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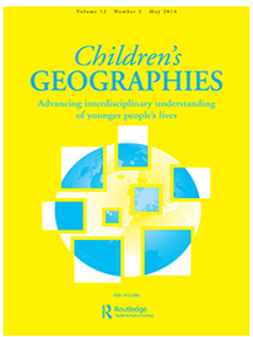

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Children's daily travel to school in Johannesburg-Soweto, South Africa: geography and school choice in the Birth to Twenty cohort study

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This paper has two aims: to explore approaches to the measurement of children's daily travel to school in a context of limited geospatial data availability and to provide data regarding school choice and distance travelled to school in Soweto-Johannesburg, South Africa. The paper makes use of data from the Birth to Twenty cohort study ($n = 1428$) to explore three different approaches to estimating school choice and travel to school. First, straight-line distance between home and school is calculated. Second, census geography is used to determine whether a child's home and school fall in the same area. Third, distance data are used to determine whether a child attends the nearest school. Each of these approaches highlights a different aspect of mobility, and all provide valuable data. Overall, primary-school-aged children in Soweto-Johannesburg are shown to be travelling substantial distances to school on a daily basis. Over a third travel more than 3 km one way to school, 60% attend schools outside of the suburb in which they live, and only 18% attend their nearest school. These data provide evidence for high levels of school choice in Johannesburg-Soweto, and that families and children are making substantial investments in pursuit of high-quality educational opportunities. Additionally, these data suggest that two patterns of school choice are evident: one pattern involving travel of substantial distances and requiring a higher level of financial investment and a second pattern involving choice between more local schools, requiring less travel and a more limited financial investment.

Keywords: school choice; school travel; Soweto; Johannesburg; Birth to Twenty

Introduction

Children's travel to school

Children's travel to school is moderated by school choice, as this influences enrolment patterns, and has the potential to increase the distance travelled by children (Pooley, Turnbull, and Adams 2005). The literature on school choice has long been characterized by ideological debate, often focused around whether or not school choice improves both educational quality and educational equality of opportunity (Henig 1994; Goldhaber 1999; Greene et al. 2010). There is recent evidence that families in countries as diverse as Chile, Kenya, Ethiopia, and Bangladesh engage in school choice, in various forms, and that most seem to be motivated by a desire to provide their children with the best possible opportunities, even in the face of often substantial constraints

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(Elacqua 2006; Elacqua, Schneider, and Buckley 2006; Cameron 2011; Weir 2011). Overall, however, the empirical literature regarding school choice in low- and middle-income countries is limited, and neither the extent nor the implications of school choice in these countries is well documented.

Globally, public schooling systems range from those where there is almost complete choice (such as New Zealand and the Netherlands) to those where children are required to attend particular schools, usually on the basis of residential location (such as Cuba, France, and Japan). Most systems are located somewhere between these extremes, with a global trend towards increasing choice (Goldhaber and Eide 2002; Plank and Sykes 2003; Alexandersson 2011). With increasing school choice globally, questions about the geographical and mobility implications of school choice have become more pertinent. There is a growing interest in the relationship between school choice, educational opportunity, and geography (Holloway et al. 2010; Bright 2011; Butler and Hamnett 2011; Holloway and Pimlott-Wilson 2011; Holloway, Brown, and Pimlott-Wilson 2011). There is evidence from high-income countries, such as the UK, USA, and Australia, that the distance children travel to school has been increasing in recent years (van Sluijs et al. 2009), and there has been a substantial volume of work exploring the ways in which school choice and distance to school interact with modes of travel (Jarvis and Alvanides 2008). By contrast, much less is known about children's travel to school in the developing world, although there is some exciting new work linking educational policy, educational opportunity, and geography (Oketch et al. 2010; Hannum, An, and Cherng 2011; Porter et al. 2011).

