spending is categorised. Costing and estimates of cost-effectiveness first require improved basic data about enrolments and spending. It is necessary to get agreement on targets, data requirements and key data sets such as population numbers. Provincial data should be regularly interrogated to resolve anomalies and get a clear picture.

Some recommendations

The differential impact may imply that impact is associated with capacity, manifested in the supportive framework for Grade R in schools, availability of good teachers and parental support. Low and differentiated learning impact may be due to a wider endemic quality issue in schools rather than specific to Grade R. Quality thus needs attention.

Two quality dimensions relate to teachers and the curriculum. For teachers, issues include training and support, including qualifications, knowledge of *how* children learn and how to facilitate learning through structured play and mediated language experiences, and methodologies to achieve Grade R learning outcomes. Curriculum issues include practical guidelines and standards, and understanding of the curriculum.

Possible interventions to improve quality of Grade R delivery include:

- Improving pre-service training through FET Colleges and revising Current Unit Standards to ensure Grade R teachers know best practice and are trained in the most effective methods and approaches.
- Increasing opportunities for in-service training focused on providing teachers with ***practical strategies*** for supporting early learning and opportunities to see and practice best teaching.
- Development and evaluation of evidence-based learning programmes, resources and early interventions designed for the local context and appropriate for children from poor backgrounds.
- On-going structured curriculum support for teachers in implementing CAPS, particularly with practical ideas on '***how'*** to achieve learning outcomes.
- Development of ***common tools*** that can be used by teachers and researchers to assess children's language, literacy and mathematics development and to track progress in learning outcomes.
- Establishing criteria of quality that schools can use to self-assess and that can be used for M&E.
- Encouragement,of both a pecuniary and non-pecuniary nature, to attract and retain good Grade R teachers.
- Making culturally relevant storybooks in all South African languages more widely.
- Evaluating curriculum delivery, both in terms of 'structural aspects' (e.g. following lesson plans) and 'process-oriented' aspects (e.g. quality of interactions, relationship between child and teacher).
- The DBE should actively pursue its target of 100% Grade R coverage while addressing issues of quality. Relaxing the 85/15 split between public and community provision towards more community sites and active support of quality community pre-schools with strong norms and standards for monitoring these could serve both quality and access goals.

1. Background to this project

South African learning outcomes in schools are known to be weak and highly unequal. Government has undertaken a number of steps to try to remedy this. One of these was the introduction and rapid roll-out of a reception year, commonly referred to as Grade R. The DBE's Strategic Plan 2011-2014 (DBE 2011b) identifies universal access to Grade R and quality Grade R programmes as one of four strategies to improve quality in the South African education system, the other three being quality learning and teaching through a focus on literacy and numeracy, increased use of standardised assessments and systemic evaluations, and improved systems of accountability and service delivery at district, provincial and national level.

One of the aims of this reception year was to reduce the backlog faced by many learners in poorer schools due to a deficient home environment. The view was that providing support to such children at early ages should assist to reduce the backlogs they face when entering Grade 1. It is this programme which is the subject of this study, with the overriding question whether it is possible to discern a *causal* effect of the introduction of Grade R on subsequent learning outcomes in school, and in particular the impact on children from disadvantaged home backgrounds.

In 2012, ReSEP undertook a scoping study for the Department of Basic Education, supported by the Department of Policy Monitoring and Evaluation in the Presidency and 3ie, on whether an impact evaluation of the introduction of Grade R and of the National School Nutrition Programme can be successfully undertaken with available data. That scoping study (Coetzee and Van der Berg, 2012) concluded that an impact evaluation that would be able to attribute causal impact to these two programmes was not possible. It was concluded, however, that there were some data available to undertake studies on the impact of early learning, including Grade R, but that the nature of the available data made causal impact less easy to establish. The authors therefore proposed that a retrospective survey be undertaken as part of the then-planned Verification part of the Annual National Assessment of 2012, on whether children participating in that study had undergone Grade R training, and to at the same time ask some questions on the background of such children so as to control for these factors in an impact evaluation. (We were less positive about the possibility of undertaking an impact evaluation for the NSNP.) However, for practical reasons, DBE did not implement such a verification process for ANA in 2012, with the result that this survey was not undertaken.

DBE did undertake a study to determine how much evidence could be garnered from three data sets, SACMEQ, NIDS and GHS. It then also put out a call for a study of the impact of Grade R. ReSEP submitted a proposal based on this call, due to the realisation that new data that could be collated from two different sources, the Annual National Survey of Schools or the Snap Survey, and the Annual National Assessment, could be used to attempt to answer the question what impact the introduction of Grade R has had on learning outcomes.

This Report reports on the research undertaken. It includes a literature review of the available evidence of the impact of early learning on learning outcomes (Chapter 2); a re-estimation of the possible impact of Grade R or other forms of early learning, based on the datasets referred to before and included in the DBE report (Chapter 3); an impact evaluation based on the newly collated data, the main part of the impact evaluation undertaken (Chapter 4); an analysis of the fiscal costs and projections thereof for Grade R (Chapter 5); and a conclusion (Chapter 6). The expansion of coverage, which provides one of the contexts for the impact evaluation, can be deduced from the treatment measure discussed in Chapter 4, but is dealt with in more detail in Section 5.2, as it is closely tied to the fiscal analysis which follows it.

As this is the Main Report (summary reports have also been produced), it is necessary that it deals with all the technical detail of what is in principle a technically sophisticated process, quantitatively estimating the *causal* impact of the provision of Grade R on learning outcomes. There are a great many issues that need to be discussed fully and that should be open to peer review. Thus the technical part of this Main Report, set out in Chapter 4, cannot avoid being technical in its nature and scope. However, to make it more accessible to non-technical readers, the last Section of Chapter 4 contains a summary of the main findings, and these are expanded on in the concluding Chapter, in Section 6.1. Non-technical readers may thus prefer to skim Sections 4.2 and 4.3. A Box is provided which presents an intuitive introduction to fixed effects regression models, as these are important to grasp the methodological strategy followed to arrive at *causal* impacts of Grade R on subsequent learning outcomes.

Feedback from this first version of the Final Report and the 25 page Outline Report, the 3 page Executive Summary and the 1 page Policy Summary will be incorporated into the final versions of these reports.

2. Literature review: exploring the evidence on early learning

2.1. Introduction

Before moving on to the estimation of the impact of the Grade R programme, this Chapter provides a literature review containing some background on both international and local evidence focused on early learning interventions. It goes beyond the commonly-cited evidence that looks at early childhood development (ECD) interventions more broadly, and looks at evidence regarding preschool specifically, as the avenue most closely aligned to Grade R and therefore relevant to this evaluation. It examines the theoretical economic case for supporting early learning and the available empirical evidence, both from cost benefit analyses and from developing countries. It then surveys whether early learning interventions enhance educational efficiency, and critically examines the evidence that points to the importance of preschool education for future learning success. In exploring the evidence from the South African context, the review assesses the potential a preschool year holds to address some of society's intractable inequalities, and what capacity it has to have meaningful impact at scale in developing countries. Finally, the review highlights the accumulated evidence which stresses the importance of **high quality** education programming to effect any long term change in children's cognitive, social and economic outcomes.

Science is unequivocal in its support for the importance of early childhood development. Calls for increased investment in young children cite neuroscience, developmental psychology and health. It is hazardous, however, to make a direct leap from neuroscience to policy recommendations. Simply because early childhood provides opportunities for more economically efficient interventions which have dramatic impact on inequality, this does not mean that the ECD policies actually implemented by communities, provinces, or national government are worthy investments. Firstly, it is difficult to design programmes that improve children's cognitive or behavioural development. Secondly, the costs of even effective programmes might outweigh the benefits they generate for children, their families, and taxpayers. And finally, programmes in early childhood require upfront and politically brave investments that may take decades to pay off.

There is recognition that the first few years of a child's life are a particularly sensitive period in the process of development, laying a foundation for cognitive functioning, behavioural, social and self-regulatory capacities, and physical health. Together with relatively constant material conditions over the course of childhood and adolescence, these early determinants tend to reinforce each other (Richter et al., 2012). Interventions in the early days have the potential to shift these trajectories. The studies that are the basis for this consensus, however, differ in method, population, type of intervention (nutrition, education, parenting education, income supplementation), and type of outcome measured (anthropometric, cognitive, behavioural, school readiness), with some outcomes being short-term and some long-term (Nores & Barnett, 2010).

The scientific knowledge base guiding early childhood policies and programmes is constrained by the relatively limited availability of systematic and rigorous evaluations of programme implementation; gaps in the documentation of causal relations between specific interventions, specific outcomes and the underlying mechanisms of change; and rare assessments of programme costs and benefits (Shonkoff & Phillips, 2000). Beyond the child health domain, information on programme effectiveness and efficacy in developing country contexts is limited, and there is hardly any data from South Africa (Dawes, Biersteker, & Irvine, 2008). The sheer variety across programmes means that there is no consistent body of evidence based on a common set of intervention modalities. Thus while there is increasing agreement about the importance of intervening to improve early development paths, there is less agreement about the most effective and efficient ways to do so. There are, however, three key stylised facts from this literature that should be highlighted at the outset:

(1) family wealth matters for young children,
(2) it is possible to intervene effectively and to improve the trajectories of young children, and
(3) the later the remediation, the less effective it is.

This review will be organised around the two themes that form the basis of the arguments for increased public investment in early learning interventions:

1. ***Educational efficiency***: Early learning programmes increase the efficiency, effectiveness and equity of school expenditures by improving test scores and the chance of school completion, and reducing drop-out, repetition and the need for remedial support.
2. ***Economic efficiency***: The early years are the most cost-effective period in the child's life in which to invest. Events in the early years of a child's life influence the child's productivity and learning ability throughout life.

These themes are interdependent: the argument for economic gains largely comes from the educational efficiencies. And while the arguments apply just as well to the non-educational aspects of ECD, this review focuses solely on the evidence surrounding early learning.

2.2. Theoretical case behind early childhood investments

The last decade has seen a blossoming of research across a range of disciplines into the long term effects of early childhood conditions. In economics, the focus is on how human capital accumulation – that is, education and skills - responds to the early childhood environment. A few relatively small studies from developed economies, most noteworthy programmes in the United States, carry a large weight in the literature. This Chapter seeks to set out what economists have learned about the importance of early childhood influences on later life outcomes, the age patterns of skills formation, ameliorating the effects of negative influences, and responses to interventions.

First, consider a simple theoretical model that outlines why investments in early learning may pay off. Cunha, Heckman and Masterov (2005) developed a model of human skill formation with a number of important insights.

Firstly, **abilities/skills matter.** A large number of empirical studies document that both cognitive and non-cognitive abilities are powerful determinants of wages, schooling, participation in crime, and success in many aspects of social and economic life (Heckman, 2007). Pure cognitive abilities include IQ. Non-cognitive abilities include qualities such as patience, self-control, temperament, time preference, perseverance, motivation, risk aversion, self-esteem and approach to learning. Abilities are shaped by genetic components and environmental influences, and are multi-dimensional rather than uni-dimensional.

Secondly, **ability formation is governed by a multistage technology.** Some abilities can be produced more effectively at a given period in life, referred to as "sensitive" periods. Other abilities can only be produced at a particular period referred to as "critical" periods. The flip side to a sensitive period is that it is also the time where the brain is most highly susceptible to the *absence* of these critical experiences, which can have lasting detrimental effects. “Sensitive” and “critical” periods mean that remediation of some abilities not acquired in early childhood is impossible or prohibitively costly later. In the extreme case of a so-called Leontieff technology, investments in skill formation during the school or post-school periods are only productive if a sufficiently high level of investment was made earlier on. Ability gaps between individuals and across socioeconomic groups open up at early ages, for both cognitive and non-cognitive skills, and children who enter school substantially behind their peers are unlikely to catch up.

Thirdly, there is **“self-productivity” in skill formation**. Skills acquired in one period persist into the next period, and skills acquired in one dimension (for example, self-control) may make it easier for a person to acquire skills in another dimension (for example, cognitive learning). Self-productivity embodies the idea that capabilities are self-reinforcing and cross-fertilising and that the effects of investment persist. For example, emotional security fosters child exploration which in turn fosters more vigorous learning of cognitive skills. A higher stock of cognitive skill in one period raises the stock of the next period’s cognitive skills. Higher levels of self-regulation and conscientiousness reduce health risks and avoid accidents. Higher levels of health promote learning.

Fourthly, there is **“complementarity” of skills**, such that skills and capabilities acquired in one period increase the productivity of investments at later ages. In a multistage technology, complementarity implies that levels of investments in capabilities at different ages bolster each other. They are synergistic. Complementarity also implies that early investment should be followed up by later investment in order for the early investment to be productive. If it is not followed up by later investment, its effect at later ages is lessened.

Finally, as a result of “self-productivity” and “complementarity”, it is argued that investments at early ages can have **important multiplier effects** (Heckman, 2007). These are the mechanisms through which skills beget skills, and motivation begets motivation. Motivation fosters skill and skill fosters motivation in a dynamic process. If a child is not motivated to learn and engage early on in life, the more likely it is that when the child becomes an adult, it will struggle in social and economic life. Thus the phenomenon reported in Chetty et al (2010), and quoted by many, that early education programmes lead to improved cognitive scores that only last for a few years, is attenuated by the fact that learning is **cumulative**: even a temporary gain in cognitive ability will lead to increased learning. Otherwise it would imply that the initial acceleration in reading is followed by a deceleration for those who have been exposed to early learning programmes, compared to other children.

All skills are built on a foundation of capacities that are developed earlier. Heckman (2008) describes how this principle stems from two characteristics, intrinsic to the nature of learning: (a) early learning gives value to acquired skills, which leads to self-reinforcing motivation to learn more, and (b) an early grasp of a range of cognitive, social and emotional competencies makes learning at later ages more efficient and therefore easier and more likely to continue. The Young Lives study shows this empirically by using panel data on a cohort of 3000 children in India (Andhra Pradesh) over 15 years. It found that **both contemporaneous and lagged test scores/inputs** affect the production of current cognitive skills (Boo, 2009). For some skills, the window of opportunity for full development is in the first three years of life (Shonkoff and Phillips

2000); other abilities, specifically non-cognitive skills, may be relatively malleable later during adolescence (Carneiro & Heckman, 2003).

These features of the technology of capability formation have consequences for the design and evaluation of public policies. Investing in disadvantaged young children is a public policy with no equity-efficiency trade-off (Heckman & Masterov, 2007). It convincingly reduces the inequality associated with the accident of birth, and at the same time raises the productivity of society at large. Dynamic complementarity and self-productivity imply an equity-efficiency trade-off for late child investments but not for early investments: the returns to late childhood investment and remediation for young adolescents from disadvantaged backgrounds are low, while the returns to early investment in children from disadvantaged environments are high (Heckman, 2007).

Nobel laureate, James Heckman and his colleagues have also been researching government spending on human capital programmes since the 1990s to establish empirical proof that public investment in quality early childhood programmes can pay for itself through gains in efficiency and productivity over a lifetime. They have found, inter alia, a large low-skilled work force in the US, unable to capitalise on the rising wage premia paid for skilled work, inadvertently perpetuating their adverse childhood environments which in turn leads to disadvantages for their children and a continuation of the cycle of poverty. Human capital determines productivity. They claim that investing early in building individual human capital can yield exponential and sustainable benefits to both the individual and society.

Heckman uses cost-benefit analysis to determine the types of human capital programmes, from job training, tax reform, higher education subsidies, and early intervention programmes that produce the most benefits and savings to society. He concludes that returns on investment are greatest for the young for two reasons: firstly, younger persons have a longer horizon over which to recover the fruits of their investments, and secondly, "skill begets skill."

2.3. Empirical evidence from benefit cost analyses

This human capital model of early childhood, with its advocacy based on cost-benefit analysis, is now strongly expressed within international ECD policy initiatives, notably by the World Bank. Some caution that this is a persuasive but high-risk strategy, raising expectations for ECD policies that are unlikely to be realised in practice, even within well-resourced large-scale programmes, and particularly within impoverished communities (Woodhead, 2006; Dawes, Biersteker, & Hendricks, 2011). Nonetheless the literature provides strong evidence that early childhood interventions in resource-rich countries render benefits far exceeding their investment costs, and that these benefits endure well into adulthood (Reynolds, Temple, Ou, Arteaga, & White, 2011; Nores & Barnett, 2010).

The economic benefits of education are usually measured in terms of adult outcomes, which are often specified in earnings functions or wage equations, as functions of years of schooling. Schooling predicts adult productivity and income, and studies from 51 countries show that each year of schooling increases wages by almost 10% on average (Psacharopoulos & Patrinos, 2004). However this concavity of returns of conventional human capital theory is not supported by available evidence in South Africa. A strong convex relationship between education and earnings is rather seen in this country, with an extremely high marginal rate of return for tertiary levels of education, and small rate of return (approaching zero) for lower levels of education (Keswell & Poswell, 2004). Nonetheless, it is more generally accepted that the non-pecuniary benefits of education, including improved health, reduced fertility, stronger citizenship, less criminality, and an improved ability to care for children are outcomes of both early and general educational investment (Alderman & Vegas, 2011). What makes the case for educational intervention specifically during early childhood so compelling is not only the direct benefits to the child, but also the positive externalities as manifest through reduced welfare dependence and a reduction in the intergenerational transmission of poverty (Burns, 2007): there is no equity-efficiency trade-off.

There are many considerations when estimating reliable benefit-to-cost ratios, such as measuring *all* benefits and costs in monetary terms, assessing diverse resource costs, and balancing between immediate gains versus long-term benefits. The largest benefit-cost ratios are associated with programmes with longer-term follow-up, because they allow measurement of outcomes such as educational attainment, delinquency and crime, earnings – the outcomes at older ages that most readily translate into monetary benefits. These studies not only demonstrate that the benefits from early interventions can be long-lasting, they also give more confidence that the savings the programmes generate can be substantial (Karoly, Kilburn, & Cannon, 2005). Programmes with evaluations that have followed children only until school entry, or slightly further, typically do not measure those outcomes that are likely to be associated with the largest monetary benefits. Because not all benefits can be translated into monetary values, benefit-cost estimates for effective ECD programmes are likely to be conservative. In addition to this, it is easier to make the argument for investment in ECD than it is to determine which aspects of ECD to prioritise, for example, health, psychological wellbeing, educational readiness or civic mindedness. Unless ECD is defined by a single outcome measure, interventions cannot be ranked according to their efficiency at producing that outcome. Children's development benefits from a range of interventions, ranging from access to immunisations, reading materials and iodine (Engle et al., 2007), and their complementarity is important; this makes cost-benefit analyses challenging (Richter et al., 2012).

There are two types of quantitative studies about ECD drawn from a very limited number of studies carried out in the USA. One set of studies uses data on high cost, high quality, pilot (model) preschool programmes and provides "laboratory" evidence of the possible returns to investments in early childhood. The other set of studies use data on larger scale programmes[1] such as the US Head Start preschool programme[2] (Heckman & Raut, 2009), and the Chicago Child-Parent Center (CPC) Education Programme[3] (Reynolds et al., 2011).

Two US studies of model programmes stand out because they randomly assigned children to treatment and control groups, had low dropout rates, and followed children over many years: the Carolina Abecedarian Project[4] and the High Scope/Perry Preschool Project.[5] These two well-known projects selected participants on the basis of low IQ ratings.[6] The Abecedarian mothers

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[1] *The UK Sure Start programme is another large scale ECD intervention. The difficulty in addressing the question of whether or not Sure Start is effective is because of the huge variety of programmes offered across the areas within which Sure Start is implemented: there is no such thing as Sure Start in the sense of a defined programme with a definable intervention strategy (Dawes, Biersteker, & Irvine, 2008).*

[2] *A relatively large scale and sustained programme, funded by the Federal government, and available to children whose parents earn incomes below the poverty line.*

[3] *The second oldest (after Head Start) federally funded early childhood programme, implemented in Chicago Public Schools since 1967 to the present.*

[4] *Which ran from 1972-1985*

[5] *Which ran from 1962 to 1967*

[6] *Children's IQs of between 75 and 85 for the Perry project, and mothers' IQs of 85 for the Abecedarian.*

were referred by welfare agencies. In addition, 98% of participants of both studies came from African American families. This convergence of low income, low IQ, welfare referrals and the targeting of ethnic minority groups, raises questions about the generalisability and relevance of the results (Penn, 2004). These two key studies were also high quality interventions, with strong programmes and low adult-child ratios of between 1:4 or 1:10 depending on the age of the child. The Perry Project had a particular and well developed, part time, educational programme for four year olds, plus home visiting. Despite these considerable limitations to the generalisability of context and scale,[7] these two programmes are widely cited in the literature (Penn, 2004).

The fact that special interventions like Perry Preschool or the Carolina Abecedarian Project had an effect on at least some target children does not prove that most programmes will do so. While small-scale ECD programmes can work, can they be reproduced on a much larger scale? The evidence raises concerns that gains on the educational, social, and economic success of children growing up in disadvantaged circumstances will not be realised when public policies are brought to scale (Barnett & Ackerman, 2006). The far larger Head Start programme is not of the same quality as the model interventions, and quality varies from centre to centre. While the programme draws mixed reviews, Head Start centres have nonetheless been of higher average quality than other preschool programmes available to low income people (Almond & Currie, 2010). Children who participated in Head Start did better later in school than their siblings who did not benefit from the preschool intervention, and two recent studies found positive effects of the preschool intervention on outcomes measured during the adolescence years (Almond & Currie, 2010; Alderman, 2011). Detailed study of long term outcomes from the programme concluded that the benefits of a large-scale programme like Head Start could offset just 40-60% of the costs, a modest (but still positive) conclusion (Currie 2001). Such relatively low returns may appear disappointing within an economic framework, but human capital is not the only - nor necessarily the most appropriate - basis for defining ECD policy, especially in global contexts (Woodhead, 2006). Evidence suggests positive impacts are not just about increased *human capital*, they are also about *social capital*.[8]

A limited number of quasi- and non-experimental studies have identified modest effects of larger-scale programmes on children's development, including greater receptive language and maths ability, cognitive, attention and social skills, as well as fewer behaviour problems (Yoshikawa et al., 2007). Almond and Currie (2010) report on an evaluation of the effects of Oklahoma's universal pre-Kindergarten: positive gains in pre-reading, pre-math and pre-writing scores suggest that a high quality universal pre-K programme might well have positive effects.[9] Only fairly recently has the evidence from low- and middle-income countries been carefully analysed (Engle et al., 2007; Engle et al., 2011), and interventions proposed which are, as they describe, '*in principle*,' feasible to take to scale in low-resource contexts. Nonetheless, the key assumption of first world policy makers - that **targeted** early childhood interventions are an appropriate and effective way to address poverty - often spill over into the developing world (Penn, 2004). However, targeting can be highly inaccurate in practice, particularly when a status (poverty and/or maternal employment) changes fairly frequently in a service that must be provided consistently

[7] *The Perry High Scope had 68 participants, half of whom attended the trial programme; the Abecedarian had 112 participants, half of whom attended the trial programme.*

[8] *For example, self-selection into classroom settings and peer groups where there are positive attitudes and expectations, and an altered relationship to their social environment.*

[9] *Though one would have to track children longer to determine whether these initial gains translate into longer term gains in schooling attainment*

over a sustained time (Barnett & Ackerman, 2006). The costs associated with administering and monitoring targeted programmes can also be high. Moreover, substantial benefits of children's learning and development extend far up the income ladder, with enrolment of children from a variety of socioeconomic backgrounds producing previously unrealised peer effects. Large-scale preschool education for four-year olds, particularly universal programmes within a community, may produce larger gains because of these peer effects.[10] Results from a study examining the effects of Georgia's universal preschool programme support this hypothesis (Barnett & Ackerman, 2006). Targeting versus universal implementation may, therefore, be an economically inefficient strategy. In the case of South Africa's great R programme, the focus was initially on targeting poorer schools on the route to universal provision.

More recent estimates of benefit-to-cost ratios for ECD interventions yield ratios substantially above 1 both in developing and developed countries. For example in Bolivia, the benefit of a 5% increase in cognitive scores and a 2% increase in height translated into a benefit of between $1·8 and $3·66 per dollar of project cost (Engle, et al., 2007). Each dollar spent on the High Scope/Perry Preschool Project has been estimated to have saved up to seven dollars in social costs[11] (Almond & Currie, 2010). In a reanalysis of the Perry data, Heckman and others conclude that rates of return are 7% to 10% for males and females, which are smaller than other estimates that have been reported, but still economically significant (Almond & Currie, 2010). The estimates from developing countries of the economic returns of schooling suggest that preschool participation contributes to increases of around 5–10% in lifetime labour income (Engle, et al., 2007). The current evaluation finds benefits equal to an improvement in average performance equivalent to 6% to 25% of a year's learning for a school moving from not providing Grade R at all to a situation where all learners are provided with Grade R.

US data also suggests that returns decline more or less continuously as income rises, and the average return for the middle class could be half of that for children in poverty (Barnett & Ackerman, 2006). Yet accessing quality ECD is a problem that affects more than just low-income families; middle-class children can also benefit from quality ECD. For example, an evaluation of Oklahoma's universal preschool programme (pre-K) for 4-year olds, which is run through public schools, serves children from all SES backgrounds, and is considered a high quality programme, found substantial benefits[12] across all participants. While the programme yields the largest gains for children in lower-income families measured at the beginning of the subsequent year relative to non-participants, gains for children who are not poor can still be quite substantial (Barnett & Ackerman, 2006). This finding is also echoed in our analysis, where the benefit from Grade R participation is much larger for schools at the top of the income distribution.

In a comprehensive review of evidence on the effects and cost-effectiveness of programmes and services for children from ages 3 to 9, Reynolds and Temple (2008) made two clear points. Firstly they noted that many programmes have assessed long-term effects into adulthood: three-quarters of the reviews reported effects at five or more years after the end of participation. This is considered rare for social programmes and indicates that lifetime impacts on economic benefits can be accurately assessed. Secondly, the accumulated evidence includes both the model

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[10] *If everyone in a kindergarten or classroom has attended preschool, classroom climate may change, median ability will rise, and dispersion in ability may narrow, with those at the bottom likely to gain most.*

[11] *This high benefit-cost ratio is driven largely by the effect of the intervention on crime reduction.*

[12] *Including an 80% of a standard deviation gain in pre-reading and reading skills, a 65% of a standard deviation gain in pre-writing and spelling skills, and a 38% of a standard deviation gain in early maths reasoning and problem-solving abilities.*

programmes, developed for research demonstration, and large-scale programmes, developed for routine implementation by schools and other institutions. Consequently, the generalisability of the evidence for policy recommendations is much stronger today than a decade ago.

Evidence on the effectiveness and cost-effectiveness specifically of preschool programmes for school readiness, school achievement, and long-term life course development is also reviewed by Reynolds and Temple (2008). They found relatively large and enduring effects on school achievement and child well-being, with high-quality programmes for children at risk producing strong economic returns ranging from about $4 per dollar invested to over $10 per dollar invested. Interestingly, relative to half-day kindergarten, the positive effects of full-day kindergarten were found to be relatively small, and generally did not last for more than a year. In summary, findings of the evaluations consistently show positive and meaningful effects for both universal and targeted programmes.[13] Although effects sizes are smaller than for intensive preschool programmes, the reach of the state-funded programmes is greater (Reynolds & Temple, 2008). Considering all societal benefits (budget savings, justice system and child welfare savings, and increased earnings), the long-range annual benefit per tax dollar invested was estimated at $12.10 for a targeted programme and $8.20 for a universal access programme (Reynolds & Temple, 2008).

In a discussion of the effectiveness of preschool programmes using results from three well-known intervention studies – the Chicago Child-Parent Centers (CPC), High/Scope Perry Preschool Programme, and the Carolina Abecedarian Project – Temple and Reynolds (2007) find strong evidence that the consistently positive economic returns of high-quality preschool programmes exceed most other educational interventions, especially those that begin during the school-age years such as reduced class sizes in the early grades, grade retention, and youth job training. The longitudinal results of the large-scale, school-based, Chicago CPC Preschool Programme showed that preschool participation was significantly associated with more years of education, a higher rate of high school completion, and a higher rate of college attendance. A recent study of the same programme, on indicators of well-being up to 25 years later for more than 1400 participants, found that, relative to the comparison group receiving the usual services, programme participation was independently linked to higher educational attainment, income, SES, and health insurance coverage, as well as lower rates of justice-system involvement and substance abuse enduring to the end of the third decade of life (Reynolds, 2011).

2.4. Enhancing educational efficiency through early learning investments

If it is indeed true that governments respond to short-term effects and face political difficulties in justifying long-term investment in human development, then the argument for improved educational efficiency is one that should be of interest. The strongest evidence for short-term gains to ECD investment emerges from increases in efficiency in the early years of primary schooling. The key question is the extent to which educational interventions in the years immediately *before* primary school entry can help reduce gaps so that children from all socioeconomic backgrounds have an equal opportunity to reap the returns from schooling.

[13] *The average effect size on cognitive skills at or near school entry was 0.42 standard deviations (Reynolds & Temple, 2008).*

Over the years, the ECD community has consistently argued for comprehensive and integrated services [14] for young children, and recognition that ECD encompasses sectors other than education, notably health and social welfare. But, as much of the strongest evidence for short-term gains comes from increases in efficiency in the early years of primary schooling, it is the education sector which has most to gain from making the case for more ECD programming. As assessed in many longitudinal studies, including in South Africa, both lack of stimulation and poor linear growth (low height-for-age) in infancy and early childhood, are related to delayed school entry, fewer years of schooling achieved, lower school performance, and lower earnings (Walker et al., 2011; Engle et al., 2007; Richter et al., 2012).

As a result of intensive literature and programme reviews of early child development policies and interventions undertaken by the International Child Development Steering Group (Engle et al., 2007; Engle et al., 2011), the policy recommendation is clear: implement early child development interventions in infancy through families and caregivers, and add group learning experiences from 3 to 6 years. Engle and colleagues (2011) reviewed evaluations of centre-based programmes which recorded substantial effects on children's cognitive development and gains in non-cognitive skills such as sociability, self-confidence, willingness to talk to adults, and motivation. Longitudinal studies recorded improvements in the number of children entering school, age of entry, retention and performance.

Early academic skills and the non-cognitive approaches to learning that can also be enhanced by ECD programmes are the foundation of later learning. This has led researchers and policymakers alike to suggest that children can be set on the path for economic success by boosting their early academic skills (Duncan, Ludwig, & Magnuson, 2007; Heckman & Masterov, 2007). Yet, in seeking to understand how early academic skills may lead to improved earnings in adulthood, an immediate challenge is the lack of studies that directly predict earnings as a function of early skills. A wide range of studies has assessed the impact of preschool programmes reported using developmental scores and changes in indicators of cognitive or non-cognitive ability. Such indicators may provide insight into the programme effectiveness on early childhood outcomes, but they often do not have the data to determine the impact of these changes in ability on **schooling outcomes**, which in turn can be used to calculate impacts on future earnings (Alderman & Vegas, 2011). The lack of such studies is due in large part to data limitations. Few studies that have assessed children's early academic skills have followed them long enough to collect data on their adult earnings or labour market experiences. As a result, connecting early achievement to later labour market outcomes requires a two-step process: first, surveying studies that link early achievement to achievement during adolescence; and second, surveying studies that link achievement during adolescence to subsequent labour market outcomes. Brooks-Gunn and colleagues (2009) arrive at such estimates. Their key finding is that early improvements in child health, academic achievement, and behaviour as well as improved parenting can yield sizable economic benefits for adult earnings.[15]

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[14] The basic features of an integrated service include provision of food, protection, health care, affectional care, stimulation, and activities to promote learning (Dawes, Biersteker, & Irvine, 2008). South Africa's National Integrated Plan for ECD (NIP) states its intention to provide, "an integrated approach for converging basic services for improved child care, early stimulation and learning, health and nutrition, water and sanitation."

[15] For example, if a programme increased both maths and reading scores by 0.40 of a standard deviation, then the likely economic benefits would range from $10 634 to $21 270 (2006 US dollars)(Brooks-Gunn, Magnuson, & Waldfogel, 2009).

The magnitude, breadth, and duration of impacts for preschool specifically have been found to be more consistent and stronger than most other remedial strategies (Reynolds & Temple, 2008), which is likely due to the greater dosage, intensity, and scope of services[16] (Reynolds et al., 2011). Heckman and Raut (2009) show that preschool benefits children in acquiring many useful cognitive and non-cognitive skills, especially for the children living in poor home environments. They show the importance of non-cognitive skills in improving school performance and life-time earnings of children, after controlling for their education level, innate ability, and family background.

It is worth an aside to explore non-cognitive skills in more detail. Narrow academic definitions of children's readiness for school are giving way to broader ones which emphasise the importance not only of cognitive competencies, but also physical, social, emotional and motivational factors (Arnold, Bartlett, Gowani, & Merali, 2007). This is supported by Duncan and colleagues (2007) who examined six longitudinal datasets from the UK, the US and Canada and report that maths and reading scores **plus attention skills** are the most important preconditions for educational achievement at school entry. Self-regulatory capacities of young children are powerful predictors of later academic success (Duncan et al., 2007; Dickinson & Porche, 2011).

Success in life and in school depends on many traits, not just those measured by IQ, grades, and standardised achievements tests. Currently, public policy in South Africa focuses on promoting and measuring cognitive ability through achievement tests, mirroring the international trends towards accountability standards[17] which concentrate attention on achievement test scores and do not evaluate important non-cognitive factors.[18] Non-cognitive skills are at least as important as cognitive skills for individual development and labour market success, with earnings tending to be higher among individuals with higher non-cognitive skills (Brunello & Schlotter, 2011).

Personality traits predict and **cause** outcomes.[19] Heckman & Kautz (2012) cite the evidence found in two key US studies. Firstly, General Educational Development (GED) recipients are high school drop outs who perform similarly to high school graduates on achievement tests, but perform far worse in many aspects of life because they lack important personality traits. Secondly, the Perry Preschool Programme improved the lives of its participants primarily through improving personality traits. An initial increase in participants' IQ disappeared gradually over 4 years following the intervention, consistent with the IQ fadeouts observed in other studies. Even though their IQs were not higher, the treatment group did better on achievement tests at age 14 than the controls (Heckman, 2008).

The processes by which cognitive and non-cognitive skills develop over the life cycle are complex and complementary, beginning early in life and continuing through to adulthood. Home and school environments have a significant role to play in enabling or impeding skill development over time (Hanushek & Woessmann, 2008; Heckman, 2008). Non-cognitive and cognitive skills are

[16] Preschools typically provide >500 hours per year (Reynolds et al., 2011).
[17] Such as the No Child Left Behind Act in the US.
[18] The neglect of non-cognitive skills in analyses of earnings, schooling, and other life outcomes is in part due to the lack of any reliable means of measuring them. There is no single, identified, dominant factor for non-cognitive skills that is equivalent to the psychometricians' "g," or general intelligence. Indeed, it is unlikely that one will ever be found, given the diversity of character traits that fall into the category of non-cognitive skills (Blakeslee, J (ed), 2005). In addition, some feel that the skill categories of "cognitive" and "non-cognitive" used by many economists are both too simplistic and inaccurate (Duncan & Magnuson, 2009).
[19] Heckman refers to the non-cognitive abilities of motivation, socio-emotional regulation, time preference, personality factors and the ability to work with others (Heckman, 2008).

inter-related domains which shape each other's development. For example, self-esteem can improve academic outcomes, which in turn may enhance future self-esteem (Rolleston & James, 2011). Cognitive skills are considered to be acquired early in life with scores becoming stable around age 10, and are possibly less malleable than non-cognitive skills (Heckman & Carneiro, 2003). There is evidence that adolescent interventions can affect non-cognitive skills (Cunha, Heckman, & Masterov, 2005), which is supported in the neuroscience that establishes the malleability of the prefrontal cortex[20] into the early 20s (Heckman, 2008). Owing to synergies between cognitive and non-cognitive skill development, interventions which concentrate on enhancing young people's non-cognitive skills have been proved to be effective in improving academic outcomes (Brunello & Schlotter, 2011; Rolleston & James, 2011).[21] It is equally easy at all stages of the child's life cycle to use personality traits to offset early disadvantages in endowments, and the most effective adolescent interventions target personality traits (Heckman & Kautz, 2012). But importantly, **increasing non-cognitive skills during adolescence cannot compensate for cognitive deficits** that have been accumulated since early childhood.

The extent to which early education represents a wise investment of public funds is determined not only by higher levels of school readiness, but also how well subsequent classroom and school experiences serve to maintain these early gains. Longitudinal data shows that benefits of Head Start fade more quickly for black children because they are more likely to attend poorer quality schools than are white ex-Head Start children (Currie, 2001), leading some to argue that the benefits of Head Start depend, in part, on the quality of the school system, a point to note in countries with weak primary schools (Alderman & Vegas, 2011). However, using rich longitudinal data from the Early Childhood Longitudinal Study-Kindergarten cohort (ECLS-K), children who attended preschool were found to enter public schools with higher levels of academic skills than their peers[22] (Magnuson, Ruhm, & Waldfogel, 2007). Their findings also suggest that most of the preschool-related gap in academic skills at school entry is quickly eliminated for children placed in small classrooms, and classrooms providing high levels of reading instruction. Conversely, the initial disparities persisted for children experiencing large classes and lower levels of reading instruction. These results point out that the longer-term effects of early childhood experience partly depend on classroom experiences during at least the first years of school. In other words, **preschool attendees achieved at relatively high levels, regardless of the type of classrooms experienced**, whereas the classroom context mattered more among children who did not attend preschool (Magnuson et al., 2007). One of the key findings of studies that examine socioeconomic gradients[23] for youth literacy scores is that gradients tend to converge at higher levels of socioeconomic status, meaning that youth from advantaged backgrounds tend to do well in any environment, while those from less advantaged backgrounds vary considerably in their proficiency among environments (Willms, 2003).

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[20] The region of the brain that governs emotion and self-regulation

[21] These results find some support in a developing world context. Rolleston & James (2011) report on a programme which focused on enhancing self-esteem, self-efficacy and raising non-cognitive skills of children from slums in Mumbai, which had a notable impact on academic outcomes. However, Brunello & Schlotter (2011) reviewed a selected group of policy measures both in the US and in Europe that aim directly or indirectly at improving non-cognitive skills, and found the evidence to be somewhat mixed and still scarce.

[22] One reason why the authors find that the effects of preschool persist, whereas other studies have not, may be because the large sample size increases the statistical power to detect such associations (Magnuson et al., 2007).

[23] The strong relationship between the literacy skills of youth and family socioeconomic status is referred to a socioeconomic gradient. Socioeconomic gradients are a useful policy tool for informing social policy, as they call attention not only to the level of learning, behaviour, and health outcomes, but also to inequalities associated with socio-economic status (Willms, 2003).

2.5. Empirical evidence from benefit cost analyses

While there is substantial empirical evidence that intensive early education interventions targeted specifically at disadvantaged children lead to significant benefits, both in the short and in the long run (Magnuson, Ruhm, & Waldfogel, 2004; Barnett & Ackerman, 2006; Karoly, Kilburn, & Cannon 2005; Belfield, 2004), much less is known about the benefits of expanding pre-primary education for the population as a whole in middle- and low-income settings (Berlinski, Galiani, & Manacorda, 2008), and little empirical evidence from developing countries has been published (Aguilar & Tansini, 2011). Alderman and Vegas (2011) highlight that this, in part, reflects the difficulty in identifying the impact of programmes from the impact of self-selection: comparisons of subsequent school achievement for those who attended preschool with those who did not, often merely show that if a family values education and is more motivated and engaged, subsequent school performance generally improves. Fairly recently, however, compelling evidence has emerged from South America.

Galiani and Berlinski (2005) evaluate the large-scale expansion of pre-primary school facilities in ***Argentina*** in the early 1990s.[24] The Argentinian government targeted construction in poor areas with low pre-primary enrolment rates.[25] Preschool participation subsequently soared, highlighting the supply constraint bottleneck. With respect to the same programme, Berlinski, Galiani and Gertler (2009) demonstrated that one year of pre-primary education increases the average third grade test marks in standardised Maths and Spanish tests by 8% of the mean, or by 23% of the standard deviation of the distribution of test scores. Moreover, self-discipline, self-control, class participation, and concentration skills in third grade are also positively enhanced. The authors argue that the contribution of preschool education is to facilitate socialisation, which in turn allows the child to take advantage of opportunities for learning as they grow older.

Berlinksi and colleagues (2008) evaluated the effect of pre-primary education on subsequent school performance in ***Uruguay*** by comparing siblings who had attended preschool to those who had not. The educational reform programme launched in 1995 in Uruguay, introduced the universalisation of preschool for four-and-five year old children aimed at enhancing children's readiness to start school. This large scale expansion of public preschool institutions focused on historic areas of low coverage enabled researchers to identify the impact of such programmes on school achievement. They showed that by age 16, children who had attended preschool had obtained, on average, one more year of school education than their siblings who had not attended preschool. Moreover, those who had not attended preschool were almost 30% more likely to have dropped out of school by age 16. Using a within household estimator, small gains from preschool attendance at early ages get magnified as children grow up. The authors concluded that a publically provided preschool education appears a very efficient and cost effective policy option in countries where the system is unable to retain a large number of children and teenagers, as is the case in many developing countries.

Aguilar and Tansini (2011) used bivariate probit and treatment effects estimations to examine a similar Uruguayan policy, and found attendance at preschool to be paramount among the factors

[24] *Argentina embarked on a large infrastructure programme to increase school attendance for children aged 3-5 in 1993, and by 1999, had built enough classrooms to accommodate an additional 186 000 children. Most of the rooms constructed were in preschool annexes of public primary education institutions. Each room accommodated 25 children, and most public preschools operate in 2 shifts (Galiani & Berlinski, 2005) (Berlinski, Galiani, & Gertler, 2009).*

[25] *The government used a non-linear allocation rule based on an index of unsatisfied basic needs using Census data.*

explaining school performance in the first school year. When the performance[26] of children in first year in 1999 was examined, academic results were explained by a number of factors related both to the school and to the characteristics of the household. When the results of the same children were studied after six years at school, a similar picture was unearthed, with attendance at preschool once again being one of the main factors explaining school performance. Their main conclusion was that preschool, and children's performance in the first year at school, are crucial for the long term academic results (Aguilar & Tansini, 2011).

Mexico provides another interesting case in which planned expansion of early childhood care and education has occurred since 2000 through three initiatives: a mandate; a quality improvement initiative; and a national curricular reform (Yoshikawa et al., 2007). The law mandating preschool attendance passed in 2001 required that all parents in Mexico send their 3-5-year olds to preschool programmes and set a timetable for 100% coverage of each of these groups.[27] This law mandated a huge and unprecedented expansion in Mexico's preschool education system within an extremely short time frame. Following its passage, enrolment of Mexican 4- and 5-year olds in preschool education programmes has increased greatly, with the result of near-universal attendance among 5-year olds as of the 2005-2006 school year and 81% attendance among 4-year olds (Yoshikawa et al., 2007). Evidence of this expansion on child outcomes is difficult to come by.

Other international early learning programmes also report higher school enrolment, less grade repetition, and fewer dropouts. ***Colombia's*** PROMESA programme reports significantly higher enrolment rates in primary school for children participating in the programme, compared with children not participating in the programme. In addition, 60% of the children who participated in the ECD programme attained Grade 4,compared with only 30% of the comparison group (Garcia, Pence, & Evans, 2008). In Colombia's PROMESA programme, and the Alagoas and Fortaleza PROAPE study of Northeast Brazil, children who participated in the programmes repeated fewer grades and progressed better through school than did nonparticipants in similar circumstances.

Nores and Barnett (2010) added to the non-US evidence base by undertaking a meta-analysis summarising research on short- and long-term effects of a wide range of early childhood interventions. They grouped results from these international studies into four outcome domains: cognition, behaviour, health, and amount of schooling. A total of 56 studies reporting the effects of 30 interventions in 23 countries in Europe, Asia, Africa, Central and South America were analysed. They confirmed that strong evidence can be found on the cognitive and behavioural benefits from these interventions, as well as the potential for large economic gains from improvements in child development outcomes. All of the major types of early childhood interventions had substantial average effect sizes across a diverse sample of programmes and countries.

Worldwide, pre-primary school attendance has nearly tripled in the last thirty years, though enrolment varies dramatically by region. For example, in 2004, pre-primary enrolment rates for children between 3 to 5 years old were approximately 73% in developed and transition countries,

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[26] *The authors found the main problem when modelling school results was finding an appropriate measure of school performance. They used measures that included the probability of passing the first school year and the probability of passing the sixth year on schedule, as well as indicators built upon the marks obtained by the children.*

[27] *Target dates of 2004, 2005 and 2008 for 100% coverage of 5-year-olds, 4-year-olds and 3-year-olds, respectively. The mandate for 3-year olds is the only such mandate in the world (Yoshikawa et al., 2007).*

compared with 32% in developing countries (UNESCO 2006). Engle et al. (2007) consider preschool enrolment to be averaging 35% in developing countries in 2001. In the past 15 years, at least 13 developing countries have instituted compulsory preschool or pre-primary programmes. The regions with the highest need when assessed by Grade 1 repetition and dropout, for example sub-Saharan Africa, have shown the slowest progress. Programme coverage is negatively associated with countries' general poverty index, leaving the poorest countries with almost no investment in early child development. However, some poor countries, such as India, have invested substantially in programmes (Engle, et al., 2007).

In many school systems, a large proportion of children do not reach basic literacy until well into their primary school years, if ever. Needless to say, the absence of a tangible learning outcome implies an inefficient education investment (Alderman & Vegas, 2011). This inefficiency is extremely costly. Grade repetition takes up classroom space, teacher time, textbooks and materials. Across sub-Saharan Africa, where the problem of inefficiency is most acute, UNESCO estimates that **33% of public expenditure on education is spent on grade repetition**, adding up to a cost of $6.2 billion (Gertsch, 2009).

Estimations in Africa assert that an increase in the preschool gross enrolment rate to 40% during the next decade could reduce repetition rates and increase the proportion of Grade 1 pupils who reach Grade 5 from 65% to 78% (Engle, et al., 2007). In another estimate, an increase in the coverage of preschool in Africa to 30% by 2015 may result in an efficiency gain of 15% in resource use in primary education (Hyde, 2008). Further evidence comes from the work of researchers Jaramillo and Mingat. They argue that there is a structural relationship between preschool and primary education, and analyse data on repetition and completion rates in schools in sub Saharan Africa in comparison with other regions. They describe a positive association between preschool enrolment and school survival, and a negative association between preschool enrolment and class repetition[28] (Garcia et al., 2008). This effect results from two sources. Firstly there is an indirect effect through the combined impact of preschool on repetition and of repetition on survival. Secondly there is a direct effect (that may represent the impact of preschool on the demand for schooling). They estimate that investments in ECD in sub-Saharan Africa would be offset by 87% as a result of higher efficiency in primary education alone (Garcia et al., 2008). It needs to be mentioned that the authors acknowledge that their data are unreliable and extremely variable, and as such have been criticised for using them to produce economic models on which to base a case for the expansion of ECD services (Penn, 2004).

Recently the initial results of the first randomised evaluation of a preschool intervention in a rural African setting have been presented (Martinez, Naudeau, & Pereira, 2012). Starting in 2008, a centre-based community driven preschool model was implemented in rural areas of the Gaza Province of Mozambique.[29] Compared to a baseline, children who attended preschool were 24% more likely to be enrolled in primary school, demonstrated improvements and outperformed their peers in cognitive, problem-solving abilities, fine-motor skills, socio-emotional and behavioural outcomes, but had mixed results in health. Some of the principal measures of communication and language development were not significantly different between the treatment and control groups, and were alarmingly low for both groups(Martinez et al., 2012).

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[28] *The higher the preschool enrolment, the higher the proportion of the cohort that survives to Grade 5.*

[29] *The project financed the construction, equipment and training of 67 classrooms in 30 communities, at a cost of approximately $2.47 dollars per student per month.*

2.6. The importance of early learning interventions for the education sector

Schools work with what families give them. The famous 1966 Coleman Report on inequality in US school achievement, and a vast subsequent literature, clearly document that the major factor explaining the variation in the academic performance of children is the variation in home environments - not the variation in per pupil expenditure or pupil-teacher ratios. Successful schools build on the efforts of successful families. Failed schools battle to cope with children from dysfunctional families who do not provide enriched home environments (Heckman & Masterov, 2007).

The developmental trajectory of most children appears to be well established at school entry: schooling simply reinforces the emerging developmental trends and usually widens the gap between good and weak, and wealthy and poor pupils (Feinstein, 2003). Almond and Currie (2010) summarise seven longitudinal studies from the US and UK which suggest that characteristics that are measured as young as age 7, can explain a great deal of the variation in educational attainment, earnings and the probability of employment in later life. The developmental window of opportunity for rapid language learning is most widely open **before** children enter school: language levels at age 3 accurately predict those at age 10 and through high school (Gertsch, 2009; Dickinson & Porche, 2011; NICHD et al., 2005). A South African study found that language delays remained stable between Grades R and 3, suggesting that the education received was not powerful enough to make a significant difference to an already entrenched problem (Klop, 2005).

Emergent literacy during the preschool period (including the ability to manipulate phonemes and to recognise letters and letter sounds) predicts later reading achievement. Similarly, emergent numeracy skills in preschool (including counting, number knowledge, estimation, and number pattern facility) predict later mathematical competence (Duncan, Dowsett, et al., 2007; Welsh, Nix, Blair, Bierman, & Nelson, 2011). However, in all these studies, experimental evidence would be necessary to make claims about causation. A US national longitudinal analysis, the Family and Child Experiences Study (FACES), indicated that economically disadvantaged children may know only one to two letters of the alphabet upon entering kindergarten, even as middle-class children know all 26 letters. By age 3, children from disadvantaged backgrounds hear only about one quarter of the words that their more advantaged peers hear. **Starting behind they will stay behind**. This is the well-known Matthew Effect, as lifted from the biblical passage (Neuman, 2009).

But while children who live in poverty tend to have less verbal interaction and begin school with fewer linguistic skills than peers from higher income groups, the relationship between socioeconomic status and learning outcomes is not straightforward. It is the home learning environment, rather than socioeconomic status, which has most effect; in other words, what parents do[30] with their children is more important than who parents are. It is well documented that caregivers can get children off to a good start even in difficult situations[31] (Gertsch, 2009; Siraj-Blatchford, Taggart, Sylva, Sammons, & Melhuish, 2008).

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[30] Practices such as reading to children, storytelling, singing, or reciting rhymes and riddles all promote language.

[31] It is important to note that not all young children exposed to poverty and adversity develop discernible physical, mental and social problems. Supportive factors enable these children to remain developmentally on track with their more advantaged peers. Long-term follow-up studies of disadvantaged children have identified three types of resilience-promoting experiences: 1) warm

School readiness involves a range of competencies with children being required to complete independent work, adhere to strict time schedule, and acquire basic literacy and maths skills for the first time (Richter et al., 2012).[32] Understanding which skills are linked to children's academic achievement has important implications for early education programmes.

There appears to be some tension in the literature on this issue. On the one hand, the evidence suggests that pre-school programmes for children from low-income homes might reduce school readiness disparities most effectively by focusing more time on direct instruction in these specific domains (Duncan, et al., 2007; O'Carroll, 2011; Naudé, Pretorius, & Viljoen, 2003). Most current efforts to enhance the impact of pre-school education on school readiness for low-income children have focused on improving domain-specific instruction to foster the acquisition of emergent literacy and numeracy skills (Konold & Pianta, 2005). On the other hand, developmental research suggests that it is the important mental processes (particularly working memory and attention control) that support effective, goal-oriented approaches to learning (Welsh et al., 2011). These mental processes are often delayed in children growing up in poverty (Noble, McCandliss, & Farah, 2007), and have been shown to play a central role in predicting school adjustment and academic attainment (Welsh et al., 2011). More specific developmental research, however, is needed to better understand the developmental interaction between domain-specific learning in emergent literacy and numeracy skills and growth in these executive function skills, in order to better inform educational strategies designed to foster school readiness.

What is clear in both the international and South African literature, however, is that opportunities for emergent literacy development through exposure to reading, pictures and mediated explanations of text are especially important during this period (Richter, Dawes, & Kadt, 2007; Van Staden & Griessel, 2011; Naudé et al., 2003) because deprivation in this area is the **primary mechanism** by which low income leads to underachievement (Dearing, McCartney, & Taylor, 2009).

Some suggest that it is worth looking at classrooms through the lens of language to better understand the beginnings of multiple pathways that lead from pre-school to later academic success (Dickinson & Porche, 2011). The comprehensive model of emergent literacy[33] posits that in the preschool years, multiple language and print-related skills are emerging in a mutually supportive fashion, with growth in one domain fostering growth in others (Dickinson & Porche, 2011). Longitudinal evidence demonstrates the direct relationship between language skills and achievement at school, '*forming the basis for the formulation of questions, elaboration of knowledge and the reduction of ambiguity in new learning situations*' (Naudé et al., 2003). Children's vocabulary, comprehension and the flexibility of their language usage as a medium of

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and supportive family relationships, 2) stability and security at home and in the community, and 3) expectations, opportunities and encouragement to participate and succeed in some area of their lives (Richter et al., 2012).

[32] For children aged three to five years, Dawes, Bray and Van der Merwe (2007) recommend the following indicators as good predictors of child outcomes and well-being: age-appropriate fine motor skills, appropriate social behaviours with adults and peers (linked to socialisation, self-esteem, confidence, and self-regulation), age-appropriate participation, interest in or a positive approach to learning, early numeracy skills, and language and literacy development.

[33] Emergent literacy can be defined as 'the skills, knowledge and attitudes that are presumed to be developmental precursors to conventional forms of reading and writing'(Kennedy et al., 2012).

both thinking and communication, have a direct influence on their ability to gain returns from formal teaching (Van Staden & Griessel, 2011).

Young children (aged 3 and 4 years) are in the process of developing **critical higher mental functions,** e.g. the ability to memorise, to pay attention, to reason, to think, and to imagine. Certain emergent literacy practices are especially effective in terms of supporting children's development of the higher functions (Kennedy et al., 2012). Another way of understanding this is that '*thinking is never more precise than the language it uses'* (Naudé et al., 2003). In general, learners who present with inadequate mediated language experiences lack higher-order thinking skills due to an absence of vertical and horizontal elaboration of language proficiency. As a result, they exhibit poor associative ability, conceptual thinking, and impaired knowledge-acquisition processes which limit their potential to achieve at school (Naudé et al., 2003).

But while there is a strong link between quality preschool preparation and competency in early literacy skills (De Witt, 2009), relatively little is known about the specific features of preschool classrooms that contribute to language acquisition (Dickinson & Porche, 2011). While low literacy levels are not unexpected in disadvantaged communities, De Witt, Lessing, and Lenyai (2006) reported that only 35% of Grade R learners meet the minimum criteria for early literacy development: the majority of learners will enter Grade 1 without the necessary skills or concepts to master reading. Being in a Grade R class does not automatically guarantee good emergent literacy preparation.

2.7. The South African focused discussion

Evidence and common sense suggest that the benefits and risks of early childhood are not identical between developing and high-income countries, and if programmes in developed countries were transplanted directly into developing countries, it is highly unlikely that the same benefits would be seen.[34] Likewise, the benefits that are seen in developing countries may not be those one would find in developed countries (Gertsch, 2009).

Very few studies have examined the impact of ECD services on child outcomes in South Africa. There are no peer-reviewed studies. The studies that have been done report mainly on health benefits for children, particularly with regard to nutrition and growth outcomes. And all these studies have been hindered by a lack of non-experimental data. Dawes et al. (2008) report only two small-scale unpublished outcome studies that are available for South African formal ECD evaluation which both found gains in child outcomes relevant to schooling following participation in high-quality, centre-based programmes compared with control groups.[35] Short & Biersteker (1984) followed the academic performance of ECD centre participants into adolescence and they performed above the school population average. A South African study of 150 rural African children suggested that cognitive ability at the end of Grade 1 predicted later progress through school, and was a good predictor of retention in school (Liddell & Rae, 2001). In other domestic studies, Fiske and Ladd (2004) allude to the expense of remedial interventions when they argue that more spending is needed in schools serving a disproportionate number of disadvantaged

[34] *While the Perry Preschool Programme had many positive effects, one of the most significant was the lower incarceration rates among young African American men, which is unlikely to be repeated in other contexts. Similarly, the biggest rate of return on investment in the Chicago Child-Parent Centers was the increase in mothers' employment.*

[35] *Vinjevold (1996) reported that black children from farm schools and townships involved in the Ntataise preschool programme demonstrated better fine motor skills, better concentration skills and more confidence.*

students to cover the differentially high cost of educating children who come to school less ready to learn.