South Africa provides an excellent setting for the study of school choice and children's travel to school in the developing world. Although limited in comparison to high-income countries, geospatial and educational data are becoming increasingly available for South Africa. School choice in South Africa is known to be widespread, and there is a good theoretical understanding of how policy and context have shaped patterns of school choice and enrolment (Fiske and Ladd 2004; Woolman and Fleisch 2006). In particular, while South African policy was not designed to encourage school choice, it interacts with policy to create an environment in which choice is both possible and often desirable for individuals. The analyses presented here contribute to the international literature in two ways, by exploring different approaches to the measurement of children's travel to school in a context of limited data availability and by documenting the extent to which relatively disadvantaged families in a middle-income country engage in school choice, and the implications that this has for their children's travel.

School choice and learner mobility in South Africa

The South African schooling system is frequently described as 'two-tier', with a relatively small group of highly performing, well-resourced schools with high fees and a much larger group of less well-performing and more poorly resourced schools, which charge lower fees, if any (Fiske and Ladd 2004). Although the large majority of learners attend public-sector schools, recent growth in independent (private-sector) schools has been rapid. Although these are predominantly well-resourced and expensive, growth in more affordable independent schools has also been documented (Du Toit 2003; Hofmeyr and Lee 2004; Schirmer, Johnston, and Bernstein 2010). South African children are legally required to attend school starting from the year in which they turn six until the age of 16. The system operates on the basis of 12 grades, at the end of which children must write and pass the national Senior Certificate (also known as Matric) in order to complete their schooling. Grades 1–7 are typically attended at primary schools, while grade 8–12 are attended at secondary schools. Primary schools tend to be substantially smaller than secondary schools, and there are consequently many more primary than secondary schools in the Gauteng province.

Recent work has highlighted the poor state of education in South Africa, which is characterized by under-performing schools and children with extremely low skill levels (Reddy 2006; Fleisch 2008; Fleisch and Schindler 2008; Spaull 2011; Van der Berg et al. 2011). Simultaneously, the schooling system is also known for the highly variable resource levels enjoyed by different schools within the public sector and the enormous variations in school performance that tend to accompany this. Under Apartheid's Bantu Education Act (1953), children's educational opportunities, along with the resources devoted to these, were determined entirely by their racial categorization (Motala 1995; Fedderke, de Kadt, and Luiz 2000; Motala, Dieltiens, and Sayed 2009). While this policy is now a thing of the past, it has left behind a persistent set of geographically defined inequalities in educational infrastructure and resources, with well-performing schools typically located in historically white[1] areas[2] (Fiske and Ladd 2004, 2005; Woolman and Fleisch 2006; Spaull 2011; Van der Berg et al. 2011).

The best available indicator for the resource levels found in public schools in South Africa is the quintile rating system, which rates schools from 1 (being the poorest) to 5 (the most affluent), primarily on the basis of the community within which the school is located (Kanjee and Chudgar 2009). Despite its name, the quintile system does not divide either schools or learners into five even groups.[3] In Gauteng (the province in which Soweto is located), the majority of schools are in quintiles 3 or above, which is in line with Gauteng being a primarily urban and comparatively affluent province. Table 1 illustrates, for the study area, the clustering of schools with different resource level in areas with different levels of historical disadvantage. Resource levels, school fees, racial composition of the student body, and school-level academic performance are all closely related, even in the context of post-Apartheid South Africa, and remain strongly tied to geography. In this context, many children and families have considerable incentive to travel often substantial distances to attend a 'better' school than those closer to home (Figure 1).

While at first glance South African educational policy appears to constrain learners to attend schools in their home neighbourhood, it provides schools with both incentives and opportunities to enrol children from further afield. School finance policies provide schools with an incentive to enrol as many fee-paying children as possible, regardless of where they live, while admissions policies provide schools with some control over which learners they enrol (although this control is often de facto rather than de jure, is subject to legal constraints, and is increasingly coming under fire). When combined with national history, the geographical distribution of

Table 1. Distribution of schools with different resource levels in different MP areas within the study area.