Evidence on beneficial schooling outcomes in literacy and numeracy from preschool in South Africa has recently been extracted in an analysis of SACMEQ III[36], as further discussed in Chapter 3 of this Report. The regression results showed that preschool education has a marked association with Grade 6 academic achievement. Strong correlation between preschool education and wealth was found, with poorer quintiles having less preschool education and higher quintiles having more preschool education. The report also found a large negative impact from grade repetition, more prevalent amongst the poorer quintiles, which increased as the number of grade-repetitions increased. (Spaull, 2011).

The Sobambisana programme[37] created an opportunity for assessing whether, and to what extent, the South African ECD experience conforms to international evidence. Its evaluation used a quasi-experimental process, with suitable controls comprising groups of beneficiaries and wait-listed comparison groups. The impact of programmes aimed at improving children's readiness for Grade R, assessed by means of cognitive, language, numeracy and academic readiness tests, was mixed. The best results were found in group programmes at ECD centres, with curricula aligned to these outcomes. It was also found that, regardless of the efforts put into community and site-based ECD programmes, some factors largely beyond the programmes' control play a significant role in tempering the results (Dawes et al., 2011).[38]

For example, the poor nutritional status of children in South Africa is of singular concern. South Africa is home to 2.2 million stunted children[39] (18% prevalence), which affects their short and long term strength, stamina and cognitive ability[40] (Richter et al., 2012). Stunting results from long-term under nutrition due to inadequate frequency of feeding and poor quality food. The trajectory of linear growth is laid down in the first two years of life, and young children who have received insufficient food **do not make up for poor growth at a later age** (Richter et al., 2012). Stunted children achieve, on average, one school grade less than their better grown peers. Stunting combined with poverty (below the third quintile for income) is associated with the loss of 2.15 grades of schooling (Walker et al., 2011). Translated into adult earnings, stunted children in Guatemala who received no intervention earn roughly 46% less as adults than stunted children who received supplementary feeding in their first two to three years (Richter et al., 2012).

For this reason, there is a strong argument for recognising that educational solutions to poor general schooling outcomes can only address part of the problem. Many South African children arrive in formal school with their developmental potential considerably compromised and as a result, they are unlikely to be able to benefit much from what are often under-resourced educational settings ("Will Grade R really improve the quality of SA education?," 2010). On the

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[36] *SACMEQ III was the first of the SACMEQ surveys to ask students about their preschool education.*
[37] *Sobambisana, a component of the Ilifa Labantwana ECD programme, was the first attempt in South Africa to develop a local evidence base for interventions aimed at improving ECD.*
[38] *High levels of stunting and under nutrition were recorded at all programme sites. Levels of cognitive development were below the norm for age. Both factors significantly reduce the efficacy of ECD.*
[39] *Below 2 standard deviations of expected height-for-age*
[40] *UNICEF reports a higher South African national figure at 23%, and neighbouring countries' stunting rates as: Mozambique 36%; Namibia 28%; Zimbabwe 32%; Lesotho 44%; Botswana 29%. The sheer numbers of children affected in South Africa eclipse those of its neighbours.*

other hand, the school feeding programmes may bring other benefits to development for very poor children who enter Grade R.

2.8. The quality imperative

In the same way that increasing access to education is no guarantee that young people will develop the skills they need for a rapidly changing and globalised world (Hanushek & Woessmann, 2011; Rolleston & James, 2011), a place in Grade R does not automatically boost a school career.

There is a consensus across a wide range of child development research in several countries that good quality ECD provision produces good outcomes - medium to large gains in cognitive and social skills - and conversely, poor provision leads to worrying outcomes, including negative, aggressive behaviour, poor language development (Currie, 2001), and an increase in child- or family-related developmental risks (Leseman, 2002). The effects of quality in the middle-range on child outcomes are small (Center on the Developing Child at Harvard University, 2007; Yoshikawa et al., 2007). For example, a large-scale study in the UK made the striking finding that three quarters of educational settings had not made any difference in children's vocabulary growth (Kennedy et al., 2012), highlighting the importance of good pedagogical practice for improved children's outcomes (Penn, 2009). In Cambodia, an evaluation of the relative effectiveness of three models of preschool provision (state, community and home-based) in poor settings (Rao et al. 2012) found that all three contributed positively to child learning over the year compared to children who did not attend preschool, even the simple and very lowly resourced home-based programmes

The report commissioned by National Treasury in 2008 argued against Grade R implementation success being measured through the number of children who have access to this year of schooling, but rather a more reliable assessment of what is actually being achieved (National Treasury, 2008). It also outlined the on-going confusion relating to the understanding of quality in Grade R, the importance of setting out indicators to judge this quality, and highlighted the importance of explicitly clarifying curricula expectations for Grade R.

Quality is key: a quality curriculum, a quality teacher or practitioner (Excell & Linington, 2011), and a quality response to the particular developmental realities of children arriving in Grade R. In terms of both programme quality and the quality of learning and teaching support material in Grade R, what little evidence there is (Dept of Basic Education, Dept of Social Development & Unicef, 2011) points to inadequacies, though resources in Grade R classrooms are not the major reason for poor quality. To understand what quality in early learning may mean, it is first critical to understand how young children learn. This is especially true for Grade R, where curriculum and pedagogy are closely related and ***what*** children learn is as important as ***how*** children learn[41] (Excell, 2011). It is strongly argued by some that Grade R should be aligned with ECD pedagogical practice, and not be seen as a "mini" or "watered-down" Grade 1 (Excell & Linington, 2011). The fact that ECD programmes can be hijacked to become essentially a downward extension of uninspiring primary schools is a well-founded and internationally-shared fear (Arnold et al., 2007).

[41] *In young children's learning, the internalisation of concepts is facilitated by a three phase approach: children first experience these concepts kinaesthetically (through movement), then three dimensionally (through exploring with concrete apparatus), and only then through pen and paper activities. Play is instrumental in supporting both learning and teaching (Excell & Linington, 2011).*

Active, child-centred, participatory methods in which children learn by doing, manipulate concrete objects, are supported in their make-believe play in both structured and playful contexts, and are engaged in storybook reading and discussion (Kennedy et al., 2012) are often replaced by ultra-formalised methods where the child is reduced to a passive recipient. A focus on 'academics' tries to establish numeracy and literacy through a more didactic practice which favours table-top, sedentary activities such as worksheets and other largely 'inactive' activities (Excell, 2011). The more informal approach, however, is the most difficult to assimilate into the public school system because of its contrary philosophical underpinnings and requirements in teacher preparation.[42]

There is a conflict: 'to ease the transition from pre-school to primary school, should we formalise what is meant to be informal, in order to give children a better start towards achieving academic success in an increasingly competitive world, or de-formalise what is usually considered formal, in an attempt to reverse the increasingly formal nature of the early years of education?' Many seem concerned that, internationally, the former seems to be the trend (Shaeffer 2006). In South Africa, the dichotomy between the two pedagogical models continues to trouble Grade R provisioning (Excell, 2011).

The Grade R curriculum has been criticised for its lack of emphasis on language and emergent literacy (O'Carroll, 2011; Naudé et al., 2003).[43] As described throughout this review, the vast majority of learners from impoverished communities suffer from inadequate school preparation and are even likely to experience '*special needs'* when entering the formal school system (Naudé et al., 2003). Here the Grade R curriculum has a key role to play in closing gaps for children who do not come from print-rich homes. Critically, this does not mean that teachers need to introduce formal and possibly inappropriate learning situations into Grade R: letters and sounds can be taught through play and in the context of developing children's vocabulary and awareness of sounds in words (O'Carroll, 2011). But when priority is not given to the teaching of letters in Grade R, the associated advantages of this important foundation remain a '*middle class secret'*.

And finally, while not in the scope of this review, probably the most important aspect of quality for an early education programme is the nature of the interaction between the teacher and the child (Currie 2001). Unreflective teachers and those working in relative isolation without easy access to support, a professional community and means of engaging with the new theories (Excell & Linington, 2011), will continue to teach to prescriptive outcomes and will not necessarily embrace appropriate pedagogies (Excell, 2011).

2.9. Conclusion from the literature

The most powerful proponents of early learning interventions in recent years are not parents, care providers, health care workers, teachers, or child development specialists – but economists. This development has been met with a fair amount of scepticism in some circles, but it effectively provides the field with considerable opportunity to strengthen its case.

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[42] *In her interviews of numerous Grade R teachers as part of her doctoral thesis, Excell (2011) found that few could actually articulate a deep understanding of how to maximise children's learning through a play-based approach. De Witt (2009), in an assessment of 70 preschools (not Grade R) in five provinces, found the lack of educational materials so complete that practitioners did no more than look after the children.*

[43] *Curriculum guidelines indicate that Grade R children should know 'some' letters by the time they start Grade R, but it would seem that the teaching of letter-knowledge is regarded as being primarily the responsibility of Grade One teachers (O'Carroll, 2011).*

Theoretically and empirically, over both the short and long terms, whether at small scale or at universal scale, in developed and developing countries: preschool interventions work. Direct intervention at the level of the child is a proven methodology for children of this age group, enabling them to become direct beneficiaries of state support, rather than support that is mediated through third parties. Paternalistic as this intervention may be, it is guided by a life cycle approach to learning: the case for violating the principle of consumer sovereignty is strongest at the preschool stages, and not at the later stages of formal schooling, where the argument is most often made (Heckman & Carneiro, 2003). The principles of equity and social justice may better be served by investing in earlier stages of education.

In sum, this review has shown the power of investing in early learning. Evidence points to the importance of preschool education for future learning success, the potential it holds to address some of society's intractable inequalities, and the capacity it has to have meaningful impact at scale in developing countries. Importantly, the accumulated evidence unequivocally stresses the importance of **high quality education programming** to effect any long term change in children's cognitive, social and economic outcomes. There are slight, if any, advantages to be gained from poor quality services (Richter et al., 2012), though there is not full agreement about the nature and determinants of quality in this area.

While good schools can go a long way toward helping poor children achieve better, the fact remains that educational inequality is rooted in economic problems and social pathologies too deep to be overcome by school alone. Grade R is not the 'magic bullet.' Yet it is recognised that a quality programme is 'a powerful equaliser,' because assistance is provided during a time when children are most able to make up for disadvantages carried over to them from previous generations.

Grade R stands the risk of becoming nothing more than the Grade 1 of yesteryear, where the ECD goals of holistic child development and encouragement of lifelong learning become distant, an instrumentalist curriculum becomes more deeply entrenched (Excell, 2011), and the status quo of educational inequality is perpetuated. This is particularly evident in the area of language and emergent literacy development, both of which serve as critical determinants of children's successful adjustment to school and as consistent predictors of later outcomes in reading and written language in the higher school phases (Justice et al., 2010;Van Staden & Griessel, 2011). It is critical that the Grade R curriculum gives teachers clear messages about the important foundations for literacy that need to be laid in Grade R (O'Carroll, 2011).

Many of the concerns regarding Grade R raised in this review are not unique to South Africa and are echoed in many western countries. However, given that South Africa is in the beginning phase of its Grade R implementation, there is still a window of opportunity to heed some of the cautions that have been expressed before this vital year simply becomes part of a more general education problem.

3. Exploring existing datasets for evidence of the impact of grade r on learning outcomes

3.1. Introduction

Given what has been set out in the previous chapter on the scarcity of research on the impact of pre-school attendance in South Africa, as well as the various findings of positive impacts in other countries, the aim of this report is to fill this gap by evaluating the impact of the Grade R programme in a more robust way than what has been done previously. The weak learning outcomes in South African schools in an international or even regional context, and the deep-seated inequalities in education played a major role in placing such strong emphasis on Grade R to address some of these problems early, for the reasons set out in the previous chapter. Whether that has been successful in terms of achieving the desired outcomes is what this and the following chapter address. This is all the more necessary given that what little literature is available in South Africa on Grade R raises serious doubts about the quality of provision, as discussed in Sections 2.7 and 2.8.

Before deciding on the best approach for this evaluation, all available data sources that could potentially offer some insights to evaluate the impact of the programme were considered. Various existing data sets contain data which could potentially be used to evaluate pre-school education in South Africa. These surveys include the CSG Evaluation, KIDS, the BT20 survey, the SMS and TIMSS, NIDS, the GHS, SACMEQ, the Systemic Evaluation and PIRLS. All of these datasets contain some information on children, their household background characteristics and their educational achievement in the form of test scores or attainment. Most of these datasets fall short for this purpose in the sense that they do not contain direct questions about whether children attended Grade R, but rather focus on pre-school attendance generally. In addition, there are also additional complications related to each of the individual data sets, as set out in table 3.1 below. Accordingly, and also because of issues around endogeneity and causation, analysis using these existing data sources cannot be conclusive regarding the impact of Grade R. Nevertheless, some of them can provide some suggestive evidence. As requested in the Terms of Reference for this study, this chapter thus contains an analysis of the impact of the programme using three datasets that were also analysed in a DBE report (2012) that also acknowledged these limitations. In the next chapter there is then an analysis of a new dataset created for this purpose from administrative data, to overcome the limitations of these other datasets and to estimate the impact of Grade R attendance on cognitive performance, a good proxy for the many measures of child well-being. This data as well as the estimation strategy are described in the next chapter.

TABLE 3.1: SUMMARY OF FINDINGS ON EXISTING DATA FOR GRADE R

Data	Useful for estimating impact?	Outcome Variables	Covariates	Identification Strategy	Advantages	Disadvantages
NIDS	Yes	Test scores (only for first wave) School repetition Employment status of caregiver	Learner and household, School-level covariates to be linked using EMIS number	Multivariate regression control-ling for learner, household and school-level effects	Detailed household level covariates Asks specifically about Grade R, not just all preschool attendance	No school-level covariates No test scores for the second wave Relatively small sample of households
SACMEQ	Yes	Grade repetition and test scores (literacy and numeracy)	At level of individual learner, house-hold and school	Fixed effects at level of the school	Comprehensive set of control variables Reliable test scores	No way to control for unobserved differences between children in a school Measures only preschool attendance generally, not Grade R No measure of quality of preschool
Systemic evaluation	Yes	Standardised test scores on numeracy and literacy Employment status of parent	At the level of the individual learner, house-hold and school	Fixed effects at the level of the school	Comprehensive set of control variables Reliable test scores	Measures only preschool attendance generally, no Grade R No measure of quality of preschool
PIRLS	Yes	Language test scores and attendance rates	At the level of the individual learner, household and school	Fixed effects at the level of the school	Comprehensive set of control variables Reliable test scores	No way to control for unobserved differences between children in a school Measures only preschool attendance generally, no Grade R No measure of quality of preschool

Note: TIMSS (Trends in Maths and Science Study), the CSG Evaluation, General Household Survey (GHS), KwaZulu-Natal Income Dynamics Study (KIDS), Birth to Twenty and SMS all are useful sources of data, but cannot be used for measuring impact of Grade R or other forms of ECD, as they do not contain outcome variables or covariates that allow for this, they make possible no identification strategy through which causal impact can be measured, and therefore hold no advantages for this purpose.

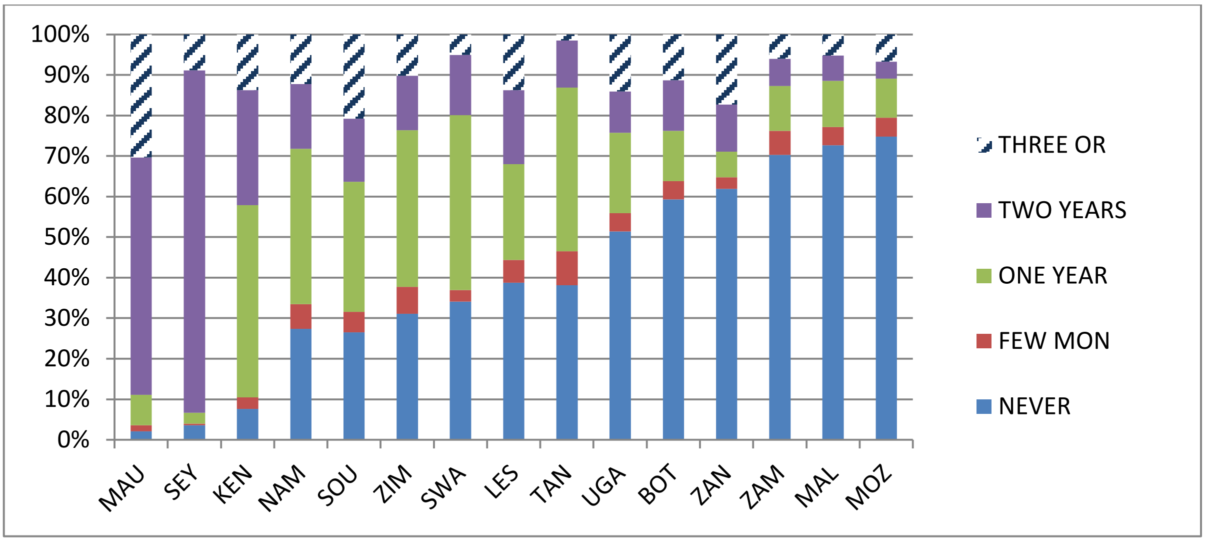
The Department of Basic Education's report (DBE, 2012) that attempted to extract available evidence on the possible impact of early learning on learning outcomes presented some evidence of association between early learning and later learning outcomes, but the nature of the data did not really allow for causal interpretations of this link. This chapter replicates and build on this work, as discussed below. What is found in this Chapter does not deviate in principle from that found in the original study, and the conclusion from the analysis therefore remains that there is some *suggestive evidence* that early learning may cause improved learning outcomes, but that the data do not allow an unequivocal statement that there is such a *causal* link. For that reason, Chapter 4 of this report remains all the more important, as it uses new data to explore whether the introduction of Grade R led to improved learning outcomes.

The next sections discuss the results obtained from analysis of these other surveys.

3.2. Evidence from SACMEQ

Figure 3.1 below shows a regional comparison of the proportion of Grade 6 students who in SACMEQ 3 in 2007 indicated that they have been exposed to preschool for varying time periods. In South Africa a majority of students had been exposed to preschool, but about 25% still did not attend any form of preschool before entering school. South Africa compares favourably to its regional partners, but is still lagging behind countries such as Mauritius and Seychelles, who boast much larger proportions of students having attended preschool for some time.

FIGURE 3.1: PRESCHOOL EXPOSURE IN REGIONAL COMPARISON



Both Spaull (2011) and the DBE study (2012) found significant coefficients for having attended preschool for a period of a year or more, with the effect being more prominent in the reading scores, conditional upon also controlling for other factors. Having attended preschool for a period of three years or more also had significant effects on the mathematics scores.

TABLE 3.2: COEFFICIENTS ON PRESCHOOL IN EDUCATION PRODUCTION FUNCTIONS USING SACMEQ 2007

	Spaull 2011 Mathematics	Spaull 2011 Reading	DBE 2012 Mathematics	DBE 2012 Reading
Months	1.72	4.33	1.34	4.33
1 Year	5.74	9.94**	5.25	9.33**
2 Years	3.73	16.78***	2.86	15.94***
3 Years or more	8.14**	11.06**	6.71**	9.90**
Observations	7854	8088	7854	8088
R -squared	0.48	0.59	0.48	0.60

Significant at 10% level, ** Significant at 5% level, * Significant at 1% level*
Source: Spaull 2011 & DBE 2012

The table below comprises the same education production functions as those modelled by the DBE, but includes various interaction effects. Models numbered [1] include the interaction effect between a *student's* SES and having attended preschool, whereas models [2] include the interaction effect of a *school's* SES (the average SES of students in the school), abbreviated as SSES, and having attended preschool. Models [3] include both these sets of interaction effects. When including these effects, it is evident that the measured effect of preschool increases both in magnitude and in statistical significance, suggesting that students or schools with a higher SES received larger gains from attending preschool that poorer children or in poorer schools. Thus, this would seem to indicate that preschool increases learning but also learning gaps between poor and rich. This is a theme that will again be relevant in the analysis of the new dataset in Chapter 4.

TABLE 3.4 EDUCATION PRODUCTION FUNCTION REGRESSIONS USING SACMEQ 2007

Variable	[1] Reading	[1] Maths	[2] Reading	[2] Maths	[3] Reading	[3] Maths
SES	-4.18	-3.13	2.99**	1.06	-0.09	0.16
SES^2	0.60	2.07**	1.13	2.42**	0.87	2.37**
School SES (SSES)	40.27***	38.03***	28.33***	29.47***	31.20***	30.30***
School SES^2	18.82***	25.02***	17.35***	23.52***	17.55***	23.55***
Some Months	**7.24**	**3.15**	**8.25***	**3.12**	**9.10***	**3.01**
1 Year	**13.11*****	**7.69***	**14.45*****	**9.26****	**14.77*****	**9.37****
2 Years	**19.57*****	**5.62***	**20.63*****	**6.88****	**21.02*****	**7.10****
3 Years or more	**11.87*****	**7.31****	**12.95*****	**8.33****	**13.09*****	**8.32****
Some Months * SES	2.85	1.5			-3.15	3.20
1 Years * SES	10.57**	6.34*			5.30	1.85
2 Years * SES	7.76**	2.18			2.20	-1.93
3 Years or more * SES	12.18***	9.23**			6.24	2.29
Some Months * SSES			10.67	-0.63	13.78*	-3.70
1 Years * SSES			16.76***	12.13**	11.71**	10.36
2 Years * SSES			14.50**	8.15	12.48**	9.98
3 Years or more * SSES			19.25***	17.03**	13.22**	14.80**
Observations	8088	7854	8088	7854	8088	7854
R-Squared	0.60	0.48	0.60	0.48	0.60	0.48

Significant at 10% level, ** Significant at 5% level, * Significant at 1% level*

In order to control for the unobservable factors inherent in school processes, school fixed effects models were also estimated. What such a fixed effects model accomplishes is to observe the relationship between the intervention (preschool) and learning outcomes *within* individual schools, and averaging that relationship across schools. It thereby eliminates those factors that operate across school and confound the relationship, such as differences in management, etc. (A fuller account and non-technical introduction to the use of fixed effects models is provided in Chapter 4, particularly in Box 4.1.) Factors such as gender, age, socio-economic status, mother's education, the frequency of speaking English at home, household size, whether a child lives at home with his parents, the number of books at home, the amount of time spent on household tasks and whether the student sometimes goes hungry were also controlled for. Individual level unobserved variables (such as ability or motivation), however, remain. These models indicate that having attended preschool for at least 2 years has a significant positive relationship with both the numeracy and reading score, after controlling for the factors mentioned.

TABLE 3.5: COEFFICIENTS ON PRESCHOOL IN SCHOOL FIXED EFFECTS REGRESSIONS USING SACMEQ 2007

	Reading	**Maths**
Preschool: 1 Year	3.01	-0.18
Preschool: 2 Years or more	6.39***	3.60*
Observations	9071	9051
R-squared	0.67	0.60

Significant at 10% level, ** Significant at 5% level, * Significant at 1% level*

Table 6 depicts the school fixed effects regressions for various sub-samples. Having attended preschool for 2 years or more seems to have a significant effect on reading scores for students in the poorest 75% of schools (Models 2), but not for maths or for either subject in the richest quartile of schools. There also seem to be reading gains for students in both urban and rural areas. Otherwise the regressions do not show much evidence of significant effects.

TABLE 3.6: COEFFICIENTS ON PRESCHOOL IN SCHOOL FIXED EFFECTS REGRESSIONS FOR THE RICHEST QUARTER AND THE POOREST THREE-QUARTERS OF SCHOOLS, USING SACMEQ 2007

	[4] Reading Richest 25% of schools	**[4] Maths Richest 25% of schools**	**[5] Reading Poorest 75% of schools**	**[5] Maths Poorest 75% of schools**	**[6] Reading Rural schools**	**[6] Reading Urban schools**
Preschool: 1 Year	12.25	11.42	1.27	-2.08	4.19	1.23
Preschool: 2 Years or more	13.04	15.14	6.05**	1.48	5.31*	5.38*
Observations	2255	2245	6816	6806	4004	5067
R-squared	0.53	0.49	0.41	0.35	0.48	0.65

Significant at 10% level, ** Significant at 5% level, * Significant at 1% level*

3.3. Evidence from GHS

The General Household Survey of 2011 included questions on whether students could write their name or were able to read with no or only some difficulty, as well as information on whether students had attended pre-schools. It thus seems is possible to estimate the relationship between attending pre-school and literacy at a young age, assuming that these variables are well recorded. As in the DBE study, the restricted models excludes children whose parents pay fees or who attend an institution that is not the nearest educational institution of its type to their home (Model 2). Models 3 and 4 further distinguish within this restricted sample between urban and rural schools. This restriction aims to reduce bias that may arise because of highly motivated parents enrolling their children in specific schools and also influencing the literacy ability of their children directly, thus creating an upward bias in the estimated coefficients. The idea is that children who attend a nearby institution that is free are likely to include many of those who would not have been enrolled at all had the Grade R programme not been rolled out. Such children therefore represent a more appropriate group for comparison to non-enrolled children.

It is notable that the effects of attending Grade R that are apparent in Model 1 of Table 3.7 remain in all three the restricted models, thus offering some support for the idea that five year old children who attend Grade R are better able to write than those who do not. Table 3.8 shows similar results, but here the outcome is the probability of being able to read with no or only some difficulty, and for the restricted rural model no significant effect is observed.

TABLE 3.7: PROBIT REGRESSIONS PREDICTING THE PROBABILITY OF FIVE YEAR-OLDS BEING ABLE TO WRITE THEIR OWN NAME WITHOUT ANY DIFFICULTY

Variable	[1] All	[2] Restricted	[3] Rural (restricted)	[4] Urban (restricted)
Crèche	0.28*	0.23	0.07	0.5
Grade R	0.87***	0.85***	0.81***	1.21***
School	1.33***	1.38***	1.14***	2.14***
Coloured	0.37*	-0.30	-1.10*	-0.42
Indian/White	0.42*	-0.49	0.93	(omitted)
Male	-0.12	-0.11	-0.27*	0.17
Difficulty: sight	-0.10	-0.38	-1.07	0.71
Difficulty: concentration	0.01	0.17	-0.17	0.21
Difficulty: walking	-0.37	-0.40	-0.17	-0.88*
Household education	0.05	0.23	0.13	0.87
Household education squared	0.00	-0.01	0.00	-0.03
SES	0.17***	0.17*	0.09	0.43**
Constant	-2.18***	-2.58***	-2.28***	-6.95**
Observations	1986	984	682	295
Pseudo R-squared	0.12	0.16	0.11	0.28

Significant at 10% level, ** Significant at 5% level, * Significant at 1% level*
Note: Province dummies included in the estimation but not reported

TABLE 3.8 : PROBIT REGRESSIONS PREDICTING THE PROBABILITY OF FIVE YEAR-OLDS BEING ABLE TO READ WITH NO OR SOME DIFFICULTY

Variable	[5] All	[6] Restricted	[7] Rural (restricted)	[8] Urban (restricted)
Crèche	0.31**	0.19	-0.16	0.59
Grade R	0.50***	0.56***	0.28	0.97***
School	1.12***	1.01***	0.66***	1.81***
Coloured	0.05	0.10	(omitted)	0.16
Indian/White	-0.16	-0.23	(omitted)	-0.47
Male	0.01	-0.07	-0.13	-0.03
Difficulty: sight	-0.66**	-0.75	-0.68	(omitted)
Difficulty: concentration	-0.29	-0.35	-0.62	0.14
Difficulty: walking	-0.12	0.09	0.41	(omitted)
Household education	-0.03	0.09	0.01	0.22
Household education squared	0.00	0.00	0.00	-0.01
SES	0.12**	0.20***	0.16*	0.45***
Constant	-1.90***	-2.74***	-1.37**	-4.53***
Observations	1987	986	654	279
Pseudo R-squared	0.08	0.10	0.07	0.22

Significant at 10% level, ** Significant at 5% level, * Significant at 1% level*
Note: Province dummies included in the estimation but not reported

Table 3.9, which also attempts to measure these effects for either of these literacy outcomes for the full sample, in addition also includes race and enrolment interaction effects. Though there are not strong racial effects beyond the socio-economic effects, what there is point to some of these literacy benefits being smaller for black children, which may hint at issues of quality of the Grade R provided, an issue that is again taken up in Chapter 4. (Note that similar quality issues appear to be present for black children attending school in other grades.)

Table 3.9: Probit regressions predicting basic literacy amongst 5-year olds with race interacted with educational enrolment

	[9] Write Name (Unrestricted)	[10] Write Name (Restricted)	[11] Reading (Unrestricted)	12] Reading (Restricted)
Crèche	0.70***	0.61	0.57*	0.76
Grade R	1.10***	0.62	0.59*	1.30***
School	2.97***	7.70***	1.68***	1.66*
Black	0.04	0.42	0.32	0.20
Crèche and Black	-0.54*	-0.42	-0.33	-0.64
Grade R and Black	-0.31	0.24	-0.12	-0.82*
School and Black	-1.77***	-6.33***	-0.63	-0.72
Male	-0.12*	-0.11	0.01	-0.07
Difficulty: sight	-0.12	-0.39	-0.68**	-0.76
Difficulty: concentration	0.01	0.15	-0.28	-0.34
Difficulty: walking	-0.39*	-0.44	-0.14	0.07
Household education	0.04	0.22*	-0.03	0.09
Household education squared	0.00	-0.01	0.00	0.00
SES	0.17***	0.17**	0.11**	0.21***
Constant	-2.09***	-2.89***	-2.08***	-3.00***
Observations	1986	984	1987	986
Pseudo R-squared	0.13	0.16	0.08	0.1

Significant at 10% level, ** Significant at 5% level, * Significant at 1% level*
Note: Province dummies included in the estimation but not reported

3.4. Evidence from the National Income Dynamics Study (NIDS)

When conducting OLS regression analysis on the National Income Dynamics study, having attended preschool does not seem to have a significant effect on a student's numeracy score or on the probability of having repeated a grade.

Alternative definitions of the categories high, medium and low school fees do not seem to render a significant effect of preschool on either numeracy scores or the likelihood of having repeated.

As numerous unobservable attributes contribute to a student's test score, fixed effects models for children in the same household were conducted to try control for those effects. Comparing two siblings where the one attended preschool and the other did not attend could to a certain extent control for family effects. However, the underlying results remain unchanged: There is no significant effect of having attended pre-school (of whatever sort) in terms of scores on the numeracy module included in NIDS, or on having repeated.

TABLE 3.12: OLS AND PROBIT MODELS PREDICTING NUMERACY SCORE AND HAVING REPEATED USING NIDS

	Numeracy score (OLS)	Have Repeated (Probit)
Male	5.43	0.54***
Age	11.56*	0.45***
Class size	-0.25	0.01
Preschool	6.51	0.19
Household size	0.40	-0.01
Income quintile 2	-15.47	-0.06
Income quintile 3	22.21	-0.03
Income quintile 4	18.45	0.01
Income quintile 5	63.02**	-0.34
Low fees	31.38*	0.24
Medium fees	29.09	0.10
High fees	162.62***	-0.72***
Fees missing	30.51	0.52
Coloured	64.69***	-0.59
Indian	-126.45***	(omitted)
White	-17.50	(omitted)
Rural informal	23.99	0.00
Urban formal	-33.01	0.27
Urban informal	-20.24	-0.63
Constant	-261.13***	-6.65***
Observations	433	418
Groups		
R-squared	0.25	

Significant at 10% level, ** Significant at 5% level, * Significant at 1% level*
Note: Province dummies included in the estimation but not reported

3.5. Summary and conclusions from other datasets

The analysis above of three alternative datasets – SACMEQ, GHS and NIDS – as in the DBE study suggests that pre-school may contribute to learning outcomes. However, the evidence is not very strong, the learning outcomes measures are variable and may be influenced by many non-observed factors, and the causal links are not clear because of endogeneity concerns.

In the SACMEQ data from 2007, it was found that learning outcomes in Grade 6 have a significant association with preschool attendance for a year or more, especially for reading. The interaction with SES suggests possibly larger gains for wealthier students. School fixed effects models (to control for unobservables) with controls for observable factors show that 2 or more years of preschool has a positive association with numeracy and reading outcomes.

In the General Household Survey of 2011, a positive association was found between attending Grade R and the reported ability of children to write their name or to read with no or only some difficulty. This also applied if one restricted the sample to only students who attended the closest school to their homes and paid no school fees, in order to eliminate possible bias that may occur through parent motivation. Some benefits appear to be smaller for black children, which may point to issues of quality, while SES strengthens the association of learning with treatment, thus potentially worsening inequality in learning.

Analysis of data from the National Income Dynamics Survey (NIDS) shows no significant association between attending any preschool and learning outcomes, either numeracy score or repeating a grade.

Given the shortcomings of the datasets highlighted above, the next chapter turns to an analysis of an alternative new dataset that was created by merging various administrative datasets, which makes it possible to distinguish Grade R attendance specifically rather than general pre-school attendance.

4. An impact evaluation using a new dataset based on combining administrative records

4.1. Introduction

Considering the weak learning in South African schools and the inequality in learning outcomes that the introduction of the Reception year was supposed to overcome, at considerable fiscal cost, it is disappointing that the existing datasets could provide only suggestive evidence that early childhood interventions of various sorts may have an effect, as was discussed in Chapter 3. This chapter addresses this void by providing a unique dataset and modelling aimed at establishing whether any causal connection can be found between the introduction of Grade R and learning outcomes in subsequent years.

Thus this chapter contains the main empirical work that is unique to this study. It is necessary that this empirical work is set out in detail so that it can be open to peer review. It is, however, somewhat technical in nature, therefore the reader who is more interested in the results of the analysis can turn to Section 4.4, and to Chapter 6, where the main results are summarised and put into wider context. For the reader without technical background in fixed effects regression, Box 4.1 provides an intuitive explanation of what it accomplishes and how its use increases confidence that the effect observed is indeed causal.

4.2. Data Description

The data set used in the analysis was obtained by merging two data sources to the EMIS masterlist of primary schools in South Africa. The first of these is the SNAP dataset that provides information on the numbers of learners registered for each grade in all South African schools; the second, the Annual National Assessments (ANA) of 2011 and 2012 that provide test performance in mathematics and home language for Grades 1 to 6.[44] The EMIS data provides further information on the location of the school (province and district), sector of the school (independent or public), school phase, school quintile and school fees charged by the school.[45] The information on school fees in 2007 provides a further control that may capture some of the differences in affluence and resource availability that the more aggregated school wealth quintile may not fully account for. The dataset comprises of 18102 schools, of which 76.4% are primary schools, 20.2% combined schools and the remaining 3.4% intermediary schools. The exceedingly large dataset allows more precise measurement and therefore smaller confidence intervals, thus it should be able to measure even relatively small impact if it occurs. Also, unlike the datasets discussed in Chapter 3, it is possible by using the administrative data to distinguish Grade R attendance specifically and the data are not on general pre-school attendance. This Section provides some information on the data on learning outcomes, while discussion of the treatment measure is held back to Section 4.2.

Table 4.1 indicates the number and proportion of schools tested and captured in various grades. In order to interpret the proportion, it is assumed that all 18102 schools in the EMIS data could

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[44] *Test information for Grade 9 learners is also provided by the ANA but is not considered for the purposes of this study.*

[45] *It was possible to extract information on school fees charged by each school in 2007 and 2011. Although 2011 is more up to date, the introduction of no fee schools in the bottom three quintile schools made the most recent data less useful to distinguish between schools in terms of schools fees, as a proxy for schools' socio-economic status (SES).*

test all 6 grades in the ANA. This thus did not make allowance for the fact that not all schools had classes covering all grades from 1 to 6. In 2011, roughly between a third and 40% of all grade classes were tested and their data captured in both mathematics and home/first additional language. This is not to say that all learners in these classrooms were tested. In 2012, the percentages were significantly higher, with between 78 and 84% of grade classes tested and captured in both ANA subjects. From table 4.2 one can see clear differences in the ANA collection across provinces. In 2011, a mere 4.3, 6.3 and 8% of schools tested all six grades in both ANA tests in the Eastern Cape, Limpopo and Mpumalanga respectively. The small percentage of schools capturing learner performance in the ANA tests in these provinces with a large number of schools resulted in only 20.5% of schools on the masterlist capturing learner performance in both ANA tests. These numbers were greatly improved to just more than 50% of schools in 2012. In contrast, in the Western Cape a majority of schools participated in the ANA tests in all six grades (and in both tests) and were captured in both 2010 and 2012. The Northern Cape also had more than 80% of schools tested and captured in all grades in both ANA subjects in 2012.

Table 4.3 further shows differences in capturing of learner performance in the ANA tests across school quintiles. In 2011, approximately half of all Quintile 1, 2 and 3 schools (which together account for about 70% of all schools, as national 'quintiles' are not really all equal sized) failed to test any learners or to capture such tests. This compares to 29 and 27% of Quintile 4 and 5 schools respectively. Only around 17% of Quintile 1, 2 and 3 schools tested learners in all 6 grades and in both tests. In 2012 there was a marked improvement in the proportion of lower quintile schools testing learners in multiple grades and in both ANA tests, with approximately 70% of schools in Quintiles 1 to 3 schools testing at least 5 grades in both tests. However, as mentioned, this does not imply that all learners were tested.

TABLE 4.1: NUMBER/PROPORTION OF SCHOOLS WITH CAPTURED PERFORMANCE BY GRADE

	2011		2012	
	Number	%	Number	%
Grade 1	7465	41.2	14769	81.6
Grade 2	7150	39.5	14865	82.1
Grade 3	6933	38.3	14574	80.5
Grade 4	7049	38.9	14487	80.0
Grade 5	7042	38.9	14089	77.8
Grade 6	5842	32.3	15178	83.9

Source: Own calculations from ANA 2011 and 2012 data.

TABLE 4.2: NUMBER/PROPORTION OF SCHOOLS WITH CAPTURED PERFORMANCE BY PROVINCE

Province	Total number of schools	% 2011	% 2012
Western Cape	1169	78.5	88.9
Northern Cape	407	57.0	80.1
Free State	992	40.0	53.4
Eastern Cape	4772	4.30	52.1
KwaZulu Natal	4222	26.3	49.6
Mpumalanga	1323	8.0	53.1
Limpopo	2605	6.3	47.2
Gauteng	1551	27.7	50.4
North West	1061	14.5	65.2

Source: Own calculations from ANA 2011 and 2012 data.

TABLE 4.3: PROPORTION OF SCHOOL TESTED AND DATA CAPTURED BY GRADE IN 2010 AND 2011

School quintile	Grade 0	1	2	3	4	5	6
	2011						
1	48.3	4.0	5.3	6.5	6.8	11.5	17.6
2	49.5	4.7	5.6	6.9	7.0	9.4	17.0
3	51.3	4.9	5.5	8.0	5.4	8.1	16.9
4	28.9	1.3	3.9	4.6	3.7	7.5	50.1
5	26.6	1.4	3.8	2.7	4.4	5.4	55.7
	2012						
1	0.0	4.6	8.4	4.7	7.9	18.8	55.6
2	0.0	5.9	9.0	4.0	9.1	20.3	51.7
3	0.0	5.0	9.4	5.7	10.4	15.9	53.6
4	0.0	2.9	5.7	5.1	4.7	14.3	67.3
5	0.0	1.4	4.8	4.5	3.8	9.5	76.0

Source: Own calculations from ANA 2011 and 2012 data.

4.3. Methodology and findings

4.3.1. Treatment measure

We are interested in measuring the impact of Grade R provision on learner performance in South Africa using a (proxy) measure of "treatment", that is, the proportion of learners in a given grade in a given school that attended Grade R. Treatment (exposure to school-based Grade R) is calculated as follows:

$$\frac{\text{\# of learners in grade } R_{(t-g)_i}}{\text{\# of learners in grade } 2_{(t-g+2)_i}} \quad (1)$$

where t is the year of testing (t = 2011, 2012), g is the current grade of the learners and i is the school and i = 1, 2, …, N. Using this formula, treatment for a Grade 5 class in school *i* in 2012 would be, for example, given by:

$$\frac{\text{\# of learners in grade } R_{2007_i}}{\text{\# of learners in grade } 2_{2009_i}}$$

Note that Grade 2 has been used as the denominator in equation (1). This is due to high levels of repetition in Grade 1 that may distort the treatment effect.

A number of caveats need mentioning with regards to the calculation of treatment. First, in some instances the number of learners in the Grade R class may exceed the number of learners in Grade 2. This could be due to the fact that the school may provide Grade R to a wider catchment of learners than actually remain in the school beyond Grade R; that is, learners may move to other schools after Grade R. The ratio of learners who received Grade R will therefore exceed 1 in such cases. In 28% of the treatment measures over zero (i.e. schools where treatment occurred) there is a ratio in excess of 1. In cases where the measure of treatment exceeds 1, these measures were top censored to be at most 1. A second complicating issue is that some of the learners in Grade 2 may have received Grade R at another educational facility other than the school that they were attending in Grade 2, including at non-school based facilities. This fact will not be reflected in the numbers in Grade R, and therefore may lead to under-estimates of the extent of treatment. Finally, where data for the number of learners in Grade R is missing, it was assumed that there was no treatment.

4.3.2. Measure of learning outcomes

As indicated, the outcome measure used is the results obtained by a particular grade (cohort) in a school in a particular year. However, in order to compare across grades, there is a need to standardise the difficulty level of the tests in each grade to make them comparable. This can be done by standardising the test scores $\frac{Y_{igt}-\bar{Y}_{gt}}{\sigma_{gt}}$, where $\bar{Y}_{gt}$ is the average test score of grade g in year t and σ_{gt} is the standard deviation of the test scores of grade g in year t. The outcome is therefore standardised to have a mean of 0 and a standard deviation of 1.

The one potential problem that derives from this methodology is that the standardisation is measured of test scores *after* treatment has already taken place. That means that the effect that is measured would *be relative to the national performance in a particular grade,* after treatment has taken place, whilst it is desirable to standardise *before* treatment, in order to measure the full effect of treatment. Therefore the results obtained should be seen in this context. If treatment simply affected the performance in each grade uniformly, it would have been possible to deal with changes in average performance by using grade level fixed effects, as is done in some of the regressions below. However, the unit of measurement – standard deviations – is affected by differential treatment and also, as will become clear, effect sizes that vary across the wealth distribution. To deal with this, the results obtained need to be normalised, which requires an adjustment. This is set out in greater detail in Appendix B. Provisional further work on this has indicated that the magnitude of such an adjustment is likely to be small and would not alter the main findings in any fundamental way, so this is ignored further in this report.

4.3.3. Empirical model

The impact of Grade R may be estimated using the following specification:

$$Y_{git} = \alpha + T + G_g + \beta R_{git} + \delta' X_{it} + \nu_i + \varepsilon_{igt} \qquad (2)$$

where Y_{git} is the standardised average test score for grade g in school i in year t as discussed above, T is a year dummy for 2012, G_g are grade dummies, R_{git} is the treatment measure defined above, X_{it} is a vector of school characteristics and β and δ are the model parameters to be estimated. The error term is made up of 2 parts: ν_i represents unobservable school factors and ε_{igt} is the remaining random error term. The model parameters are estimated using ordinary least squares regression and robust standard errors clustered at school level are calculated.

The interest is specifically in the size and significance of β, the impact of Grade R. β may be biased if any unobservable school quality characteristics contained within ν_i are related both to treatment R and the outcome Y_{git}. Further bias in β may arise if the schools that provide Grade R are a self-selected group with selection based on unobservable school quality. Given that test scores are observed for Grades 1 through 6 in two years, there are potentially 12 observations for each school. It is therefore possible to use the variation in treatment across grades within schools to identify the impact of treatment on test performance correcting for school unobservables. The above model is therefore extended to include school specific dummy variables. This gives a unique intercept for each school that captures the effect of unobservable school quality or other unobservable factors, something later discussed in a lay person's introduction to fixed effects in Box 4.1.[46]

The analysis is further also extended to quantile regressions that estimate the effect of explanatory variables on the dependent variable at different points of the dependent variable's conditional distribution. This allows testing whether or not the relationship between treatment and test performance is significantly different at different points of the test score distribution. This can also be interpreted as differences with which schools of divergent effectiveness or quality are able to translate Grade R attendance into improved test score performance. Using the same dependent variable and regression covariates as in (2), the parameter of interest is calculated by minimizing the following expression:[47]

$$\sum_{t\epsilon\{t:y_t\geq x_t\beta\}} \theta|y_t - x_t\beta| + \sum_{t\epsilon\{t:y_t<x_t\beta\}} (1-\theta)|y_t - x_t\beta| \qquad (3)$$

The coefficient vector β will therefore differ depending on the quantile that is being estimated.

To account for fixed effects in the quantile regression models, (3) is estimated but the standardised test score is replaced with the *difference in the standardised test score between 2012 and 2011* and the treatment with the *difference in treatment between 2012 and 2011. This first-differencing* approach factors out any school fixed effects including time invariant school quality unobservables. This model is further estimated allowing for a heterogeneous impact of treatment across 2012 and 2011. Note that this model will only be based on the sample of schools for which performance in both tests across the same grades were captured in both 2011 and 2012.

4.3.4. Results: Summary statistics for treatment measure

Table 4.4 indicates the proportion of schools between 2005 and 2012 within each of the school wealth quintiles that reported having Grade R learners. The proportion of schools with Grade R learners is increasing over time across all school quintiles, particularly within the poorer quintiles. The proportion of Quintile 1, 2 and 3 schools with Grade R learners approximately doubled from 2005 to 2012. Quintile 5 has the lowest proportion of schools with Grade R learners at 77%. The expansion of Grade R provision to learners is further reflected in the average treatment by grade in table 5. Approximately 40% of Grade 6 learners in the lower quintile schools are measured to have attended Grade R. This is compared to about 70% of learners in Grades 1 and 2. As is expected from the information contained in table 4, whilst average treatment is similar across all school quintiles for higher grades, Quintile 5 schools have the lowest average treatment for the lower school grades (table 4.5). This is related to the provision of pre-school and Grade R facilities by Quintile 5 schools, but may also be influenced by the use of private institutions offering these services by learners from wealthier socio-economic backgrounds. Treatment may therefore be under-estimated in the case of learners attending Quintile 5 schools.

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[46] *Given that learner performance is only aggregated at the school level, it is not possible to account for household background and teacher/classroom characteristics that may determine the effect of Grade R on learner performance. Assuming relative learner and teacher homogeneity within schools as well as a significant correlation of learner and teacher characteristics to school quality factors, one may posit that estimation at the school level controlling for school quality through fixed effects approximates the impact of our treatment of interest fairly well. However, the coefficient on treatment should not be interpreted as truly causal, but it will be referred to as the treatment effect controlling for unobservable school quality and functioning.*

[47] *For simplicity sake all explanatory variables in (2), that is T, G, R and X, have been collapsed into one vector X. Similarly, all model parameters are given by a parameter vector* β.

TABLE 4.4: PROPORTION OF SCHOOLS WITH GRADE R LEARNERS 2005-2012, BY SCHOOL QUINTILE

School quintile	2005	2006	2007	2008	2009	2010	2011	2012
1	43.9	51.4	63.1	72.0	79.2	83.0	85.4	86.1
2	45.3	53.6	65.1	74.5	82.3	87.0	89.2	90.3
3	50.7	59.8	67.7	73.8	80.3	85.2	87.3	89.2
4	54.9	60.8	66.4	71.3	76.4	79.6	82.3	84.2
5	57.3	60.5	64.0	66.0	71.5	75.7	77.3	78.9
All	48.0	55.1	64.2	71.7	78.5	83.1	85.3	86.6

Source: Own calculations from SNAP 2005-2012 and EMIS masterlist.

TABLE 4.5: AVERAGE TREATMENT BY SCHOOL QUINTILE AND GRADE, 2012

	Grade						
School quintile	1	2	3	4	5	6	Total
1	0.661	0.696	0.622	0.521	0.451	0.377	0.558
2	0.693	0.726	0.654	0.541	0.467	0.387	0.580
3	0.654	0.689	0.618	0.517	0.456	0.394	0.557
4	0.553	0.587	0.527	0.451	0.399	0.358	0.481
5	0.503	0.506	0.439	0.402	0.407	0.390	0.442
Total	0.642	0.672	0.600	0.506	0.447	0.380	0.543

Source: Own calculations from SNAP 2005-2012 and EMIS masterlist.

One potential concern for identifying the treatment effect is for using a pooled sample of 2011 and 2012 performance, given the notable differences in the sample of schools captured across the two years. Table 4.6 compares the average mathematics and home language test scores and treatment of two samples, the first being the sample of schools captured in both years (Sample A) and the second the sample of schools that were only captured in 2012 (Sample B). As evidenced by the 2012 test scores, the former group of schools are on average better performing schools than the latter. A comparison of the 2011 and 2012 test scores of Sample A schools reiterates this; the higher test scores of Sample A in 2012 compared to 2011 does not necessarily imply that performance improved, but rather that schools' average performance amongst sample A schools is higher relative to Sample B schools. Table 6 further shows that the average treatment of Sample A schools increased from 2011 to 2012 and that treatment amongst Sample B schools is on average higher than Sample A schools. As the lower quintile schools are under-represented in the 2011 sample, particularly schools from the Eastern Cape, Limpopo and KwaZulu Natal, pooling the 2011 and 2012 samples may therefore distort the treatment effect, as the group of schools for which performance data was captured for 2011 may be a self-selected group within the overall sample. Given these findings, the analysis is undertaken with both pooled and separate year samples. A further issue with using the pooled sample is that the test scores are standardised with reference to the grade within year sample. The standardised test scores of schools that were captured in 2011 and 2012 may be artificially higher in 2012 as the reference group comprises a larger proportion of weaker performing schools

TABLE 4.6: COMPARISON OF TEST SCORES AND TREATMENT BY GRADE

	Captured in both years				**Captured in 2012, not 2011**	
Grade	Average test score	Average treatment	Average test score	Average treatment	Average test score	Average treatment

	2011	2011	2012	2012	2012	2012
	Mathematics test					
1	0.0013	0.609	0.0715	0.618	-0.0491	0.682
2	-0.0119	0.599	0.1047	0.651	-0.0703	0.742
3	-0.0014	0.504	0.1007	0.601	-0.0714	0.674
4	0.0114	0.460	0.1269	0.508	-0.0872	0.546
5	0.0260	0.392	0.1271	0.461	-0.0895	0.490
6	0.0203	0.344	0.1025	0.389	-0.0690	0.401
	Home language test					
1	-0.0009	0.609	0.0444	0.618	-0.0310	0.681
2	-0.0055	0.599	0.0922	0.651	-0.0619	0.742
3	-0.0043	0.504	0.1070	0.601	-0.0760	0.674
4	0.0217	0.460	0.1943	0.508	-0.1335	0.546
5	0.0336	0.392	0.1985	0.461	-0.1398	0.490
6	0.0277	0.344	0.1471	0.389	-0.0990	0.401

Source: Own calculations from SNAP 2005-2012, EMIS masterlist, ANA 2011 and ANA 2012.

4.3.5. Results: Least square and fixed effects regression results

The analysis starts with estimates of several ordinary least squares regressions and school fixed effects models. The full results of these are shown in tables A1 and A2 of Appendix A. As a reminder, the dependent variable in all models is the standardised test score. This implies that regression coefficients are interpreted as the proportion of a standard deviation change in test scores. Treatment is coded as a ratio that lies between 0 (no treatment) and 1 (full treatment). The coefficient on treatment therefore indicates the proportion of a standard deviation change in average test score as a result of a change in treatment from 0 to 1, i.e. associated with increasing treatment from zero to full treatment (100% of the cohort having undergone Grade R).

Controlling only for school wealth quintile, it is found that this is positively and significantly related to test performance. A similar result is found using school fees rather than wealth quintile. Unsurprisingly, the wealthier the school, the better the results, even when considering exposure to Grade R. The results of the third column on tables A1 and A2 indicate that both wealth quintile and school fees have a separate positive and significant relationship with mathematics and home language performance. After controlling for all covariates, Quintile 5 schools are estimated to perform on average 30 to 45% of a standard deviation higher in mathematics and home language than Quintile 1 schools. Table 4.7 below summarises the estimated coefficient on the variable of interest, the proportion of learners who attended Grade R. The first column of table 4.7 shows the results from a regression based on a pooled sample of 2011 and 2012 test scores. There is a positive and statistically significant coefficient on treatment of approximately 15% of a standard deviation for both mathematics and home language. Columns (2) and (3) indicate the results from regression run separately for the 2011 and 2012 samples respectively. The results indicate no significant difference in the effect of treatment on home language test scores across the two years, but that the effect of treatment on mathematics test score was slightly smaller in 2012 compared to 2011.[48]

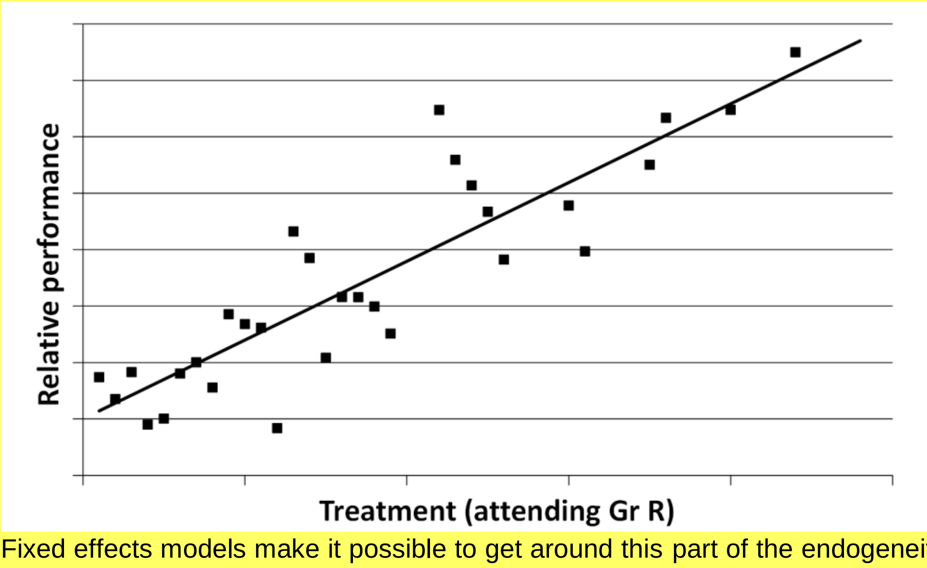
These OLS regressions may suffer from endogeneity bias, however. There may be factors related to school and provincial decision making which affect both school performance and the likelihood of more children attending Grade R. Thus, for instance, it is possible that better managed schools would have been able to introduce Grade R earlier, while such schools may also benefit in terms of their performance. Alternatively, attempts by the authorities to expand Grade R rapidly in poor schools may have increased treatment in those schools where performance lags. Thus OLS may give biased results, because of such factors confounding the relationship between treatment and performance in the ANA tests.

Box 4.1: A non-technical explanation of fixed effects regression models

A short digression on fixed effects for non-technical readers may be in order. Suppose there are observations in a hypothetical example as shown in Figure 4.1 below. Each observation is for a specific grade (cohort) in a specific school, assuming for this purpose that no other variables influencing learning outcomes are included in the model. The relationship between treatment (attending Grade R) and performance in the ANA tests (the learning outcome) would then be captured in the slope of the regression line shown. This is what occurs in an OLS regression.

However, it is quite possible that endogeneity may bias this result if there are factors that are related to *both* the treatment variable *and* the outcome variable and that are not incorporated into the model (these are typically so-called unobservables). Thus part of the relationship that would be observed between schools would be biased, as it would not reflect the real impact of treatment on learning. This is what is referred to as endogeneity. The measured impact then would show a combination of the impact of treatment on performance as well as of the variable that created the endogeneity. In such a situation it would not be possible to get an estimate of the *causal* impact of treatment, simply an association between treatment and performance.

FIGURE 4.1: HYPOTHETICAL EXAMPLE: TREATMENT AND PERFORMANCE



Fixed effects models make it possible to get around this part of the endogeneity problem. As treatment and performance differs between different grades in a school, it is possible to establish this relationship solely *within* rather than both within and between schools. Thus the unobserved factors that differ between schools need not come into play, as the model is now effectively estimated within schools. It is possible to establish an average relationship that holds within all schools, then. This would be an estimate of impact

[48] *The unavailability of data on school fees in the OLS considerably reduces the sample. Separate regressions without controls for school fees reduce the coefficient on treatment considerably in 2012 for mathematics to 0.055 from 0.145, and for home language to 0.078 from 0.165. Similar results apply to 2011 and the pooled sample.*

that would be unaffected by unobserved factors within schools, i.e. after the endogeneity has been removed. In that sense, such an estimate can be regarded as *causal*.

Figure 4.2 contains the same hypothetical observations that were shown in the previous figure, but now it is apparent that there are six observations for each of five schools in this example. A fixed effects model simply estimates an average slope that would give the best fit within all school taken together, as shown in Figure 4.3. In this particular hypothetical example, the fixed effect estimate (slope of the parallel lines) would be for a greater impact than in the original figure, but the effect may well change in the other direction, depending on the underlying relationship.