Area	Number of schools in each quintile					Average quintile rating for schools in area
	Q1	Q2	Q3	Q4	Q5	
Historically white areas						
Alberton	1	1	2	4	15	4.3
Germiston	1	2	1	6	21	4.4
Johannesburg	7	5	15	131	61	4.1
Randburg	2	0	0	1	11	4.4
Roodepoort	3	1	0	2	27	4.5
Sandton	1	1	0	4	12	4.4
Historically black, coloured, or Indian areas						
Diepkloof	0	3	18	0	3	3.1
Meadowlands	0	2	36	5	0	3.1
Soweto	5	10	136	70	2	3.2

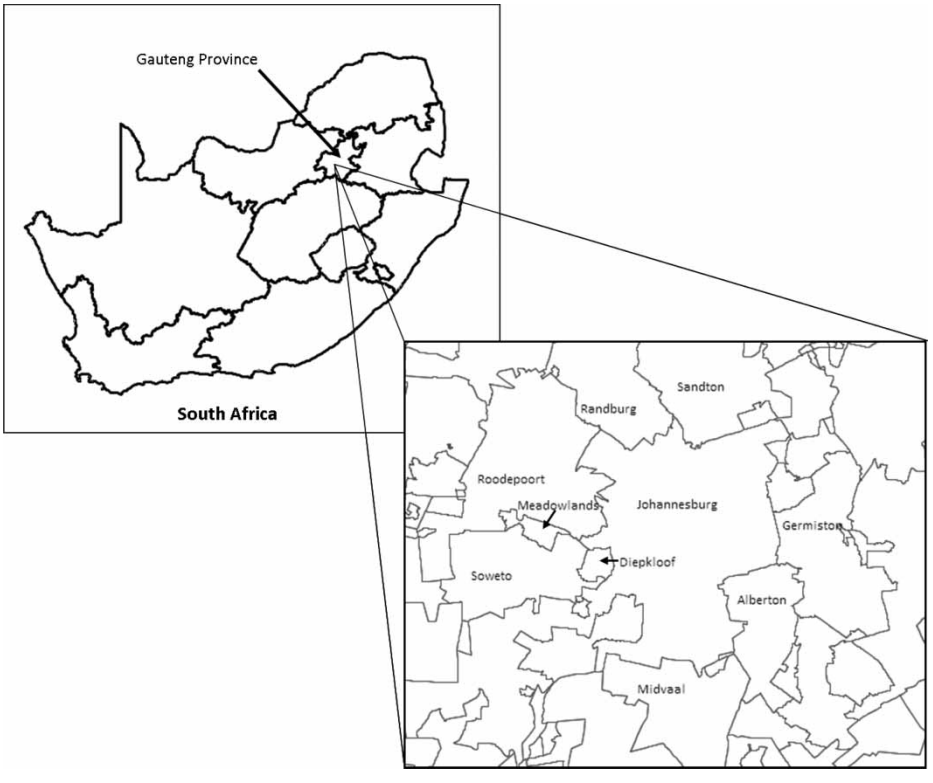

Figure 1. Location of the study area within South Africa, Census 2001 MP boundaries, and the names of MP areas within the study area.

schools with different resource levels, and the fairly slow pace of residential desegregation, the policy environment results in a context in which many children and families engage in school choice and, in particular, pursue enrolment in schools fairly far from their homes (Pampallis 2003; Maile 2004; Woolman and Fleisch 2006).[4] Typically, however, enrolling at a school far from home comes at a fairly marked financial cost, driven by both school fees and the cost of transport.

Several studies have shown that quite extensive numbers of South African children do travel on a daily basis to schools that are relatively far from their homes, a phenomenon which we term 'learner mobility' (Sekete, Shilubane, and Moila 2001; Nelson Mandela Children's Fund 2005; Woolman and Fleisch 2006; Karlsson 2007; Lancaster 2012). Policy suggests that children are expected to attend a school within 3 km (straight-line distance) of their home (Martin 2010), and, as access to educational opportunities within this radius is very good in urban contexts, travel greater than this distance is generally unnecessary. In the sample used for this study, the greatest straight-line distance between a child's home and their nearest public primary school was 3.14 km, while the mean distance was only 0.417. This highlights the extent to which the travel documented in this paper is not driven by constrained geographical access. Karlsson (2007) provides evidence that the single largest group of commuters in contemporary South Africa is school children, while a nationally representative survey of Grade 12 learners in 2001 found that 24.9% of them lived more than 10 km away from their school (Cosser and Du Toit 2002). As the major determinant of mobility seems likely to be the ability to pay higher fees and additional transportation, it is probably strongly linked to socio-economic status, leaving