FIGURE 4.2: HYPOTHETICAL EXAMPLE: TREATMENT AND PERFORMANCE FOR SIX GRADES IN FIVE SCHOOLS

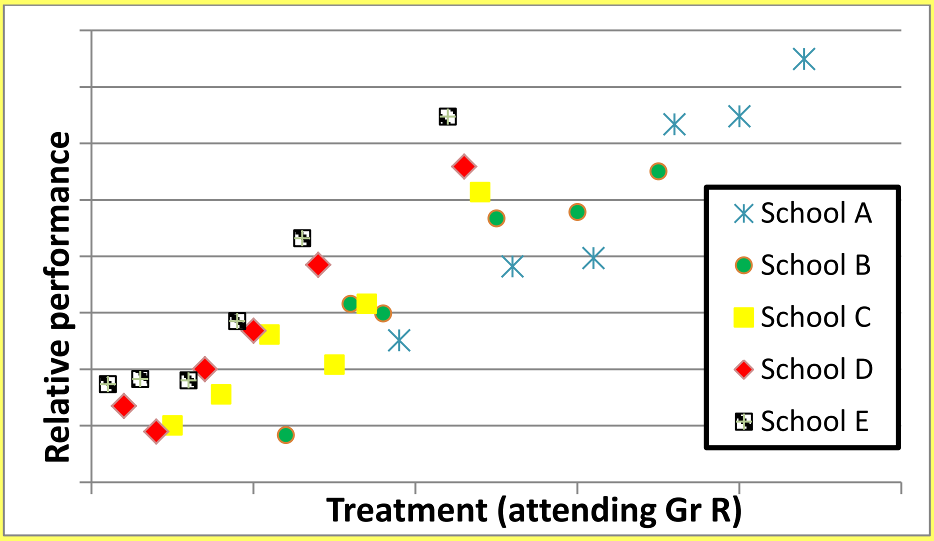
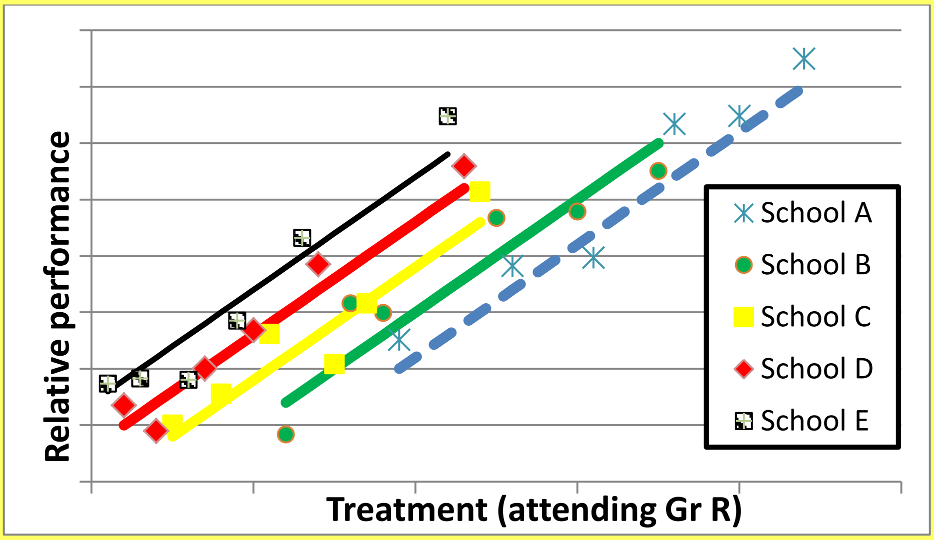


FIGURE 4.3: HYPOTHETICAL EXAMPLE: TREATMENT AND PERFORMANCE FOR SIX GRADES IN FIVE SCHOOLS WITH SCHOOL FIXED-EFFECTS ESTIMATE SHOWN



Thus, to overcome the endogeneity bias referred to, the next set of regressions use fixed effects at the school level. This is possible because there are a number of tests undertaken in each school, for the different grades, for mathematics and reading, and in both 2011 and 2012. Standardising the test scores to have a mean of zero and a standard deviation of 1 means that all the test results are expressed in the same metric, namely the relative performance of South African schools. Sample selection issues in 2011 may still confound the comparison between 2011 and 2012, though, thus it may be better to use the separate effects in each of these years. Because of the fixed effects specification, though, the bias in the 2011 and pooled sample resulting from the sample selection would influence the results less than in OLS.

The final three columns of table 4.7 show the estimated impact of treatment after controlling for school fixed effects. The full estimated model results are shown in table A3 of Appendix A. It is immediately clear that the inclusion of school fixed effects significantly reduces the size of the estimated treatment effect. However, the effect of treatment remains statistically significant. Once again results from the pooled model (column 4), the 2011 sample (column 5) and the 2012 sample (column 6) are shown. The results appear to indicate that school quality unobservables have a greater positive relationship to the mechanism/s through which treatment has an impact on mathematics performance than is the case for home language performance. After accounting for school fixed effects, the effect of treatment on average mathematics and home language performance in the pooled sample is 5.3% and 9.3% of a standard deviation respectively. Estimation results using only the 2011 and 2012 samples indicate the underlying differences between the schools captured in the two years. The treatment effect on mathematics score is estimated to be three times greater in the 2011 than in the 2012 sample, presumably because of the sample drawn in 2011 being schools in which the quality of treatment (i.e. quality of the Grade R programme) may have been higher and that this particularly affected mathematics performance. It has already been shown that Quintile 4 and 5 schools were over-represented in the sample of schools captured in both 2011 and 2012 and that the 2011 sample of schools are on average better performing schools. It is therefore suspected that using the pooled sample over both years may distort the treatment effect. For consistency the analysis henceforth focuses primarily on the results based on the 2012 sample, though all results for 2011 are presented in Appendix A.

Using only the 2012 sample of schools, treatment is estimated to have an impact of 2.5% and 10.2% of a standard deviation on mathematics and home language test scores respectively. Filmer et al (2006) have described 40% of a standard deviation as being roughly equal to one grade level in school. Therefore, the estimates here indicate an improvement in average performance equivalent to somewhere between 6 and 25% of a year’s learning, respectively, for having learners enrol in Grade R. This is an average effect over all grades, from Grade 1 to 6.

TABLE 4.7: ORDINARY LEAST SQUARES AND SCHOOL FIXED EFFECTS REGRESSION RESULTS

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	**Standardised Mathematics test score**					
Treatment	0.159***	0.199***	0.145***	0.053***	0.074***	0.025**
	(0.012)	(0.020)	(0.015)	(0.011)	(0.018)	(0.013)
School fixed effects	No	No	No	Yes	Yes	Yes
Grade fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	47694	14954	32740	129410	41451	87959
R-squared	0.230	0.267	0.223	0.001	0.001	0.000
Dependent variable:	**Standardised Home language test score**					
Treatment	0.151***	0.153***	0.165***	0.093***	0.060***	0.102***
	(0.012)	(0.020)	(0.014)	(0.011)	(0.018)	(0.012)
School fixed effects	No	No	No	Yes	Yes	Yes
Grade fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	47696	14957	32739	129419	41461	87958
R-squared	0.315	0.306	0.338	0.001	0.001	0.001

*** Significant at 5% level, *** Significant at 1% level*
Regressions in column 1: Pooled sample, grade fixed effects but no school fixed effects
Regressions in column 2: 2011 sample, grade fixed effects but no school fixed effects
Regressions in column 3: 2012 sample, grade fixed effects but no school fixed effects
Regressions in column 4: Pooled sample, grade fixed effects and also school fixed effects
Regressions in column 3: 2011 sample, grade fixed effects and also school fixed effects
Regressions in column 4: 2012 sample, grade fixed effects and also school fixed effects

The effect of treatment may not be homogenous across school wealth quintiles. The school fixed effects models were thus re-estimated separately for each school wealth quintile, the results of which are shown in table 4.8.[49] Treatment is estimated to have no statistically significant effect on test performance in the lower quintile schools, except in the case of home language performance in Quintile 2 schools. A positive and significant effect of approximately 10 and 20% of a standard deviation is estimated for the sample of Quintile 4 and Quintile 5 schools respectively. It therefore appears that the provision of Grade R to all learners will result in approximately half a year's learning in the wealthiest quintile of schools, while there is statistically no indication of benefits for the lower quintiles of schools.

[49] *Table A4 of Appendix A shows the treatment effect for the different school wealth quintiles estimated using the pooled and 2011 samples.*

TABLE 4.8: SCHOOL FIXED EFFECTS RESULTS, BY SCHOOL WEALTH QUINTILE

	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Dependent variable:	**Standardised Mathematics test score**				
Treatment	0.015	0.009	-0.008	0.101**	0.203***
	(0.023)	(0.028)	(0.030)	(0.050)	(0.048)
School fixed effects	Yes	Yes	Yes	Yes	Yes
Grade fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	25024	16968	15567	7322	6398
R-squared	0.003	0.002	0.003	0.011	0.095
Dependent variable:	**Standardised Home language test score**				
Treatment	0.017	0.077***	-0.002	0.115**	0.194***
	(0.022)	(0.026)	(0.029)	(0.051)	(0.050)
School fixed effects	Yes	Yes	Yes	Yes	Yes
Grade fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	25024	16968	15567	7322	6398
R-squared	0.003	0.002	0.003	0.011	0.095

*** Significant at 5% level, *** Significant at 1% level*
Robust standard errors in parentheses. 2012 ANA sample only.

In order to capture possible differences in school functioning within school quintiles, the sample of schools was sub-divided into four groups: Quintile 1 to 4 schools in weaker performing provinces; Quintile 5 schools in weaker performing provinces; Quintile 1 to 4 schools in top performing provinces; and Quintile 5 schools in top performing provinces.[50] This was based on the premise that the top performing provinces may face fewer constraints with regards to the functioning of school based programs. The results of fixed effects regression based on these samples are shown in table 4.9.[51] Treatment is estimated to have a positive and statistically significant effect across all four sub-samples, that is, also in the bottom four quintiles. However, there are noticeable differences in the magnitude of the effect. Treatment is only estimated to increase average mathematics performance by 1.8% of a standard deviation in the case of poorer schools in weak performing provinces. This is compared to an effect of 9.6% of a standard deviation for Quintile 5 schools in the same provinces, which is numerically equivalent to the impact of Grade R in poorer schools in the top performing provinces. This suggests that programmes such as Grade R provision provide greater benefits when implemented within a well-functioning education system, even in the poorer schools in such provinces. The wealthiest schools in the top performing provinces have the largest impact of treatment in mathematics performance at 16% of a standard deviation improvement. Similar results are found for home language test score in that the effect of treatment is smaller for Quintile 1-4 schools (3-4% of a standard deviation) relative to Quintile 5 schools (13% of a standard deviation). However, unlike mathematics performance, there do not appear to be any statistically significant differences in the effect of treatment across the two province groupings within the same school wealth quintiles.

The final school fixed effects model tests for differences in the treatment effect across the different grades. The results of fixed effects regressions estimated for each grade are shown in table 4.10. There is a significant effect of treatment for Grade 3 mathematics and Grade 3 and

[50] *The top performing provinces here identified include Gauteng, Northern Cape and Western Cape, with the remaining 6 provinces falling under the weaker performing group.*
[51] *Results from the pooled and 2011 samples are shown in table A5 of Appendix A.*

Grade 4 home language. It is worth mentioning that the school fixed effects model estimated here differs from those estimated previously because the treatment effect is identified using variation in treatment *within* the same school and grade across the two years. This is in contrast to using the variation in treatment within the same school across grades.

4.3.6. Results: Quantile regression results

It is possible that there may be differences in the strength of the treatment effect between schools at different distances from the conditional distribution, e.g. for schools that over- or under-perform relative to what would be expected. A common way of teasing out such differences is through the use of quantile regressions. Quantile regression departs from OLS in that it does not minimise the squared residuals but rather the absolute value of the residuals, and further that observations at different points in the distribution are weighted differently. Thus, if a quantile regression is run at the 90% percentile or 0.90 quantile, observations in the top 10% of the distribution are given 9 times the weights of the other 90% of observations.

Table 4.11 shows the treatment effect estimate using OLS and then at the 0.10, 0.20, 0.50, 0.80 and 0.90 quantiles.[52] The quantile regression results suggest some important differences across different points in the distribution of test scores. The treatment effect is estimated to be largest at the median and smallest at the 10^{th} and 90^{th} percentiles.[53] At first glance this may be a surprising result, as one might expect treatment to have the largest effect amongst the most effective (highest performing) schools at the top of the conditional test score distribution. One possibility is that this may be due to the fact that the marginal returns to treatment may "taper off" at the top end of the test score distribution as these schools have less to gain from treatment. Schools in the middle of the test score distribution have more to gain from treatment and do gain more, according to these estimates. While schools at the bottom end of the performance distribution schools also potentially have much to gain, weak school functioning may limit the gains they actually make.

[52] *The full set if results are shown in table A6 of Appendix A.*

[53] *Note that these quantile regressions do not make allowances for school quality unobservables and therefore it is not necessarily presumed that the magnitudes of the coefficients on treatment provide causal estimates of the effect of Grade R on performance.*

TABLE 4.9: EFFECT OF TREATMENT BY SCHOOL WEALTH QUINTILE AND PROVINCE

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Weak performing provinces		Top performing provinces		Weak performing provinces		Top performing provinces	
	Quintiles 1-4	Quintile 5	Quintiles 1-4	Quintile 5	Quintiles 1-4	Quintile 5	Quintiles 1-4	Quintile 5
Dependent variable:	**Standardised Mathematics test score**				**Standardised Home language test score**			
Treatment	0.018**	0.096**	0.104***	0.160***	0.030***	0.133***	0.041	0.137***
	(0.007)	(0.045)	(0.030)	(0.051)	(0.007)	(0.049)	(0.032)	(0.052)
School fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Grade fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	54095	3219	10786	3179	54094	3219	10786	3179
R-squared	0.002	0.030	0.009	0.239	0.023	0.275	0.134	0.679

*** Significant at 5% level, *** Significant at 1% level*
Robust standard errors in parentheses. 2012 ANA sample only.

TABLE 4.10: EFFECT OF TREATMENT BY GRADE

	Mathematics						**Home language**					
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
Treatment	0.0098	0.0254	0.0653**	0.0983**	0.0713	0.0497	-0.0015	-0.0242	0.1089***	-0.0310	-0.0126	0.0134
	(0.0437)	(0.0276)	(0.0299)	(0.0417)	(0.0407)	(0.0626)	(0.0416)	(0.0278)	(0.0331)	(0.0410)	(0.0477)	(0.0719)
School fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	22217	18469	16726	15116	12895	11249	22219	18470	16725	15119	12896	11250
R-squared	0.0003	0.0008	0.0033	0.0002	0.0000	0.0004	0.0000	0.0012	0.0052	0.002	0.0022	0.005

*** Significant at 5% level, *** Significant at 1% level*
Robust standard errors in parentheses. 2012 ANA sample only.

TABLE 4.11: QUANTILE REGRESSION RESULTS

	Quantile					
	OLS (mean)	10th	20th	50th	80th	90th
Dependent variable:	**Standardised mathematics test score**					
Treatment	0.145**	0.089**	0.144**	0.175**	0.154**	0.158**
	(0.015)	(0.019)	(0.017)	(0.018)	(0.022)	(0.031)
Observations	32740	32740	32740	32740	32740	32740
Dependent variable:	**Standardised home language test score**					
Treatment	0.165**	0.136**	0.153**	0.181**	0.163**	0.130**
	(0.014)	(0.018)	(0.015)	(0.019)	(0.021)	(0.027)
Observations	32739	32739	32739	32739	32739	32739

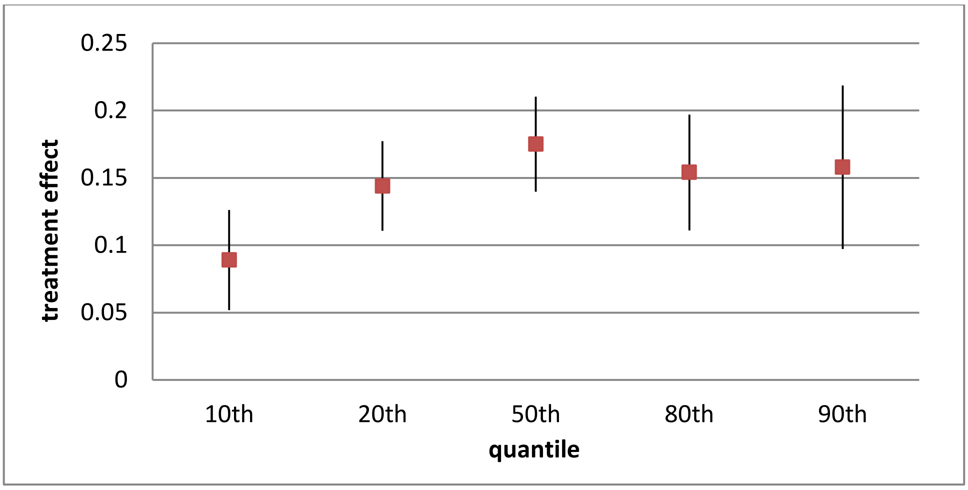
Significant at 10% level, ** Significant at 5% level, * Significant at 1% level*
Robust standard errors in parentheses. 2012 ANA sample only.

For comparison purposes the treatment effects reflected in table 4.11 are plotted in figures 4.4 and 4.5 with 95% confidence intervals. The treatment effect on mathematics performance estimated for the 10th percentile is (for the most part) statistically significantly lower than the estimated treatment effects estimated at higher quintiles. The higher treatment effect estimated at the median is not statistically significantly different from the coefficients estimated at higher quantiles. In the case of home language performance, there does not appear to be a statistically significant difference in the coefficient on treatment across all quantiles.

Thus it would appear at first sight that there may be some trend towards convergence between the performance of the best performing schools and some of those closer to the centre of the distribution as a result of the introduction of the Grade R programme, but that this convergence does not extend to the weakest schools: The introduction of Grade R has not assisted them to catch up with the better performers. In fact, the very weakest appear to have fallen further behind.

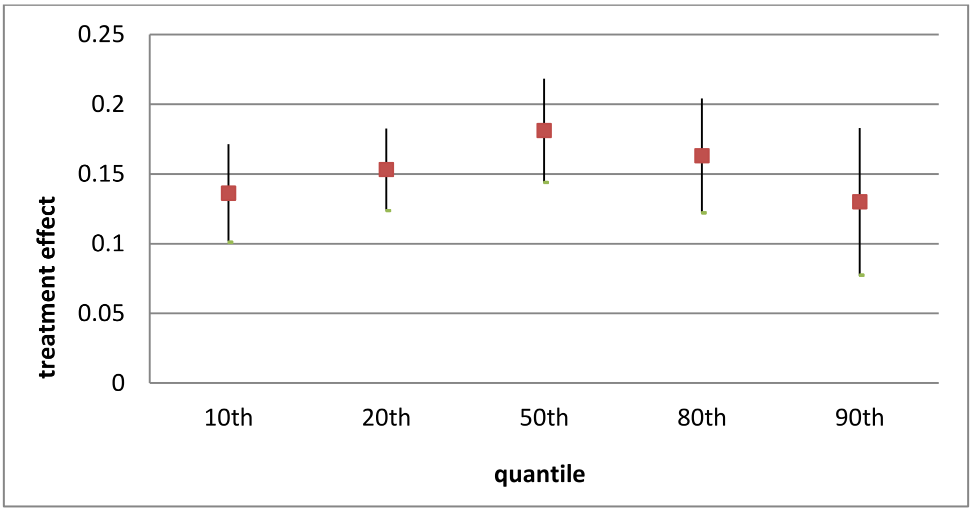
These results should be interpreted with caution, however, as they may be biased because school fixed effects could not be used in normal quantile regression. Thus it is likely that they are subject to the same bias that exists with OLS. A way around this, to make it possible to account for school unobservable factors through fixed effects and nevertheless estimate quantile rather than ordinary regressions, is to focus on a dependent variable that is the first difference between the results in 2012 and those in 2011. This is done in the next Section.

FIGURE 4.4: QUANTILE REGRESSION TREATMENT EFFECTS ON MATHEMATICS TEST SCORES WITH 95% CONFIDENCE INTERVALS



Source: Own calculations from 2012 ANA, EMIS masterlist and SNAP 2005-2012 data.

FIGURE 4.5: QUANTILE REGRESSION TREATMENT EFFECTS ON HOME LANGUAGE TEST SCORES WITH 95% CONFIDENCE INTERVALS



Source: Own calculations from 2012 ANA, EMIS masterlist and SNAP 2005-2012 data.

4.3.7. Results: First-differenced quantile regressions with fixed effects

As mentioned in the methodology, the quantile regressions are next re-estimated, but an attempt is also made to control for school fixed effects by using the *difference* in standardised test scores across 2011 and 2012. The outcome variable is no longer the *level* of performance but the *change in performance* of a given grade from 2011 to 2012. The interest here is therefore in measuring the impact of treatment at different points of the distribution of these performance changes. As mentioned, it is only possible to use the sample of schools for which performance was captured for the same grade across both years. Given this, the dependent variable is estimated using performance scores which are re-standardised using only data from this sample. The estimated treatment effects cannot be compared to the earlier analysis because they are based on different samples. Specifically, Quintile 4 and 5 schools as well as schools from the Western Cape, Northern Cape and KwaZulu-Natal are over-represented and schools from the Eastern Cape and Limpopo are under-represented in the sample used for the first-differenced quantile regression models. However, the results may suggest how the effect of treatment differs, if at all, across school performance quantiles once accounting for school unobservables. The results of the first-differenced quantile regressions are indicated in table 4.12. The first panel of table 4.12 show the estimated treatment effect assuming constant returns on school observables across the two years. The second panel also allows for different returns to school observables. It is worth pointing out that the negative estimated treatment effects on 2011 do not imply a negative effect of treatment. The negative sign is related to the specification of the dependent variable, $Y_{ig2012} - Y_{ig2011}$, therefore a negative sign on the treatment effect for 2011 is in fact interpreted as a positive effect of treatment on performance in 2011.

When the treatment effects from table 4.12 are plotted with 95% confidence intervals (not shown), it becomes apparent that the effect of treatment on performance is reduced once controlling for school observables. This is true across all quantiles. In the case of mathematics and home language performance, the treatment effect is similar across the 10th, 20th and 50th percentiles. The effect of treatment is significantly larger for the 80th and 90th percentiles, once accounting for school observables and unobservables. The results are for the most part quite similar when allowing for heterogeneous effects of treatment across 2011 and 2012. There is no significantly different effect across quantiles in 2011 for both mathematics and home language. In 2012, however, the treatment effect is estimated to be significantly larger at the 80th and 90th percentiles.

Thus, encouragingly, it appears that schools across the distribution that were included in this sample that was tested in both years did benefit from Grade R. Less encouragingly, however, it would appear as if there are indeed significantly *stronger* effects at the top of the distribution, if one controls for school effects, and that treatment – the introduction of Grade R – actually *widens* the performance gap between schools, at least in the sample of schools tested in both years. This remains true even with controls for factors observable at the school level, such as school fees.

TABLE 4.12: FIRST-DIFFERENCED QUANTILE REGRESSIONS

	Mathematics					Home language				
	q10	q20	q50	q80	q90	q10	q20	q50	q80	q90
Differenced regressions *without* controls for observable factors										
Treatment	0.218**	0.192**	0.202**	0.314**	0.389**	0.121**	0.109**	0.103**	0.279**	0.366**
	(0.032)	(0.022)	(0.015)	(0.025)	(0.036)	(0.034)	(0.024)	(0.017)	(0.024)	(0.039)
Treatment*2012	0.230**	0.200**	0.244**	0.443**	0.582**	0.118**	0.110**	0.147**	0.396**	0.552**
	(0.034)	(0.024)	(0.016)	(0.026)	(0.038)	(0.037)	(0.026)	(0.018)	(0.025)	(0.040)
Treatment*2011	-0.211**	-0.188**	-0.169**	-0.202**	-0.229**	-0.121**	-0.109**	-0.063**	-0.157**	-0.221**
	(0.033)	(0.024)	(0.016)	(0.026)	(0.038)	(0.036)	(0.025)	(0.018)	(0.025)	(0.040)
School controls	No	No	No	No	No	No	No	No	No	No
Observations	31835	31835	31835	31835	31835	31840	31840	31840	31840	31840
Differenced regressions including controls for observable factors										
Treatment	0.259**	0.228**	0.214**	0.242**	0.337**	0.179**	0.157**	0.140**	0.262**	0.282**
	(0.031)	(0.023)	(0.016)	(0.024)	(0.034)	(0.035)	(0.022)	(0.019)	(0.026)	(0.037)
Treatment*2012	0.299**	0.253**	0.244**	0.311**	0.422**	0.228**	0.212**	0.212**	0.364**	0.441**
	(0.034)	(0.026)	(0.018)	(0.027)	(0.036)	(0.037)	(0.026)	(0.020)	(0.028)	(0.038)
Treatment*2011	-0.217**	-0.203**	-0.180**	-0.193**	-0.291**	-0.117**	-0.119**	-0.083**	-0.187**	-0.222**
	(0.032)	(0.024)	(0.017)	(0.027)	(0.036)	(0.035)	(0.025)	(0.019)	(0.028)	(0.038)
School controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	31835	31835	31835	31835	31835	31840	31840	31840	31840	31840

Significant at 10% level, ** Significant at 5% level, * Significant at 1% level*
Robust standard errors in parentheses. 2012 ANA sample only.

4.4. In summary: The impact of Grade R on school performance

The analysis above has shown significant, though modest, effects of the introduction of Grade R on learning performance throughout the primary school grades, and this effect does not decline with time. For the 2012 sample, Grade R improves mathematics and home language test scores from Grade 1 to 6 respectively by 2.5% and 10.2% of a standard deviation. Filmer et al (2006) regard 40% of a standard deviation as roughly one grade level in school. Therefore, Grade R causes an improvement in average performance equivalent to 6% or 25% of a year's learning across all grades, or for a school year of 200 days, it amounts to what the average learner should learn in 12 days or in 50 days of instruction for mathematics and home language respectively.

When the impact was evaluated separately for each quintile, there was in most cases ***no significant effect on test performance in lower quintile schools.*** A positive and significant effect of approximately 10% and 20% of a standard deviation was measured for Quintile 4 and Quintile 5 schools respectively. Thus the provision of Grade R to all learners will result in approximately half a year's learning in the wealthiest quintile, while there is statistically no indication of benefits for the lower quintiles.

To capture possible differences in school functioning, the sample of schools was sub-divided into four groups: Quintiles 1 to 4 schools in weaker performing provinces; Quintile 5 schools in weaker performing provinces; Quintiles 1 to 4 schools in top performing provinces; and Quintile 5 schools in top performing provinces. The top performing provinces here identified were Gauteng, Northern Cape and Western Cape. This analysis was based on the premise that the top performing provinces may face fewer constraints with regard to the functioning of school based programs and the quality of the Grade R teachers they may be able to attract. In mathematics, Grade R increased average performance by only 1.8% of a standard deviation in poorer schools in weak performing provinces, compared to an effect of 9.6% of a standard deviation for Quintile 5 schools in the same provinces. This is similar to the impact of Grade R in poorer schools in the top performing provinces. This suggests that Grade R provision provides greater benefits for mathematics learning when ***implemented within a well-functioning education system***, even in poorer schools in such provinces. The wealthiest schools in the top performing provinces experience the largest impact of treatment in mathematics at 16% of a standard deviation. For home language test score, there does not appear to be any statistically significant differences in the effect of treatment across the two province groupings within the same school wealth quintiles.

Quantile regression results also show that ***the treatment effect is significantly larger for the 80th and 90th percentiles, in both mathematics and home language.***

Thus, encouragingly, it is now clear from this evaluation that schools across the distribution that were included in this sample that was tested in both years did benefit from Grade R. This was made possible by the creation of a unique and exceedingly large dataset based on administrative data. The size of the dataset makes it possible to estimate effects quite accurately and generally with high levels of confidence, even for small effect sizes. Less encouragingly, however, the effects of treatment are quite small and also differentiated across the system. There were indeed *stronger* effects at the top of the distribution, and **the introduction of Grade R actually *widened* the performance gap between schools**.

Thus the gains follow a pattern that is all too familiar in the South African schools system: Positive interventions in schools to improve performance fall on fertile ground in some schools – mainly in stronger provinces and higher quintiles, where capacity may already be strong. The schools that have the largest deficits unfortunately do not gain as much and may even fall further behind. This may have much to do with the quality of interventions, as discussed in the literature review, and the ability of schools to implement them. This will be returned to in the Conclusions.

Finally, it needs to be emphasised that the effects measured here refer to learning (cognitive) outcomes only. As Chapter 2 showed, there is a great deal of evidence that good early childhood development interventions can also contribute to non-cognitive outcomes, which are not measured in this study. It is also likely that there were gains from nutritional interventions in schools for some learners, but given the very limited gains in cognitive outcomes, it is unlikely that improved nutrition was an important channel through which learning gains occurred for children who attended Grade R.

5. GRADE R – COVERAGE AND COST

5.1. Objective and overview

The objective of this component of the investigation into the impact of Grade R was to assess current coverage of the target population and cost of provision in order to make estimates of requirements for further expansion of the system and funding requirements (a cost model) and also to determine programme costs (overall and per learner) for potential use in assessing cost-effectiveness. A broad question therefore relates to what additional investments will be required from the state to ensure the universalisation of good quality Grade R.

The focus in this part of the study fell on clarification of targets and indicators as per White paper 5 and how they were subsequently used, the analysis of EMIS data on Grade R and checking the consistency of this dataset with other reports and data sets and analysis of the trend in and composition of provincial Grade R spending and budgets.

Section 5.2 identifies the different indicators of coverage and provides the available evidence on current coverage and gross enrolment. Section 5.3 provides a brief overview of models of Grade R financing and the size and composition of spending on ECD and Grade R before comparing average costs per Grade R place between provinces. Section 5.4 provides a brief conclusion and some recommendations.

5.2. Population, enrolment and coverage: Status quo and prospects

5.2.1. The Grade R targets

As mentioned in the Introduction in Chapter 1, the importance of ECD, and Grade R specifically, is highlighted in the DBE's Strategic Plan 2011-2014 which identifies universal access to Grade R and quality Grade R programmes as one of the four strategies to improve quality in the South African education system. The other three mechanisms for quality improvement are: quality learning and teaching through a focus on literacy and numeracy; increased use of standardised assessments and systemic evaluations; and improved systems of accountability and service delivery (to schools) at district, provincial and national level. (DBE 2011b). ECD is also highlighted in Goal no 12 of the Department of Basic Education's Action Plan 2025, the broad goal being to "improve the access of children to Early Childhood Development (ECD) below Grade 1".

This focus on state funding and provision of Grade R provision dates from at least Education White paper 5 on ECD in 2001 (DoE 2001). The White Paper, among other things, outlined alternative modes of provision, a funding and governance model, and specific targets for Grade R coverage of the cohort of 5-year olds and for the extent of state provision.

The White Paper stated the government targets of universal Grade R by 2010 (later extended to 2014)[54] in a number of ways, focusing on overall targets but also on modes of provision and financing[55.] The White Paper set the following targets:

> In terms of coverage of the cohort of five-year olds: "*… to provide all learners with ten years of compulsory school education, including one year of early childhood development called the Reception Year*". This seems to imply a goal of 100% attendance by 5-year olds in some form of Grade R.

[54] *The DBE's recent indicator document (DBE 2011c) explains that "the original intention of phasing in Grade 1 for every child by 2010 was not met, and had thus been extended to 2014".*

[55] *The White Paper anticipated three "types" of provision: (1) Reception Year programmes within the public primary school system". (2) "Reception Year programmes within community-based sites." (3) "Independent provision of Reception Year programmes".*

In terms of prior attendance of Grade 1 learners of Grade R: *"… by 2010 all learners that enter Grade 1 should have participated in an accredited Reception Year programme*".

In terms of the proportion of public schools offering Grade R: "Our first priority is that all our public primary schools should become the sites for the provision of accredited Reception Year programmes."

In terms of coverage of the cohort of five-year olds by public school-based Grade R provision: "*Our medium-term goal is that approximately 90% of all five year olds, some 810 000, would be accommodated within [public] school-based Reception Year-programmes*".

In term of overall extent of state subsidisation of the system: *"…we shall have created a system that is 75% state subsidised rather than the current estimated 25% of state subsidisation*".

Earlier documentation (DoE 2006) summarised the 2005 White Paper targets as also including a spending level target which was also incorporated in the Norms and Standard for funding of Grade R.[56] This target is that "*per learner public spending in Grade R should equal around 70% of Grade 1 expenditure level*".

In terms of governance and financing it was indicated that Grade R at Independent Schools would not be subsidised and that public schools would be funded from "grants-in-aid" on "a per learner basis" from which they then have to fund all Grade R inputs, including personnel. Similarly, community sites would be funded on a per-learner basis.

The different layers of targets set (some for what can be seen as overall coverage and some for inputs and the split between public and private inputs) and the failure to carefully distinguish between seems to have created confusion[57]. It is therefore necessary to systematically work through the targets and their indicators.

The next Section will focus on the financing and spending targets (overall extent of state subsidisation and level of per learner funding), while this Section looks at the coverage targets and what it indicates about the challenge ahead towards "universal Grade R". It initially focuses on specific targets for the state as set out in (1) to (4) above.

5.2.2. Trends in the size of the Grade R population cohort (5-year olds) & coverage of the cohort

The South African Schools Act, 1996 determines that the age of admission for Grade R is four turning five by 30 June in the year of admission. Age of admission is not defined but it is presumably the youngest age at which a child may enter the grade in a public school. Grade R

[56] *The 2001 White Paper 5 stated that … "Each department would …begin to subsidise Reception Year places at [selected public] … schools at the appropriate percentage of the cost of a primary per learner cost in the province (approximately 70%)".*

[57] *White Paper 5 itself at one point (par 6.13) says that "Our medium-term goal (2010) is that approximately **85 per cent** of all 5 year olds, some 810 000, would be accommodated within primary school-based Reception Year programmes" and elsewhere (par 4.1.1.6) that "Our medium-term goal (2010) is that **approximately 90 per cent of all five year olds**, some 810 000, would be accommodated within primary school-based Reception Year programmes." (Bold italics added). The Western Cape Education Department in early 2013 interpreted the target as follows: "According to White Paper 5, the requirements of national policy on early childhood development will be satisfied that we have achieved universal access when at least 80% of public primary schools offer Grade R, with independent pre-schools largely catering for the balance." In a 2004 circular the province said: "The current fragmented provision of pre-school education must be aligned with the requirement of the national policy (White Paper 5 on Early Childhood Education), to have 85% of all Grade R learners enrolled at public schools by 2010." The circular also said that: "The National policy: Education White Paper 5 on Early Childhood Development, promulgated in terms of the National Education Policy Act, (Act 27 of1996), requires that by 2010 most of the "five- turning six-year-olds, … would be accommodated within primary school-based reception year programmes" (paragraph 6.1.3) and "that some community-based sites [would] become part of the public [school] system" (paragraph 6.1.4)."*

classes can therefore be expected to consist, during the first 6 months of the year, largely of 4-year olds (turning 5 before June 30) and 5-year olds (turning 6 after June) and, during the second six month of the year, of 5-year olds and 6-year olds. Mid-year estimates of the number of five-year olds in South Africa therefore seem to be an appropriate target for the number of learners for participation in Grade R.

Table 5.1 indicates that, in terms of the Actuarial Society of South Africa (ASSA) modelling, the number of 5-year olds in South Africa peaked at around 2005 (nearly 1.1 million 5-year olds), declined towards 2012 and is expected to remain quite stable at just over 1 million over the next 20 years. In overall terms, the stabilisation in population numbers therefore removes some pressure from the provision of Grade R classes (and educational opportunities more generally), but provincial differences are important. Three provinces experienced significant increases in the number of five-year olds over the years from 2000 to 2011. In Gauteng the number of 5-year olds was projected to have grown by 36% over the period or 2.83% per year, in Northern Cape by 32% (2.6% per year) and Western Cape by 13% (1% per year).The number of 5-year olds is expected to continue declining between 2010 and 2025 in Eastern Cape, Free State and Limpopo and to start declining in Northern Cape. In other provinces growth of the cohort is estimated to between 0.01% on average per year in Western Cape to 0.33% per year in Mpumalanga. For Gauteng also, only modest growth in 5-year olds (0.11% per year) is projected.

TABLE 5.1: MID-YEAR ESTIMATES OF 5-YEAR OLD COHORT, 2000 TO 2025

	2000	2005	2010	2012	2015	2020	2025
EC	171 463	165 905	142 916	138 582	137 976	131 375	123 342
FS	56 634	58 223	56 297	54 968	54 921	54 448	53 190
GT	147 407	186 501	202 022	202 464	195 113	194 609	203 422
KZN	236 066	234 880	217 848	211 686	213 649	221 471	224 725
LIM	150 269	148 528	133 544	129 683	132 729	132 526	129 084
MPU	76 456	81 072	83 133	83 501	82 154	84 217	85 817
NC	17 612	17 815	23 109	25 480	22 397	22 892	23 196
NW	81 144	82 197	66 444	59 850	68 697	67 983	67 004
WC	86 047	95 470	97 371	96 252	96 303	95 929	96 914
Total	1 023 097	1 070 591	1 022 682	1 002 467	1 003 939	1 005 451	1 006 693

Source: Actuarial Society of South Africa, ASSA 2008 demographic model

Compared to this slow overall decline in the age cohort (but rapid growth in Gauteng and Western Cape), the massive expansion in Grade R places in schools (public and independent) is evident in Table 5.2. Between 2001 and 2012 the numbers of places increased from just under 242 000 to nearly 768 000 in 2012. This translates into an average annual growth of 11% per year for more than 10 years, or more than 45 000 additional Grade R learners per year or more than a thousand classrooms per year.

The most rapid expansion was in North West (where public Grade R learner numbers grew at an average annual 28%), Mpumalanga (24%) and the Eastern Cape (21% per year). Initial coverage in these provinces was, however, very low (10% in the Eastern Cape in 2001, 6% in Mpumalanga and 3% in North West. KwaZulu-Natal (9% per year) and Limpopo (3% per year) showed more moderate growth but from a Grade R enrolment base that was already relatively high in 2001 (30% and 54% respectively).

TABLE 5.2: NUMBER OF GRADE R LEARNERS IN ALL SCHOOLS (PUBLIC AND INDEPENDENT), 2001 TO 2012

	2001	2005	2010	2012
EC	18 873	105 231	164 803	158 363

FS	16 002	18 449	27 209	30 639
GT	23 920	41 073	76 460	95 374
KZN	73 993	79 276	175 541	189 169
LIM	84 243	98 273	113 432	117 950
MPU	5 803	14 171	51 758	59 202
NC	4 042	6 598	12 387	15 036
NW	3 176	9 737	42 010	44 489
WC	11 473	32 389	43 603	57 643
Total	241 525	405 197	707 203	767 865

Source: EMIS, Annual Survey

Public provision expanded slightly faster than independent provision (11% per year against 9% per year). In only two provinces, Eastern Cape and Limpopo, did independent provision expand faster than public provision. Tables 5.3 and 5.4 provide the splits between the number of public and independent school Grade R learners.

TABLE 5.3: NUMBER OF GRADE R LEARNERS IN PUBLIC SCHOOLS, 2001 TO 2012

	2001	2005	2010	2012
EC	18 662	103 944	161 514	153 536
FS	15 568	17 892	26 498	29 811
GT	18 004	34 810	66 378	83 308
KZN	72 208	76 975	171 278	185 063
LIM	82 570	97 093	110 197	114 654
MPU	5 306	12 954	50 291	57 345
NC	3 889	6 457	12 196	14 751
NW	2 754	9 271	41 183	43 259
WC	10 176	30 468	40 830	54 119
Total	229 137	389 864	680 365	735 846

Source: EMIS Annual Survey database

In 2001 95% of Grade R school learners (229 137) were in public schools, a proportion that remained fairly unchanged by 2012 (96%). Some provinces had a fairly large proportion of Grade R learners in independent schools in 2001, specifically Gauteng (with 25% of Grade R learners in independent schools), North West (13%) and Western Cape (11%). By 2012, only Gauteng had more than 10% of Grade R learners in Independent Schools, with all other provinces having less than 4% of Grade R learners in independent schools.

TABLE 5.4: NUMBER OF GRADE R LEARNERS IN INDEPENDENT SCHOOLS, 2001 TO 2012

	2001	2005	2010	2012
EC	211	1 287	3 289	4 827
FS	434	557	711	828
GT	5 916	6 263	10 082	12 066
KZN	1 785	2 301	4 263	4 106
LIM	1 673	1 180	3 235	3 296
MPU	497	1 217	1 467	1 857
NC	153	141	191	285

NW	422	466	827	1 230
WC	1 297	1 921	2 773	3 524
Total	12 388	15 333	26 838	32 019

Source: EMIS Annual Survey database

To calculate total a Grade R gross enrolment rate, it is necessary to add Grade R learners at community sites to the number of Grade R learners in schools. There are various problems with this data on ECD learners available for this study. Firstly, a good data time series is not available, secondly, data for 2012 was not available for the study and, thirdly, it is unclear exactly how good the coverage of the data is (there may be community sites that are not registered and not included in the survey). Therefore, in order to estimate overall coverage using administrative data, 2011 data from the Annual EMIS Survey was used.

TABLE 5.5: NUMBER OF GRADE R LEARNERS IN PUBLIC AND PRIVATE INSTITUTIONS, NUMBER OF 5-YEAR OLDS AND GROSS ENROLMENT RATES BY PROVINCE, 2011

2011	Gr R learners in public schools	Gr R learners in public ECD centres	Gr R learners in Independent Schools	Gr R learners in independent ECD Centres	Total Gr R learners	5-year olds	Gross enrolment rate
EC	164 925		3 821		168 746	141 780	119%
FS	30 889	223	890	3 776	35 778	55 599	64%
GT	73 807		11 008	15 510	100 325	200 438	50%
KZN	180 494	628	3 584	1 658	186 364	213 866	87%
LIM	107 502	5 237	3 394	334	116 467	133 382	87%
MPU	56 162	2 390	1 504	3 129	63 185	82 003	77%
NC	13 181	2 719	226	1 511	17 637	23 327	76%
NW	42 062	1 709	1 033	829	45 633	66 029	69%
WC	50 495	332	3 237	15 368	69 432	96 806	72%
Total	719 517	13 238	28 697	42 115	803 567	1 013 229	79%

Source: EMIS Annual Survey and Survey of ECD Centres

Table 5.5 shows that according to official sources (the 2011 Annual EMIS survey of schools and the 2011 survey of ECD Centres) there was in 2011 a total number of 803 567 learners in Grade R places in South Africa. Community sites (both public and independent) added about 55 000 places to the 767 000 school places. Independent ECD community centres are especially important in Northern Cape (24% of Grade R places), Western Cape (23%), Gauteng (15%) and Free State (11%).

The final column of Table 5.5 provides a total gross enrolment rate for Grade R, calculated as the total number of Grade R learners in schools and community ECD centres. According to these estimates, coverage of the Grade R cohort is just under 80% or 803 567 learners out of an estimated cohort of 5-year olds of just over 1 million. However, it should be remembered that such a measure of coverage does not consider that many of those in Grade R may not be 5-year olds. Coverage by this measure ranges from 119% in the Eastern Cape to 50% in the Gauteng. Perhaps three groups can be distinguished amongst the provinces:

The "achievers", which are likely to have full Grade R coverage of five-year olds by 2014, namely Eastern Cape, KwaZulu-Natal and Limpopo. Eastern Cape already has gross enrolment rate of more than 100%, pointing to underage enrolment and repetition. Limpopo and KwaZulu-Natal were close to 80% in 2011.

The "aspirants", with between 70% and 80% of the cohort covered, namely Mpumalanga, Northern Cape, North West and Western Cape.

The "laggards", with coverage well below 70%, namely Free State (64%) and Gauteng (50%). The low coverage in Gauteng is somewhat puzzling and may either point to missing data (Community centres and Independent provision not adequately captured in data) but can also be partly explained by the projection of a very strong increase in the number of 5-year olds in the province from 147 000 in 2000 to just over 200 000 in 2012.

Stats SA's General Household Survey tells a somewhat different story than the administrative data. Firstly, already in 2009 the General Household Survey indicated that 78% of 5-year olds were in an education programme of some sort, up from 39% in 2002 (DBE 2011c). Administrative data used above indicate that close to 80% coverage was only reached in 2011. Secondly, the ranking of provinces is different between the administrative data and the household survey data. While Eastern Cape and Limpopo are still at the top of the list using the GHS (as is the case for administrative data), KwaZulu-Natal falls back substantially and one of the laggards in terms of administrative data, the Free State, becomes one of the top performers (with 86% coverage of 5-year olds). Gauteng, lagging significantly in terms of coverage in terms of the administrative data, also performs adequately in terms of the GHS (with coverage of 73% in 2009).

The Department of Education has previously pointed to the discrepancies between administrative and survey data with regard to Grade R coverage.: "*The education system, relying as it does on administrative data, tends to underestimate provisioning of ECD. South Africa is already, in general, providing more ECD than it typically acknowledges to itself, and hence to international organisations*." (DoE Macro Trends 2009)

Both administrative and survey data therefore tell a story of rapid growth in the coverage of (gross enrolment in) Grade R, indicating that some of the poorest provinces have expanded coverage most and that the country will be close to universal coverage by 2014. Yet, discrepancies between survey data and administrative data coupled with population projections, both with regard to levels of coverage and ranking of provinces, make for a murky picture and substantial uncertainty with regard to planning and costing. Urgent further work is therefore necessary to establish more agreement about cohort size, Grade R places and coverage. Some of the issues involved have been investigated by Gustafsson (2012) but not the Grade R situation specifically.

5.2.3. The proportion of learners in Grade 1 who have previously attended Grade R

On the basis of EMIS data the DBE in 2011 stated that "*the percentage of learners enrolled in Grade 1 who had previously attended a pre-primary programme, increased substantially from 61% in 2006 to 71% in 2009*" (DBE 2011c). The DBE calculation is reproduced in Table 5.6, which also shows a recalculation using as the denominator not all Grade Rs but only those enrolled for the first time, thus excluding repeaters. Two things can be noted from the table. Firstly, the DBE calculation underestimates the proportion of Grade 1s enrolled in Gr R during the previous year because repeaters were included in the denominator. Hence, in terms of this data, the system was in 2009 at 84.7% much closer to its target than the DBE reported. Secondly, the proportion declined. While the number in Grade 1 for the first time expanded, the number of those who attended Grade R in the previous year declined. In terms of most recent estimates, therefore, 74.5% of those enrolled in Grade 1 for the first time attended Grade R in the previous year.

TABLE 5.6: PROPORTION OF LEARNERS IN GRADE 1 (TOTAL AND FIRST TIME ENROLLED)

	2006	2007	2008	2009	2010	2011	2012
Gr 1 learners who attended Gr R in previous year	736 305	769 003	761 737	785 886	698 880	769 993	756 141
Gr1 learners (all)	1 205 775	1 180 569	1 124 520	1 115 054	1 121 781	1 183 984	1 216 880
% of all Gr 1s who attended Gr R in previous year	61.1%	65.1%	67.7%	70.5%	62.3%	65.0%	62.1%
Gr 1 learners (first time enrolled)	1 031 065	860 359	899 056	926 026	954 358	1 024 924	1 014 404
% of first time Gr 1s who attended Gr R in previous year	71.4%	89.4%	84.7%	84.9%	73.2%	75.1%	74.5%

Source: EMIS Annual Survey database

The national Department of Basic Education's latest Annual Performance Plan (DBE 2013), however, provides a different estimate for this indicator, but the source of the data is not clear. The low level of the indicator in 2009/10 (compared to EMIS data) and the dramatic jump in coverage over a one-year period (2010/11 to 2011/12) suggests that the data is wrong.

TABLE 5.7: DBE ANNUAL PERFROMACE PLAN 2013/14 – INDICATOR FOR GRADE R COVERAGE

Strategic objective	Programme Performance Indicator	Audited/Actual performance			Estimated performance	Medium-term targets		
		2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
4.4.2 Strengthen school management and promote functional schools	The number of schools built in the ASIDI project				49	140	150	171
4.4.3 Universalise Grade R	Percentage of Grade 1 learners who have received formal Grade R according to a School Monitoring Survey (SMS)	51%	57%	83%	84.8%	87%	92%	97%

Source: Extract from DBE 2013 (Annual Performance Plan 2013/14)

5.2.4. The proportion of public ordinary schools with Grade 1 also offering Grade R

Table 5.8 shows the significant progress that has been made in introducing Grade R in public schools offering Grade 1. In 2011 89% of public schools offering Grade 1 (mostly primary and combined schools) offered Grade R. Of 17 316 public schools with Grade 1, 15 372 offered Grade R.

While government can therefore be seen to have reached about 90% of its target in terms of schools with Grade R by 2011, there is significant provincial variation. Three of the poorest provinces are very close to having Grade R in all schools, with Eastern Cape leading with 97%, followed by KwaZulu-Natal at 96% and Limpopo at 94%. The Free State is the worst performer in terms of this indicator (only 54% of schools with Grade 1 having Grade R). Four provinces are at 80% coverage (Gauteng, Mpumalanga, North West and Western Cape) with the Northern Cape also lagging at 74%. Of the 1 944 public schools still without Grade R, roughly 25% are in the Free State and another 25% in Gauteng and Western Cape.

TABLE 5.8: PUBLIC SCHOOLS WITH GRADE 1 CLASSES WHO ALSO HAVE GRADE R CLASSES (2011)

2011	Public Gr1 Schools	Public GrR Schools	% of public primary schools with GrR	No of Gr1 schools without GrR
EC	4 626	4 478	97%	148
FS	988	532	54%	456
GT	1 370	1 132	83%	238
KZN	4 040	3 887	96%	153
LIM	2 427	2 274	94%	153
MPU	1 249	998	80%	251
NC	435	320	74%	115
NW	1 072	865	81%	207
WC	1 109	886	80%	223
Total	17 316	15 372	89%	1 944

Source: EMIS, Annual Survey

Before drawing final conclusions and making recommendations about coverage and coverage gaps it will be necessary to review the nature of schools without Grade R in some depth. In the Free State and Northern Cape the uncovered schools may mostly be small farm schools where there are various obstacles to including Grade R in a multi- grade environment. It may also be that a 100% target for those provinces with substantial Grade R capacity in community centres and independent schools, such as Gauteng and Western Cape, may not be appropriate.

5.2.5. Public coverage of the Grade R cohort (5-year olds)

Compared to a target of 90% of 5-year olds in public Grade R in 2014, the average for the country stood at 73% in 2012, ranging from 56% in the Western Cape to 112% in the Eastern Cape. In the Eastern Cape there is therefore over-enrolment in Grade R. Given the fact that repeaters should not be a problem in Grade R, this may be evidence of underage enrolment. For example, in the Western Cape at the time of the 2012 Annual School Survey only 20% of Grade Rs were 4-years old, in the Eastern Cape this proportion was 49.3%. This is a similar trend towards very early enrolment that was initially evident in some areas in Grade 1 that seems to have moved down to Grade R level now. After the Eastern Cape, the highest public gross enrolment rate is in KwaZulu-Natal (87% of 5-year olds) and Limpopo (88%).

TABLE 5.9: GRADE R ENROLMENT IN PUBLIC SCHOOLS AS A PROPORTION OF 5-YEAR OLDS, 2005 TO 2012 (TARGET: 90%)

	2005	2010	2012
EC	63%	113%	111%
FS	31%	47%	54%
GT	19%	33%	41%
KZN	33%	79%	87%
LIM	65%	83%	88%
MPU	16%	60%	69%
NC	36%	53%	58%
NW	11%	62%	72%
WC	32%	42%	56%
Total	36%	67%	73%

Source: EMIS: Annual Survey

If provinces were to reach the target of a 90% public gross enrolment rate (effectively reached by Eastern Cape. KwaZulu-Natal and Limpopo) by 2014, the biggest challenges lie in Gauteng and Western Cape. Gauteng is to add nearly 100 000 Grade R learners in public schools and the Western Cape 33 000. Relative to size of the education sector the Free State and Northern Cape also face a significant challenge.

TABLE 5.10: ADDITIONAL PUBLIC GRADE R PLACES REQUIRED (FOR 90% COVERAGE OF THE COHORT), 2012 TO 2014

	No of public Grade R places required, 2012
EC	-42 528
FS	18 060
GT	99 772
KZN	17 189
LIM	1 521
MPU	19 890
NC	6 125
NW	17 045
WC	33 103

Source: EMIS, Annual Survey

5.3. Expenditure on Grade R, per learner cost and further spending requirements

This Section uses data on provincial expenditure and budgets to determine total public spending on Grade R and to estimate cost per learner, using the data on learner numbers in Section 6.2. In order to understand expenditure on Grade R it is necessary to briefly look at funding alternatives available to provinces.

Data used is the National Treasury's 2012 provincial database, which provides expenditure by department and programme ("main division") and also disaggregates programme expenditure by sub-programme and by economic classification. Early Childhood Development is a separate programme in provincial budgets, which is further subdivided into sub-programmes for: Grade R in Public Schools; Grade R in Community Centres, Pre-Grade R, Professional Services, Human Resource Development and "Conditional Grant" spending.

While the School Funding Norms and Standards determine that cost of Grade R must be separately accounted for from spending on the rest of publicly ordinary school spending (Grades

1 to 12), the fact that the bulk of Grade R spending is for such schools makes it likely that in some cases Grade R spending (for example the spending on certain Grade R teachers) might be classified under the public ordinary schooling programme. It is also possible, although not likely in the light of low spending on Grade R, that Grade R resources could in some cases be used in providing education to other grades. Grade R also absorbs some of the management capacity at the school level (spent and budgeted for under programme 2, Public Ordinary Schooling) and at the district and provincial level. Estimates of these "overhead costs" have not been included in spending estimates below but should be in a more refined costing.

5.3.1. Funding Grade R

The overall approach to Grade R funding, in line with White paper 5, is that all funding should be per learner, or the allocation per school would be determined by the number of Grade R learners in the school. Within this framework of per capita funding there are then two options for provincial education departments. One alternative is for the province to transfer all Grade R funding due to a school to a bank account under the control of the school's governing body who will take full responsibility for all expenditures (also salaries to ECD practitioners). This can be referred to as the "transfer" model. A second alternative is for the province to pay salaries of practitioners and to transfer what remains of a school's per capita allocation directly to the school (funding for goods and services and payment for utilities, referred to as the provincial "salary" model).

The best example of the transfer model is the Western Cape (see WCED 2012 and 2013): The bulk of its Grade R spending (60% In 2011/12) is transferred directly to schools. Schools in 2013 receive a subsidy ranging from R20 per learner per day (R4 000 per learner per annum) for quintile 1 schools to R16 per learner per day (R3 200 per annum) for quintile 5 schools. The minimum subsidy per school (in the case of schools with fewer than 20 learners) is R84 000 per year. Schools are advised that the minimum salary for an ECD practitioner should be R6 000 per month or R72 000 per annum. Schools are also advised that 80% of their subsidy should contribute to teacher salaries, 10% to LTSM and 10% to payment of utilities and other daily running costs.

It was not possible to find such detailed descriptions of the provincial model for other provinces but budget allocations across economic items provide some indication of the approaches followed. While the Northern Cape also transfers more than 50% of Grade R funding to schools, most other provinces seem to pay the bulk of Grade R spending in the form of salaries from the provincial head office. Personnel expenditure comprises 76% of Grade R spending in the Eastern Cape and 95% in the Free State. The situations in Gauteng and Limpopo are not clear, as more than 50% of expenditure in these provinces are classified as "goods and services". In Limpopo a large part of this expenditure on goods and services is classified as professional fees for "business and advisory services" and as "Agency and support/outsourced services". In Gauteng nearly 50% of this large category (goods and services) is classified as "property payments " and "operating payments".

5.3.2. Overall spending on Grade R and composition

Table 5.11 shows that provincial education spending on ECD more than doubled over the three years between 2008/09 and 2011/12, growing at an average annual 30.2% in real terms. While all provinces showed growth of more than 10% per year in real terms, the biggest growth was in Gauteng, 80% per year in real terms. The real growth in Gauteng was so large, and happened so dramatically in 2011/12, as to suggest a correction in budget allocation rather than real growth in spending. Other provinces with exceptionally large increases in expenditure over the three years were Mpumalanga, Limpopo and KwaZulu-Natal.

TABLE 5.11: PROVINCIAL SPENDING AND BUDGETS ON EARLY CHILD DEVELOPMENT (PROGRAMME 7), CURRENT PRICES, 2008/09 TO 2014/15

Province	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
	Audited			Revised estimate	Medium-term estimates		
	R 000	R 000	R 000	R 000	R 000	R 000	R 000
Eastern Cape	249 108	267 621	358 689	428 380	515 327	601 867	686 667
Free State	64 257	77 151	87 099	114 678	118 858	126 877	133 264
Gauteng	92 393	236 249	165 552	661 609	529 310	710 598	754 108
KwaZulu-Natal	202 646	250 487	352 992	697 760	771 937	962 048	1 099 452
Limpopo	80 285	158 369	408 098	242 054	209 180	197 030	203 987
Mpumalanga	63 096	75 006	112 212	198 195	212 683	273 743	318 019
Northern Cape	25 725	53 933	45 484	57 421	67 715	87 648	99 729
North West	135 162	140 175	225 360	291 668	325 289	385 938	429 315
Western Cape	228 748	288 620	345 895	388 476	428 969	490 175	551 914
Total	**1 141 420**	**1 547 611**	**2 101 381**	**3 080 241**	**3 179 268**	**3 835 924**	**4 276 455**

Source: National Treasury. Provincial Budget Database

Provincial ECD spending is dominated by spending on Grade R in public schools, which absorbed 73% of ECD spending in 2011/12, followed by Grade R in Community Centres (8%) and Pre-Grade R (10%). This is the case for all provinces except Limpopo, where Grade R in schools absorbs only 38% of expenditure (Grade R in community centres making up a further 25% and Pre-Grade R 37%).

TABLE 5.12: TOTAL PROVINCIAL SPENDING AND BUDGETS ON EARLY CHILD DEVELOPMENT (PROGRAMME 7), BY SUB-PROGRAMME, 2008/09 TO 2014/15

Sub-programme	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
	Audited			Revised estimate	Medium-term estimates		
	R 000	R 000	R 000	R 000	R 000	R 000	R 000
Grade R in Public Schools	873 774	1 225 988	1 608 171	2 238 828	2 176 569	2 813 682	3 203 667
Grade R in Community Centres	129 368	134 615	168 119	261 739	303 216	317 803	332 913
Pre-Grade R	78 054	91 844	179 017	304 770	300 870	323 572	338 370
Professional Services	2 563	2 821	1 668	20 117	28 352	30 573	32 208
Human Resource Development	57 661	75 159	80 452	94 547	120 195	125 838	131 869
Conditional Grant	-	17 184	63 954	160 240	250 066	224 456	237 429
Total	**1 141 420**	**1 547 611**	**2 101 381**	**3 080 241**	**3 179 268**	**3 835 924**	**4 276 455**

Source: Calculations from National Treasury, Provincial Budget Database and EMIS, Annual Survey data

5.3.3. Calculating per learner costs

The cost per public school Grade R learner in 2011/12 was calculated as the total provincial spending on Grade R in public schools divided by the number of Grade R learners in public schools according to EMIS in 2011. The average cost so calculated, including capital spending, is R3 112 per learner per year, ranging from R845 per learner per year in Limpopo to R7 823 per learner in Gauteng. This average of R3 112 compares to an average spending of about R10 500 per learner in public ordinary school (excluding Grade R) in 2011.[58] The Grade R spending in all

[58] *"Growth in public spending per learner has increased from around R3 500 in 2000 to around R11 000 in 2012" (DBE 2013)*

provinces is therefore substantially below the 70% benchmark set in the funding norms and standards and widely seen as cause and indicator of quality problems in the sector.

However, the data contained in this table appear highly suspect. The ratio of per capita spending between Gauteng and Limpopo of more than 9 to 1 cannot be accurate. Even if teacher salaries in Gauteng were 3 times as high as in Limpopo, class sizes would also have to be about three times as large in Limpopo as in Gauteng to make ratios of this magnitude in personnel spending possible (and personnel spending dominates within overall spending). So both these figures may be inaccurate. Ignoring these two outlier values produces average expenditure of around R3 300 per child, a figure of the same order of magnitude as the average calculated from the available fiscal data, so the calculated average will be used in further fiscal calculations. However, it would be well to remember that it is likely to err on the low side, as inaccuracies in accounting procedures are more likely to lead to Grade R spending being recorded as general school spending than the other way round.

TABLE 5.13: PROVINCIAL SPENDING PER GRADE R LEARNER IN PUBLIC SCHOOL, 2011 (INCLUDING AND EXCLUDING CAPITAL EXPENDITURE)

2011	Public school Gr R spending per public school Grade R learner including capital expenditure on ECD programme	Public school Gr R spending per public school Grade R learner excluding capital expenditure on ECD programme
EC	R2 199	R1 880
FS	R2 707	R2 707
GT	R7 823	R7 820
KZN	R2 836	R1 299
LIM	R845	R845
MPU	R2 623	R2 104
NC	R3 736	R3 735
NW	R4 592	R3 783
WC	R4 409	R3 488
Total	R3 112	R2 500

Calculations from National Treasury, Provincial Budget Database and EMIS, Annual Survey data

If one deducts all capital expenditure in programme 7 from spending on Grade R in public schools, it reduces the per learner per year spending in 2011 to approximately R2 500 per year. Very large capital expenditure in KwaZulu-Natal reduces per learner recurrent expenditure from R2 836 to R1 299 per year.

5.3.4. Potential funding needs

Given the significant differences between provinces in terms of coverage and cost of provision of a Grade R place, projections of an overall spending gap may not be particularly useful. If government must fund 90% of Grade R places (for 5-year olds), another 212 000 places may be necessary in the public system. At an average cost of R3 112 per place that will require about R220 million per year extra over the next three years or a cumulative R660 million after 3 years. If average spending is to be increased, the cost of universal coverage will obviously increase, as a number of provinces spend much less than the average at this stage.

5.4. Conclusion

South Africa has made remarkable progress over the last decade in providing access to Grade R in the school system in general and in the public school system in particular. However, questions remain about coverage (given different approaches to target definitions and uncertainties about data) and about quality (with spending data suggesting widely varying spending per learner and spending significantly below the target of 70% of spending per learner in grades above Grade R).

Coverage estimates using administrative data and population projections confirm rapidly expanding coverage but raise questions about population estimates and the presence of under-age children in Grade R on the one hand (with some provinces having coverage above 100%) and, on the other hand, whether all types of institutions are satisfactorily covered by the data (there is unexpectedly low coverage on the basis of administrative data in a number of provinces such as Gauteng, Free State and Western Cape).

Issues with regard to spending and unit cost include extremely low estimated spending per learner in some provinces, possibly suggesting cross-subsidisation of Grade R from other programmes or data inaccuracies due to the way spending for Grade R is categorised. As the impact evaluation in Chapter 4 has shown that Grade R adds only 2.5% of a standard deviation to mathematics performance in subsequent years, and 10.2% of a standard deviation to spending gains in home language, as against normal progression of 40% of a standard deviation[59], learning gains from this year for subsequent years are only 6% for mathematics and 25% for home language of what can be regarded as the norm. Even the low and probably under-estimated cost calculations of Grade R discussed in this chapter (R3 112 as against spending of R10 500 per child in other grades) is still a much higher proportion of cost per learner outside Grade R. Thus, despite the limitations of the cost data, it is clear that ***compared to learning and cost in other grades, Grade R is not cost-effective in terms of learning outcomes***. More accurate and thus higher cost estimates for Grade R would further strengthen this conclusion.

Before costing models can be refined and more accurate estimates of cost-effectiveness can be attempted it is essential that the basic data about Grade R enrolments and spending on Grade R be improved. It is therefore necessary to get agreement on targets, data requirements and key data sets such as population number. In addition, provincial data should be regularly interrogated and discussed to resolve anomalies and get a clear picture of provincial performance, in order to inform planning going forward. Understanding of what has been attained in terms of coverage and of spending will be enhanced by better setting out of the different provincial delivery models.

[59] *Some authors even regard 50% of a standard deviation (rather than 40%) as a better estimate of annual learning. Learning gains in mathematics in the National School Effectiveness Study (NSES) were 0.34 of a standard deviation between Grade 3 and Grade 4, and 0.52% of a standard deviation between Grade 4 and Grade 5. (Spaull 2012, unpublished document, University of Stellenbosch). Thus the 40% of a standard deviation commonly used to reflect international experience of learning is not inappropriate as benchmark for a year of schooling in South Africa. It must be remembered, though, that South African learners progress from a much lower starting point.*

6. Summary and conclusion, and some policy recommendations

6.1. Summary and conclusion

This study set out to provide a literature review of the impact of early childhood development generally, and Grade R specifically; to re-analyse the datasets that were analysed in the DBE report that found some, though limited, evidence supportive of a possible positive impact of ECD and Grade R attendance on learning; to create a new dataset from administrative data and to use this to estimate the impact of Grade R on subsequent learning; and to assess some fiscal issues around Grade R.

The report showed that there is a wide consensus in the literature that preschools potentially have beneficial impacts that are strong and long lasting, with repercussions into adulthood, and that important equity gains result from such interventions. In this analysis, it became apparent that the quality of preschool interventions is crucial, and that Grade R does not simply mean an earlier start to school, but requires a very specific type of intervention to be successful with such younger children. In particular, there is a critical role for language and emergent literacy in Grade R, to ease children into the formal schooling process and to lay the foundations for learning in subsequent years.

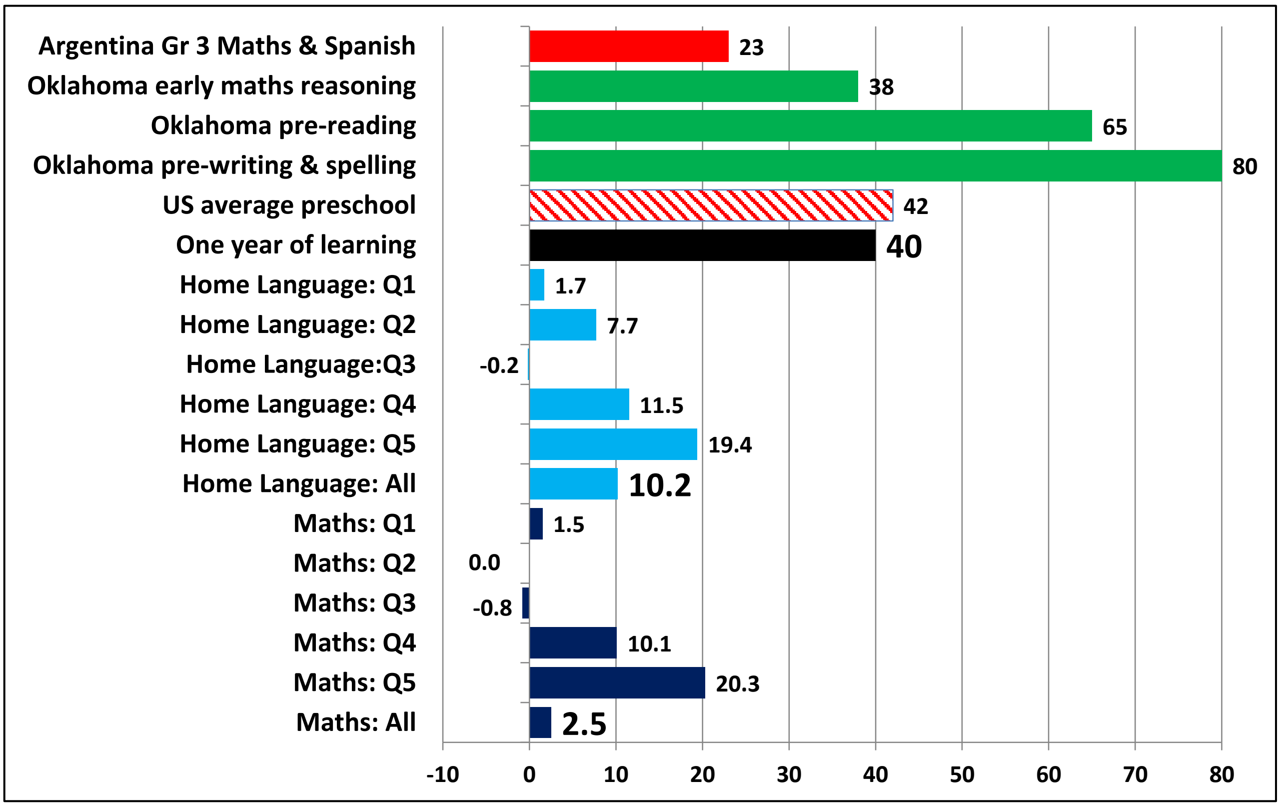
The massive roll-out of Grade R fits neatly into the lessons of the international literature, that early interventions are required to deal with learning deficits faced by many children. The weak performance of South African schools in international tests emphasised the need for early interventions, and the large degree of inequality in that performance focused attention on the need to reduce such inequalities. Thus early intervention was imperative. However, the rapids of the roll-out, and a long history of inefficiency in educational interventions in the school system, raised the question whether this major intervention was having the intended effects, and whether it was cost-effective. Thus the need for impact evaluation.

The re-estimation of models using data from NIDS, SACMEQ and the GHS broadly confirmed what the DBE report had already found, that the association of ECD with the learning outcomes that could be measured in these datasets provides suggestive evidence of an impact on learning, but that no causal links could be extracted, due to limitations with the data, an issue already made clear by this research team in the scoping study undertaken in 2012 (Coetzee and Van der Berg 2012).

The creation of a new dataset by combining information from various existing datasets made possible a new impact evaluation. Due to the repeated measurement in each school (ANA results from Grade 1 to 6) and different treatment intensities that could be measured for different cohorts of students, it was possible to turn to fixed effects models to overcome many of the problems of endogeneity that plague such evaluations. Thus it became possible to conclude, with strong evidence, that **there were significant, though small, effects of Grade R exposure on learning in subsequent years**. There is no clear evidence that the benefits of such learning faded out in the first six years of primary school beyond Grade R.

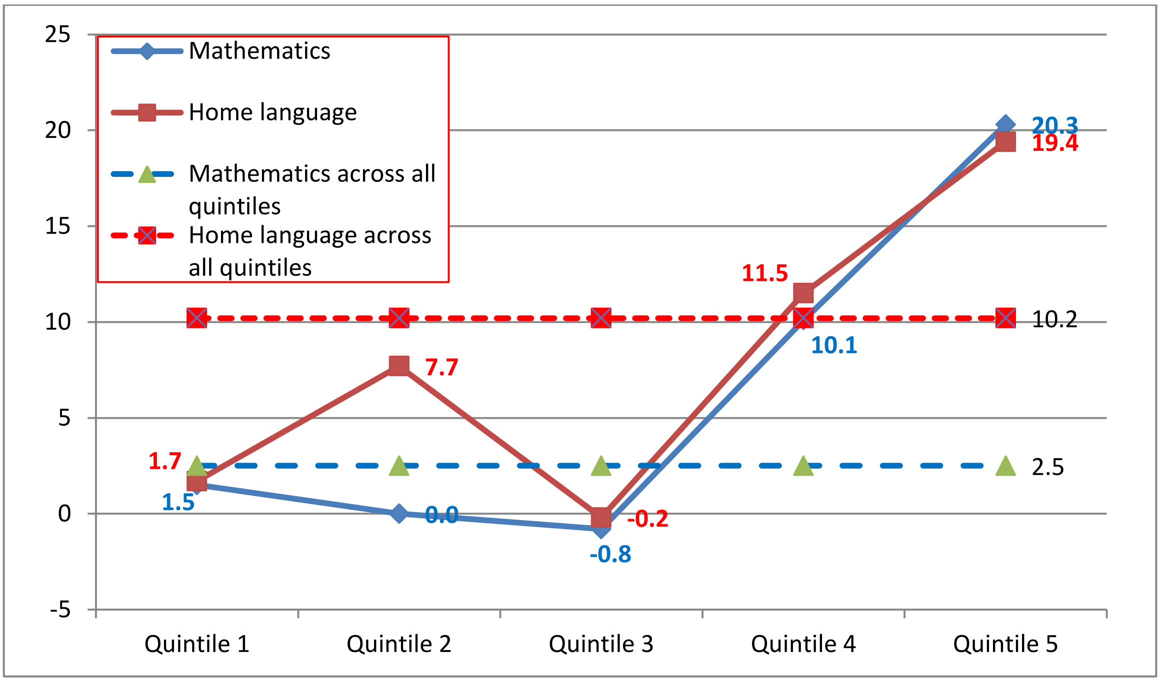
To put the impact of the Grade R programme into perspective, exposure to Grade R increased mathematics scores in subsequent years on average by 2.5% of a standard deviation, and home language scores by 10.2% of a standard deviation. How this compares to other estimates referred to in the literature review in Chapter 2 is set out in Figure 6.1. In a review of preschool programmes in the United States, Reynolds and Temple (2008) found average effects to be about 42% of a standard deviation on cognitive outcomes shortly thereafter. In comparison, Oklahoma's universal preschool programme (pre-K) for 4-year olds, considered a high quality programme, had experienced a 80% of a standard deviation gain in pre-reading and reading skills, a 65% of a standard deviation gain in pre-writing and spelling skills, and a 38% of a standard deviation gain in early math reasoning and problem-solving abilities (see discussion in Chapter 2). In Argentina, it was found that one year of pre-primary education increased the average third grade test marks in standardised Maths and Spanish tests by 23% of a standard deviation of the distribution of test scores (Berlinski, Galiani and Gertler 2009).

FIGURE 6.1: SUMMARY: SOUTH AFRICAN EFFECT SIZES OF TREATMENT WITH GRADE R IN COMPARISON (MEASURED IN PERCENTAGE OF A STANDARD DEVIATION OF TEST/COGNITIVE PERFORMANCE)



Unlike in South Africa, in Oklahoma, these effects were much larger amongst lower-income families (Barnett & Ackerman, 2006). In South Africa, the impact evaluation found that the effects were more substantial for the higher quintiles (10.1% of a standard deviations for Quintile 4 in Mathematics, 20.3% for Quintile 5; 11.5% for Quintile 4 in Home Language, 19.4% for Quintile 5), but close to zero in most cases for the other three quintiles in both subjects. Figure 6.2 summarises the results.

FIGURE 6.1: SUMMARY OF FIXED EFFECTS ESTIMATES OF IMPACT BY SUBJECT, 2012 (MEASURED IN PERCENTAGE OF A STANDARD DEVIATION IN LEARNING OUTCOMES FROM GRADE 1 TO 6)



Thus there is a net positive impact of Grade R on learning outcomes in South Africa: the impact is much stronger in the more affluent schools, while the impact in lower quintile schools is extremely weak. It was also shown that effects appear to be stronger in certain provinces, namely Gauteng, Northern Cape and Western Cape. First differenced fixed effects in used with quantile regressions further support a view that impact is higher at the top end of the socio-economic and school performance spectrum. ***Currently, Grade R further extends the advantage of more affluent schools, rather than acting to reduce inequalities***.

Together this seems to point to a possibility that impact is associated with the capacity to deliver a quality programme. If this is indeed the case, capacity could perhaps manifest itself in the supportive framework for Grade R, in the availability of good teachers, and in parental support. Clearly, however, there is a quality dimension that needs to be investigated in order to ensure that Grade R has a greater impact, and that it serves to narrow rather than widen existing inequalities.

The impact measured in this study was only in terms of learning (cognitive) outcomes only. As Chapter 2 showed, good early childhood development programmes can also contribute to non-cognitive outcomes, which were not measured here. Some learners probably gained from attending Grade R through improved nutrition, but the very limited gains in cognitive outcomes make it unlikely that improved nutrition was an important channel through which learning gains occurred.

Chapter 5 of the report dealt with coverage of Grade R, costs and cost effectiveness. Coverage has expanded greatly, particularly in poorer schools, and the gross enrolment rate has reached 80% of 5-year olds. Further expansion to universalise Grade R is well under way and within reach, and the slowing down of fertility has also slowed the expansion of numbers of children who need to be accommodated. Against the rapid expansion must be put a warning that success should not be measured by access alone, but by what is actually being achieved (National Treasury, 2008).

Cost per public school Grade R learner in 2011/12 was calculated at R3 112 per year, compared to R10 500 in public ordinary schools excluding Grade R, thus well below the 70% benchmark that had been set. Actual spending on Grade R may be higher, given inaccuracies in recording such spending. If government funds 90% of Grade R places, 212 000 more places may be needed. At R3 112 per place that will require R220 million per year extra over the next three years, but that may be an under-estimate. An accurate picture is complicated by weak administrative and population data, and low recorded spending per learner suggests cross-subsidisation of Grade R from other programmes or inaccuracies in how Grade R spending is categorised. It is essential to improve the basic data about Grade R enrolments and spending.

As the impact evaluation in Chapter 4 has shown that Grade R learning gains are for mathematics only 6% and for home language 25% of what can be regarded as normal progression for a year of learning, even the low and probably under-estimated costs of providing Grade R places shown in that chapter constitute a still a much higher proportion of cost per non-Grade R learner than their relative learning. Thus, despite the limitations of the cost data, it is clear that compared to learning and costs in other grades, a year of Grade R is not cost-effective in terms of improving learning outcomes. More accurate and thus higher cost estimates for Grade R would further strengthen this conclusion. It is important to note that such a statement on cost-effectiveness is in terms of cognitive outcomes only, and does not consider possible non-cognitive gains. Also, this statement is relative to cost-effectiveness in the rest of the school system, which is also not high.

Yet Grade R has now become an important part of the school offering and despite the finding on its low cost-effectiveness it would be **unthinkable not to continue with universalising Grade R**, in the light of the international literature on the value of Early Childhood Development in reducing learning deficits, international evidence that such early interventions can be the most cost-effective ones, and the great efforts that have been put in place to institute this programme. The challenge now is to deal with the issue of the low quality of the Grade R programme that is provided and to ensure that it makes the contribution to early childhood development that it was intended to do. Rapid roll-out put great strains on quality of provision, and turning this around ***before*** the system settles into low quality is essential. Though this is not the focus of this report, the recommendations that follow do draw from existing research and earlier reports to provide some guidance on desired interventions to improve quality. This is the only route to improve cost-effectiveness, as the cost of providing Grade R places is already quite low and may have to rise to deal with some of the quality concerns. ***To improve cost-effectiveness would thus require greater learning gains resulting from enhanced quality.*** This needs to be put into place with great urgency.

6.2. Recommendations

The findings of this impact evaluation point to problems of implementation quality of Grade R, despite the great success with access roll-out. To some extent the relatively rapid roll-out may have contributed, but to a large extent the problems of Grade R that emerged from the analysis – a modest overall learning impact and benefits being far less in poorer schools – may indicate that these are more endemic issues that cannot really be laid at the door of implementation of Grade R in particular.

6.2.1. Dealing with quality

Nevertheless, it is possible to use this opportunity to reiterate once again some of the known issues and problems of implementation and policy choices in ECD. Readers are particularly referred to previous work such as the findings and recommendations emanating from the National Treasury research (2008), the research done for the Gauteng Department of Education (2009), the Eastern Cape Provincial Department of Education (2008) and the SAIDE Grade R research project.

Although many factors influence quality of pre-school or Grade R provision, research seems to suggest two key quality dimensions that may differ across parts of the system. The first of these relates to training, quality, the support they receive from both the department and their schools, their qualifications and the pedagogical rigour of these, and their knowledge of *how* children learn and consequent understanding of how to facilitate learning through structured play and mediated language experiences, and the expected methodologies to achieve Grade R learning outcomes. In her interviews of numerous Grade R teachers as part of her doctoral thesis, Excell (2011) found that few practitioners could actually articulate a deep understanding of how to maximise children's learning through a play-based approach. It is recommended that opportunities for in-service training are increased, focused on providing teachers with ***practical strategies*** for supporting early learning and opportunities to see and practice best teaching, including observations, simulations, role-plays and working in contextually appropriate model environments. Importantly, this needs to be supported with on-going, on-site ***mentoring***.

Linked to this is the recommendation to improve pre-service training through FET Colleges. The current Unit Standards limit the extent to which teachers develop the skills and knowledge to support early learning. There is a need for compulsory, evidence-based early childhood education content in all ECD qualifications. Revisions to Unit Standards and Learning Programmes are essential to ensure that Grade R teachers are conversant with best practice around supporting early learning, and trained in the methods and approaches that have been shown to be most effective. Finally it is recommended that encouragement, both pecuniary and non-pecuniary, is given to Grade R teachers to ensure that good and qualified teachers do not aspire to move into other Grades in the Foundation Phase, to the detriment of the quality of Grade R provided.

The second quality dimension that requires attention is the curriculum, and specifically, **practical curriculum guidelines and standards**, and confidence in teachers' knowledge and understanding of the curriculum. Here, on-going structured curriculum support for teachers is recommended with regard to the implementation of CAPS, particularly with practical ideas on '***how'*** to achieve the learning outcomes stipulated in CAPS. It is essential that schools that are DSD registered (i.e. community preschools that are currently only registered to provide ECD with the Department of Social Development and are working towards registration with DBE) receive support to deliver CAPS. Many of the factors such as safety, cleanliness, and organisation of the child's environment and impact on learning are already being measured as part of the formal registration processes. Thus there is a need to evaluate the delivery of the curriculum – do teachers show fidelity to ***both*** the 'structural aspects' of curricula (e.g. using specified materials, following lesson plans) and 'process-oriented' aspects (e.g. quality of the interaction and relationship between child and caregiver)? In the South African context, quality of provision is also affected by the availability of materials that support the implementation of the curriculum. De Witt (2009), in an assessment of 70 preschools in five SA provinces, found the lack of educational materials so complete that practitioners did no more than look after the children.

It is also recommended that ***common tools*** are developed that can be used by teachers and researchers to assess children's language, literacy and mathematics development and to track progress in learning outcomes. The establishment of quality criteria, including indicators and measures, that enable both schools and ECD centres to self-assess, and which can be used for M&E at provincial and national level is vital. Criteria for evaluating the suitability of potential interventions could include evidence-based content that has been written for the local context, addresses the needs of disadvantaged children and children learning in a second language, and whether interventions or tools can be used effectively by educators with little training, are compatible with a variety of delivery contexts, and are relatively inexpensive.

Finally, it is recommended that recognition, resources and funding be given to support the significant role played by home-learning environments, including potential awareness-raising campaigns to help parents/caregivers understand and value their role in supporting early learning in the home. To this end, culturally relevant storybooks in all South African languages should be made more widely available to parents/caregivers, in particular through community libraries.

6.2.2. Coverage

The DBE should actively pursue the target of 100% Grade R coverage while simultaneously addressing issues of quality. Given the evidence on the importance of early learning and the long term impact of not investing in the early years, one cannot be prioritised over the other.

A relaxation of the 85/15 split between public and community provision of Grade R towards more community sites and the active support of quality community pre-schools could serve both quality and access goals simultaneously.

6.2.3. Researching Grade R

There is currently little systematic evidence on teaching and learning in Grade R and the quality of Grade R in terms of developmental needs (see Chapter 2 in this regard). DBE should encourage research in these matters, including funding of independent classroom based research in Grade R, and of the progression of children from Grade R to Grade 1. Such research would improve the evidence base for policy and interventions to enhance quality.

6.2.4. Data needs

It is essential that the data and knowledge base for the provision of Grade R be improved. This requires more attention to the population estimates and projections, improvements but especially greater use of the official enrolment data to address the issue of under-age enrolment where it is common, and especially attention to the accounting procedures and classification relating to the cost of Grade R provision.

The dataset created from administrative data has shown the power of the Grade R testing as a way of measuring performance throughout the education system. The value of this new data for education decision making will undoubtedly become clearer as time passes and it is use more widely to interrogate aspects of the education system. It is crucial for some of the purposes for which this data will be used that the Annual National Assessments should be testing accurately over time as well. This requires that more attention be given to equating of the difficulty level of these tests over time, and doing so utilising the advanced techniques that have become common in testing systems throughout the world, to ensure proper calibration and measurement of progress.

Though cognitive testing at Grade R level is more complex – it requires more individual working with children – and it is therefore not yet desirable to expand the ANA tests to Grade R, systemic testing is required to understand more about the quality of Grade R and the learning deficits that many children experience at the beginning of their school career. Such testing should be on a large enough scale to measure performance and progress across the system, and should be used to inform interventions aimed at improving the quality of Grade R.

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APPENDIX A

TABLE A1: OLS RESULTS, MATHEMATICS TEST SCORE

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Quintile 2	0.019*		0.014	0.003	0.000	0.038*	-0.113**
	(0.008)		(0.016)	(0.015)	(0.015)	(0.018)	(0.030)
Quintile 3	0.081**		0.010	0.023	0.019	0.053**	-0.087**
	(0.008)		(0.014)	(0.014)	(0.014)	(0.016)	(0.027)
Quintile 4	0.293**		0.059**	-0.055**	-0.052**	0.019	-0.240**
	(0.010)		(0.016)	(0.016)	(0.016)	(0.019)	(0.029)
Quintile 5	1.044**		0.459**	0.299**	0.301**	0.405**	0.042
	(0.010)		(0.019)	(0.019)	(0.019)	(0.024)	(0.034)
Log school fees 2007		0.244**	0.187**	0.192**	0.196**	0.179**	0.228**
		(0.002)	(0.003)	(0.004)	(0.004)	(0.004)	(0.006)
2012 year dummy			0.083**	0.103**	0.096**		
			(0.009)	(0.009)	(0.009)		
Grade 2			-0.006	-0.009	-0.015	-0.002	-0.039
			(0.014)	(0.014)	(0.014)	(0.017)	(0.023)
Grade 3			-0.027	-0.027	-0.022	-0.033	0.000
			(0.014)	(0.014)	(0.014)	(0.017)	(0.023)
Grade 4			0.000	-0.001	0.017	0.008	0.040
			(0.014)	(0.014)	(0.014)	(0.017)	(0.024)
Grade 5			-0.005	-0.004	0.022	-0.006	0.085**
			(0.014)	(0.014)	(0.014)	(0.017)	(0.024)
Grade 6			-0.030*	-0.029*	0.008	-0.023	0.089**
			(0.014)	(0.014)	(0.014)	(0.017)	(0.025)
Free State				-0.267**	-0.264**	-0.266**	-0.279**
				(0.027)	(0.027)	(0.038)	(0.038)
Gauteng				-0.185**	-0.178**	0.016	-0.413**
				(0.024)	(0.024)	(0.034)	(0.034)
Limpopo				-0.207**	-0.225**	-0.259**	-0.061*
				(0.017)	(0.017)	(0.022)	(0.028)

Mpumalanga				-0.247**	-0.251**	-0.223**	-0.317**
				(0.016)	(0.016)	(0.022)	(0.023)
North West				-0.515**	-0.499**	-0.527**	-0.442**
				(0.020)	(0.020)	(0.026)	(0.034)
Northern Cape				-0.642**	-0.672**	-0.678**	-0.682**
				(0.019)	(0.019)	(0.025)	(0.031)
Western Cape				-0.141**	-0.123**	-0.064**	-0.251**
				(0.017)	(0.017)	(0.023)	(0.025)
KwaZulul Natal				-0.584**	-0.580**	-0.577**	-0.559**
				(0.029)	(0.029)	(0.035)	(0.059)
treatment					0.159**	0.145**	0.199**
					(0.012)	(0.015)	(0.020)
constant	-0.161**	-1.056**	-0.925**	-0.650**	-0.760**	-0.620**	-0.792**
	(0.005)	(0.011)	(0.020)	(0.026)	(0.027)	(0.034)	(0.044)
Observations	106030	58291	47694	47694	47694	32740	14954
R-squared	0.098	0.174	0.198	0.227	0.23	0.223	0.267

Significant at 10% level, ** Significant at 5% level, * Significant at 1% level*
Robust standard errors in parentheses.

TABLE A2: OLS RESULTS, HOME LANGUAGE TEST SCORE

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Quintile 2	0.012		0.004	-0.008	-0.010	0.029	-0.126**
	(0.008)		(0.015)	(0.015)	(0.015)	(0.017)	(0.030)
Quintile 3	0.095**		0.008	0.020	0.017	0.053**	-0.096**
	(0.008)		(0.013)	(0.013)	(0.013)	(0.015)	(0.027)
Quintile 4	0.411**		0.151**	0.040**	0.043**	0.125**	-0.176**
	(0.010)		(0.015)	(0.016)	(0.016)	(0.018)	(0.029)
Quintile 5	1.290**		0.616**	0.452**	0.454**	0.586**	0.139**
	(0.010)		(0.018)	(0.019)	(0.019)	(0.022)	(0.034)
Log school fees 2007		0.306**	0.222**	0.227**	0.230**	0.225**	0.242**
		(0.002)	(0.003)	(0.004)	(0.004)	(0.004)	(0.006)
2012 year dummy			0.149**	0.174**	0.168**		
			(0.009)	(0.009)	(0.009)		
Grade 2			-0.008	-0.010	-0.016	0.017	-0.085**
			(0.014)	(0.013)	(0.013)	(0.016)	(0.023)
Grade 3			-0.051**	-0.052**	-0.047**	-0.052**	-0.037
			(0.014)	(0.014)	(0.014)	(0.016)	(0.024)
Grade 4			0.076**	0.074**	0.091**	0.094**	0.094**
			(0.014)	(0.014)	(0.014)	(0.016)	(0.024)
Grade 5			0.069**	0.068**	0.093**	0.083**	0.116**
			(0.014)	(0.014)	(0.014)	(0.017)	(0.024)
Grade 6			0.042**	0.041**	0.077**	0.088**	0.071**
			(0.014)	(0.014)	(0.014)	(0.017)	(0.025)
Free State				-0.181**	-0.177**	-0.195**	-0.201**
				(0.027)	(0.026)	(0.036)	(0.038)
Gauteng				-0.311**	-0.304**	-0.172**	-0.490**
				(0.024)	(0.024)	(0.032)	(0.035)
Limpopo				-0.286**	-0.303**	-0.365**	-0.079**
				(0.017)	(0.017)	(0.021)	(0.028)
Mpumalanga				-0.330**	-0.333**	-0.354**	-0.365**
				(0.015)	(0.015)	(0.021)	(0.023)

North West				-0.597**	-0.582**	-0.648**	-0.487**
				(0.020)	(0.020)	(0.025)	(0.034)
Northern Cape				-0.637**	-0.666**	-0.713**	-0.640**
				(0.019)	(0.019)	(0.024)	(0.031)
Western Cape				-0.296**	-0.280**	-0.178**	-0.534**
				(0.017)	(0.017)	(0.022)	(0.026)
KwaZulul Natal				-0.546**	-0.541**	-0.588**	-0.424**
				(0.029)	(0.029)	(0.033)	(0.060)
Treatment					0.151**	0.165**	0.153**
					(0.012)	(0.014)	(0.020)
Constant	-0.200**	-1.330**	-1.192**	-0.850**	-0.954**	-0.814**	-0.815**
	(0.005)	(0.011)	(0.020)	(0.025)	(0.026)	(0.033)	(0.044)
Observations	106035	58293	47696	47696	47696	32739	14957
R-squared	0.151	0.255	0.289	0.313	0.315	0.338	0.306

Significant at 10% level, ** Significant at 5% level, * Significant at 1% level*
Robust standard errors in parentheses.

TABLE A3: SCHOOL FIXED EFFECTS RESULTS

	Mathematics			**Home language**		
	Pooled sample	2011	2012	Pooled sample	2011	2012
Grade 2	-0.007	-0.008	-0.004	-0.006	-0.013	-0.005
	(0.006)	(0.012)	(0.008)	(0.006)	(0.011)	(0.007)
Grade 3	-0.004	-0.021	0.001	-0.006	-0.024	-0.003
	(0.007)	(0.013)	(0.008)	(0.007)	(0.013)	(0.008)
Grade 4	0.011	0.025	0.004	0.022**	0.033**	0.017
	(0.008)	(0.013)	(0.009)	(0.008)	(0.013)	(0.009)
Grade 5	0.025**	0.039**	0.015	0.031**	0.023	0.028**
	(0.008)	(0.014)	(0.009)	(0.008)	(0.013)	(0.009)
Grade 6	0.034**	0.038*	0.026**	0.038**	0.036**	0.035**
	(0.009)	(0.015)	(0.010)	(0.008)	(0.014)	(0.009)
Treatment	0.053**	0.074**	0.025*	0.093**	0.060**	0.102**
	(0.011)	(0.018)	(0.013)	(0.011)	(0.018)	(0.012)

Constant	-0.040**	-0.053**	-0.022*	-0.064**	-0.040**	-0.070**
	(0.009)	(0.015)	(0.010)	(0.008)	(0.014)	(0.010)
School fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	129410	41451	87959	129419	41461	87958
R-squared	0.001	0.001	0.000	0.001	0.001	0.001

Significant at 10% level, ** Significant at 5% level, * Significant at 1% level*
Robust standard errors in parentheses.

TABLE A4: FIXED EFFECTS MODEL ESTIMATES ACROSS QUINTILES, POOLED AND 2011 SAMPLES

	Quintile 1		Quintile 2		Quintile 3		Quintile 4		Quintile 5	
	Pooled	2011	Pooled	2011	Pooled	2011	Pooled	2011	Pooled	2011
Dependent variable:	**Standardised mathematics test score**									
Year 2012 dummy	0.047**	-	0.037*	-	0.122**	-	0.176**	-	0.181**	-
	(0.015)		0.018		(0.017)		(0.018)		(0.015)	
Grade 2	0.016	0.033	-0.016	-0.020	-0.031*	-0.039	0.015	-0.045	0.013	0.003
	(0.013)	(0.024)	0.015	(0.029)	(0.015)	(0.028)	(0.017)	(0.027)	(0.015)	(0.026)
Grade 3	0.052**	0.022	-0.015	-0.089**	-0.073**	-0.073*	-0.088**	-0.120**	0.053**	0.103**
	(0.015)	(0.027)	0.018	(0.032)	(0.017)	(0.032)	(0.021)	(0.034)	(0.020)	(0.031)
Grade 4	0.025	0.068*	-0.060**	-0.086**	-0.074**	-0.085**	0.010	-0.016	0.307**	0.280**
	(0.016)	(0.028)	0.019	(0.033)	(0.018)	(0.032)	(0.023)	(0.033)	(0.021)	(0.028)
Grade 5	0.030	0.043	-0.083**	-0.138**	-0.091**	-0.095**	0.020	0.025	0.443**	0.509**
	(0.017)	(0.030)	0.019	(0.034)	(0.019)	(0.032)	(0.025)	(0.035)	(0.024)	(0.031)
Grade 6	0.056**	-0.030	-0.033	-0.145**	-0.085**	-0.121**	-0.044	0.045	0.359**	0.619**
	(0.017)	(0.031)	0.021	(0.036)	(0.020)	(0.034)	(0.026)	(0.037)	(0.026)	(0.036)
Treatment	0.020	0.029	0.001	-0.009	-0.015	-0.032	0.103*	0.112*	0.168**	0.131*
	(0.020)	(0.034)	0.024	(0.041)	(0.026)	(0.045)	(0.041)	(0.056)	(0.039)	(0.054)
Constant	-0.234**	-0.192**	-0.133**	-0.077*	-0.097**	-0.046	-0.013	0.024	0.507**	0.526**
	(0.019)	(0.029)	0.023	(0.035)	(0.023)	(0.036)	(0.028)	(0.038)	(0.027)	(0.035)
Observations	36758	11734	24327	7359	22583	7016	11693	4371	10657	4259
R-squared	0.001	0.002	0.002	0.007	0.008	0.004	0.023	0.012	0.126	0.207
Dependent variable:	**Standardised home language test score**									
Year 2012 dummy	0.003	-	0.002	-	0.123**	-	0.303**	-	0.362**	-

	(0.014)		(0.016)		(0.017)		(0.021)		(0.018)	
Grade 2	0.012	0.034	0.022	0.046	0.001	-0.009	-0.043*	-0.119**	-0.116**	-0.228**
	(0.013)	(0.024)	(0.015)	(0.028)	(0.014)	(0.028)	(0.017)	(0.029)	(0.015)	(0.026)
Grade 3	0.057**	0.028	0.027	-0.009	-0.022	-0.022	-0.104**	-0.122**	-0.199**	-0.189**
	(0.014)	(0.026)	(0.017)	(0.031)	(0.016)	(0.031)	(0.020)	(0.032)	(0.018)	(0.028)
Grade 4	-0.099**	-0.049	-0.096**	-0.039	-0.093**	-0.004	0.224**	0.095**	0.593**	0.282**
	(0.015)	(0.027)	(0.017)	(0.031)	(0.017)	(0.030)	(0.023)	(0.032)	(0.019)	(0.026)
Grade 5	-0.094**	-0.053	-0.120**	-0.123**	-0.078**	-0.02	0.267**	0.131**	0.616**	0.362**
	(0.016)	(0.028)	(0.018)	(0.031)	(0.018)	(0.030)	(0.024)	(0.033)	(0.018)	(0.027)
Grade 6	-0.094**	-0.070*	-0.090**	-0.066	-0.054**	-0.022	0.228**	0.133**	0.521**	0.306**
	(0.016)	(0.030)	(0.019)	(0.035)	(0.019)	(0.032)	(0.023)	(0.034)	(0.020)	(0.028)
Treatment	0.008	-0.007	0.043	0.029	-0.004	-0.006	0.052	0.036	0.097*	0.064
	(0.019)	(0.034)	(0.023)	(0.039)	(0.026)	(0.045)	(0.042)	(0.061)	(0.041)	(0.055)
Constant	-0.172**	-0.129**	-0.172**	-0.166**	-0.147**	-0.138**	-0.096**	0.039	0.597**	0.808**
	(0.018)	(0.028)	(0.021)	(0.033)	(0.022)	(0.033)	(0.028)	(0.037)	(0.024)	(0.033)
Observations	36762	11739	24327	7359	22583	7016	11691	4369	10660	4262
R-squared	0.008	0.003	0.01	0.008	0.009	0	0.093	0.041	0.357	0.237

Significant at 10% level, ** Significant at 5% level, * Significant at 1% level*
Robust standard errors in parentheses.

TABLE A5: FIXED EFFECTS REGRESSION RESULTS BY PROVINCE AND SCHOOL WEALTH QUINTILE

	Pooled	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled	2011	2012
	Weak performing provinces			Top performing provinces			Weak performing provinces			Top performing provinces		
	Quintile 1 – 4						Quintile 5					
Dependent var:	**Standardised mathematics test score**											
Grade 2	-0.027**	-0.029	-0.025*	0.085**	0.055**	0.104**	-0.03	-0.016	-0.044	0.050**	0.016	0.079**
	(0.009)	(0.017)	(0.010)	(0.014)	(0.021)	(0.018)	(0.027)	(0.054)	(0.030)	(0.016)	(0.026)	(0.019)
Grade 3	-0.014	-0.043*	-0.003	0.009	-0.059*	0.043*	-0.069*	0.003	-0.122**	0.161**	0.160**	0.164**
	(0.010)	(0.020)	(0.011)	(0.016)	(0.024)	(0.021)	(0.032)	(0.063)	(0.036)	(0.023)	(0.033)	(0.027)
Grade 4	-0.042**	-0.052**	-0.040**	0.075**	0.068**	0.070**	0.125**	0.113*	0.120**	0.459**	0.380**	0.529**
	(0.011)	(0.020)	(0.012)	(0.018)	(0.023)	(0.023)	(0.034)	(0.052)	(0.040)	(0.025)	(0.031)	(0.030)
Grade 5	-0.053**	-0.081**	-0.044**	0.086**	0.071**	0.087**	0.234**	0.369**	0.146**	0.619**	0.593**	0.641**
	(0.011)	(0.021)	(0.012)	(0.019)	(0.024)	(0.023)	(0.037)	(0.059)	(0.040)	(0.029)	(0.035)	(0.033)
Grade 6	-0.013	-0.136**	0.027*	0.027	0.095**	-0.027	0.149**	0.447**	-0.022	0.539**	0.717**	0.400**
	(0.011)	(0.021)	(0.013)	(0.020)	(0.025)	(0.024)	(0.038)	(0.067)	(0.041)	(0.033)	(0.041)	(0.037)
Treatment	0.014*	-0.005	0.018*	0.083**	0.000	0.104**	0.106*	0.084	0.096*	0.111**	0.044	0.160**
	(0.007)	(0.015)	(0.007)	(0.025)	(0.037)	(0.030)	(0.044)	(0.089)	(0.045)	(0.042)	(0.061)	(0.051)
Constant	-0.123*	-0.096**	-0.131**	-0.034*	-0.062**	0.011	0.510**	0.352**	0.617**	0.753**	0.698**	0.797**
	(0.009)	(0.018)	(0.010)	(0.016)	(0.023)	(0.021)	(0.035)	(0.069)	(0.037)	(0.027)	(0.0370	(0.031)
Observations	76521	22426	54095	18840	8054	10786	4925	1706	3219	5732	2553	3179
R-squared	0.001	0.004	0.002	0.005	0.011	0.009	0.033	0.1	0.03	0.216	0.314	0.239
Dependent var:	**Standardised home language test score**											
Grade 2	0.016	0.059**	-0.007	-0.048*	-0.129**	0.013	-0.112**	-0.201**	-0.075*	-0.120**	-0.245**	-0.021
	(0.009)	(0.017)	(0.010)	(0.013)	(0.021)	(0.017)	(0.026)	(0.052)	(0.029)	(0.017)	(0.027)	(0.022)
Grade 3	0.028**	0.048*	0.017	-0.044**	-0.177**	0.042*	-0.247**	-0.221**	-0.280**	-0.137**	-0.172**	-0.123**
	(0.010)	(0.019)	(0.011)	(0.015)	(0.023)	(0.020)	(0.029)	(0.054)	(0.035)	(0.020)	(0.031)	(0.025)
Grade 4	-	-0.050**	-0.189**	0.307	0.051*	0.492**	0.425**	0.204**	0.535**	0.747**	0.327**	1.090**

	0.148**											
	(0.010)	(0.019)	(0.011)	(0.017)	(0.023)	(0.024)	(0.031)	(0.046)	(0.038)	(0.021)	(0.032)	(0.025)
Grade 5	-0.162**	-0.122**	-0.182**	0.373**	0.163**	0.498**	0.455**	0.273**	0.552**	0.765**	0.415**	1.021**
	(0.010)	(0.019)	(0.011)	(0.018)	(0.023)	(0.025)	(0.030)	(0.046)	(0.037)	(0.021)	(0.033)	(0.025)
Grade 6	-0.128**	-0.094**	-0.142**	0.303**	0.114**	0.418**	0.401**	0.239**	0.460**	0.647**	0.343**	0.885**
	(0.010)	(0.020)	(0.011)	(0.017)	(0.024)	(0.023)	(0.034)	(0.055)	(0.040)	(0.022)	(0.033)	(0.027)
Treatment	0.016*	-0.015	0.030**	0.059*	0.018	0.041	0.123**	0.034	0.133**	0.066	0.019	0.137**
	(0.007)	(0.017)	(0.007)	(0.024)	(0.036)	(0.032)	(0.044)	(0.081)	(0.049)	(0.045)	(0.064)	(0.052)
Constant	-0.137**	-0.139**	-0.136**	-0.029	-0.001	-0.019	0.630**	0.621**	0.662**	0.961**	0.964**	0.950**
	(0.008)	(0.018)	(0.009)	(0.015)	(0.022)	(0.021)	(0.031)	(0.059)	(0.035)	(0.024)	(0.038)	(0.029)
Observations	76525	22431	54094	18838	8052	10786	4927	1708	3219	5733	2554	3179
R-squared	0.015	0.01	0.023	0.073	0.055	0.134	0.192	0.142	0.275	0.391	0.322	0.679

Significant at 10% level, ** Significant at 5% level, * Significant at 1% level*
Robust standard errors in parentheses.

TABLE A6: QUANTILE REGRESSION RESULTS FOR FIRST-DIFFERENCED PERFORMANCE AND FIXED AFFECTS, INCLUDING CONTROLS FOR SCHOOL OBSERVABLES

	Mathematics					**Home language**				
Quantile	10th	20th	50th	80th	90th	10th	20th	50th	80th	90th
Quintile 2	0.003	-0.003	0.015	0.045	0.093**	0.030	0.005	0.023	0.025	0.066*
	(0.023)	(0.021)	(0.022)	(0.026)	(0.034)	(0.023)	(0.019)	(0.023)	(0.024)	(0.032)
Quintile 3	0.081**	0.050**	0.051**	0.017	0.02	0.091**	0.043*	0.045*	0.022	0.030
	(0.021)	(0.019)	(0.020)	(0.023)	(0.031)	(0.020)	(0.017)	(0.020)	(0.021)	(0.028)
Quintile 4	0.078**	0.028	0.002	-0.077**	-0.028	0.154**	0.121**	0.132**	0.081**	0.067*
	(0.025)	(0.023)	(0.023)	(0.028)	(0.037)	(0.025)	(0.021)	(0.024)	(0.025)	(0.033)
Quintile 5	0.367**	0.375**	0.402**	0.364**	0.352**	0.548**	0.551**	0.597**	0.592**	0.576**
	(0.034)	(0.030)	(0.028)	(0.033)	(0.044)	(0.034)	(0.027)	(0.029)	(0.031)	(0.043)
Log school fees 2007	0.183**	0.198**	0.208**	0.178**	0.154**	0.209**	0.237**	0.246**	0.257**	0.246**
	(0.006)	(0.005)	(0.005)	(0.007)	(0.010)	(0.0060	(0.005)	(0.006)	(0.007)	(0.010)
Grade 2	0.034	-0.009	-0.049*	0.004	0.028	0.04	0.046**	0.018	-0.003	-0.010
	(0.022)	(0.020)	(0.021)	(0.024)	(0.032)	(0.021)	(0.018)	(0.021)	(0.022)	(0.030)
Grade 3	-0.066**	-0.123**	-0.090**	0.008	0.057	-0.078**	-0.080**	-0.069**	-0.009	-0.027
	(0.022)	(0.020)	(0.021)	(0.024)	(0.032)	(0.021)	(0.018)	(0.021)	(0.023)	(0.030)
Grade 4	0.079**	-0.04	-0.077**	0.019	0.098**	0.383**	0.216**	0.036	-0.024	-0.069*
	(0.022)	(0.020)	(0.021)	(0.024)	(0.033)	(0.022)	(0.018)	(0.021)	(0.023)	(0.030)
Grade 5	0.107**	-0.039	-0.147**	0.025	0.157**	0.416**	0.220**	-0.008	-0.068**	-0.100**
	(0.022)	(0.021)	(0.021)	(0.025)	(0.033)	(0.022)	(0.018)	(0.022)	(0.023)	(0.030)
Grade 6	0.086**	-0.057**	-0.201**	-0.006	0.170**	0.359**	0.234**	0.029	-0.059**	-0.109**
	(0.022)	(0.021)	(0.021)	(0.025)	(0.033)	(0.022)	(0.018)	(0.022)	(0.023)	(0.030)
Free State	0.338**	0.335**	0.259**	0.197**	0.146*	0.187**	0.147**	0.192**	0.117**	0.121*
	(0.041)	(0.038)	(0.038)	(0.044)	(0.059)	(0.040)	(0.033)	(0.039)	(0.041)	(0.055)
Gauteng	0.277**	0.253**	0.182**	0.128**	0.056	0.299**	0.245**	0.213**	0.071**	0.026
	(0.024)	(0.022)	(0.022)	(0.027)	(0.036)	(0.024)	(0.019)	(0.023)	(0.024)	(0.033)
Limpopo	-0.223**	-0.320**	-0.468**	-0.522**	-0.505**	-0.271**	-0.337**	-0.411**	-0.389**	-0.399**
	(0.023)	(0.021)	(0.021)	(0.025)	(0.033)	(0.022)	(0.018)	(0.022)	(0.023)	(0.031)
Mpumalanga	-0.053*	-0.105**	-0.287**	-0.403**	-0.424**	-0.155**	-0.204**	-0.338**	-0.382**	-0.358**
	(0.026)	(0.024)	(0.025)	(0.029)	(0.039)	(0.026)	(0.021)	(0.026)	(0.027)	(0.036)

North-West	-0.198**	-0.161**	-0.325**	-0.421**	-0.457**	-0.132**	-0.141**	-0.225**	-0.363**	-0.315**
	(0.039)	(0.037)	(0.037)	(0.044)	(0.058)	(0.039)	(0.032)	(0.039)	(0.040)	(0.053)
Northern Cape	0.074	0.055	-0.049	-0.085	-0.07	0.220**	0.138**	0.170**	0.153**	0.216**
	(0.045)	(0.042)	(0.042)	(0.049)	(0.066)	(0.044)	(0.036)	(0.043)	(0.046)	(0.061)
Western Cape	0.502**	0.426**	0.221**	0.098**	0.062	0.621**	0.517**	0.402**	0.244**	0.177**
	(0.029)	(0.027)	(0.027)	(0.030)	(0.040)	(0.028)	(0.023)	(0.028)	(0.029)	(0.038)
KwaZulu-Natal	0.106**	0.078**	0.001	0.000	-0.031	-0.018	-0.01	0.013	-0.01	-0.005
	(0.019)	(0.018)	(0.018)	(0.021)	(0.028)	(0.019)	(0.016)	(0.019)	(0.020)	(0.026)
Treatment	0.089**	0.144**	0.175**	0.154**	0.158**	0.136**	0.153**	0.181**	0.163**	0.130**
	(0.019)	(0.017)	(0.018)	(0.022)	(0.031)	(0.018)	(0.015)	(0.019)	(0.021)	(0.027)
Constant	-2.097**	-1.740**	-0.981**	-0.055	0.428**	-2.330**	-2.016**	-1.297**	-0.487**	0.011
	(0.034)	(0.031)	(0.032)	(0.040)	(0.056)	(0.033)	(0.027)	(0.033)	(0.038)	(0.053)
Observations	32740	32740	32740	32740	32740	32739	32739	32739	32739	32739

Significant at 10% level, ** Significant at 5% level, * Significant at 1% level*
Robust standard errors in parentheses.

APPENDIX B[60]

The process that determines the test score y_{sgc} for school s, in grade g by cohort c is:

$$y_{sgc} = \mu_g \sigma_g + \eta_s \sigma_g + \beta \sigma_g x_{sc} + u_{sgc}$$

where μ_g is a grade fixed effect, η_s is the (mean-zero) school fixed effect, x_{sc} is the treatment share for cohort c in school s and u_{sgc} is the model error term, which is assumed to be i.i.d $\left(0, \sigma_g^2\right)$. The different grades therefore have different intercepts and variances, but the treatment effect β is expressed in terms of the normalised test variation.

Suppose one now calculates the normalised test score as

$$z_{sgc} = \frac{y_{sgc} - E\left(y_{sgc}|g\right)}{se\left(y_{sgc}|g\right)}$$

where

$$E\left(y_{sgc}|g\right) = \mu_g \sigma_g + \beta \sigma_g E(x_{sc}|g)$$
$$var\left(y_{sgc}|g\right) = \sigma_g^2 + var(\eta_s)\sigma_g^2 + \beta^2 \sigma_g^2 var(x_{sc}|g) + \beta cov(\eta_s, x_{sc}|g)\sigma_g^2$$
$$= \sigma_g^2 [1 + var(\eta_s) + \beta^2 var(x_{sc}|g) + \beta cov(\eta_s, x_{sc}|g)]$$

There are two potential problems with this normalisation, the normalisation used in the main fixed effects models that were estimated. Firstly, assuming $\beta > 0$, the average will increase with $E(x_{sc})$ in a way that will not be reflected in the normalised test score. Secondly, the standard error of the test scores will be higher after the implementation of the treatment if treatment varies by school (i.e. if $se(x_{sc}|g) > 0$) and will further increase if better performing schools have more exposure to the treatment (i.e. if $ov(\eta_s, x_{sc}|g) > 0$). In this case regressing z_{sgc} on x_{sc} (in a school fixed effects regression) will estimate the parameters from the following equation

$$z_{sgc} = \eta_s \frac{\sigma_g}{se\left(y_{sgc}|g\right)} + \beta \frac{\sigma_g}{se\left(y_{sgc}|g\right)} \left(x_{sc} - E(x_{sc}|g)\right) + \frac{u_{sgc}}{se\left(y_{sgc}|g\right)}$$

The probability limit of the fixed effects coefficient on the treatment variable will therefore be $\beta \frac{\sigma_g}{se\left(y_{sgc}|g\right)}$ instead of β. One way to fix this is to rather normalise the test scores with respect to the counterfactual (no treatment) test score distribution

$$\tilde{z}_{sgc} = \frac{y_{sgc} - E\left(y_{sgc}|g, x_{sc} = 0\right)}{se\left(y_{sgc}|g, x_{sc} = 0\right)} = \left\{z_{sgc} + \beta \sigma_g E(x_{sc}|g)\right\}. \frac{se\left(y_{sgc}|g, x_{sc} = 0\right)}{\sigma_g^2 [1 + se(\eta_s)]}$$

This requires estimates of σ_g, β, $E(x_{sc}|g)$, $se\left(y_{sgc}|g, x_{sc} = 0\right)$, $se(\eta_s)$, which can be calculated.

[60] Thanks are due to Rulof Burger and Dieter von Fintel for assistance with this normalosation.