those of lower socio-economic status at risk of being left in the most poorly performing schools (Pampallis 2003; Fiske and Ladd 2004). Understanding the ways in which children from different socio-economic backgrounds are able to interact with these geographies of opportunity feeds into a range of discussions linking geography and child well-being.

This paper represents the first attempt to explore various approaches to the definition and measurement of learner mobility at a population level in contemporary Johannesburg-Soweto. Data are drawn from 1997 and 2003, a window of time considered critical to the development and establishment of new, post-Apartheid patterns of interaction with educational opportunity. While children's travel to school is not always a reflection of school choice, there are a number of reasons to accept children's travel as a reasonable proxy for choice in the urban South African context. First, as indicated above, children in urban South Africa very rarely need to travel much to access public schooling at the primary level. Second, policy does not actively promote school choice, and does not subsidize the additional costs incurred by children attending a school further from home than necessary, increasing the likelihood that additional travel is an active choice on the part of families. Finally, while distance can only be a proxy for choice, in the absence of any population level data which speak directly to choice, the information provided here still constitutes a valuable addition to knowledge on school choice in Johannesburg-Soweto.

Methods

The Birth to Twenty cohort study, Johannesburg-Soweto

This paper draws on data from the Birth to Twenty (Bt20) cohort study, which started in 1989 with pilot studies to test the feasibility of a long-term follow-up study of children's health and well-being (Yach et al. 1991). Women were enrolled in their second and third trimester of pregnancy through public health facilities and interviewed regarding their health and social history and current circumstances. Singleton children ($n = 3\ 273$) born between April and June 1990 and resident for at least 6 months in the municipal area of Soweto-Johannesburg were enrolled into the birth cohort and have been followed up 16 times between birth and 20 years of age (Richter, Norris, and De Wet 2004; Richter et al. 2007). Attrition over two decades has been comparatively low (30%), mostly occurring during children's infancy and early childhood, and approximately 2300 children and their families remain in contact with the study (Norris, Richter, and Fleetwood 2007). The sample is roughly representative of the demographic parameters of urban South Africa with equal numbers of male and female participants. Assessments across multiple domains have been made of children, families, households, schools and communities during the course of the study, including growth, development, psychological adjustment, physiological functioning, genetics, school performance, and sexual and reproductive health. The third generation, children of Bt20 children, began to be born in 2004. The Bt20 research programme, including all data collection, has received clearance by the Ethics Committee on Human Subjects at the University of the Witwatersrand (M010556).[5]

The majority of cohort members live in Soweto, a large township in the Gauteng province of South Africa. In 2008, Soweto was estimated to have a population of approximately 1.3 million, almost all of whom are black African. Under the Group Areas Act, Soweto was designated as a separate town for black Africans, but in 2002 it became part of the City of Johannesburg. While Soweto has seen substantial economic development since the end of Apartheid in 1994, it remains one of the more disadvantaged parts of Johannesburg, and average adult educational attainment is low by urban standards. Although there are a large number of schools in the area, they are

predominantly poorly performing, and often have space for substantially more children than they are able to enrol (Msila 2005).

Empirical approach and sources of data

To date, the majority of research on learner mobility has explored the question either by focusing on particular schools or by making use of a small sample, typically drawn from a fairly geographically constrained area (Sekete, Shilubane, and Moila 2001; Fiske and Ladd 2004; Msila 2005, 2009; Hunter 2010). While these approaches provide valuable data, particularly with regards to the causes and implications of the phenomenon, learner mobility appears to be highly clustered around particular schools and amongst particular groups of people, highlighting the need for a study drawing on a broader population to answer questions about the actual scale of the phenomenon. In the absence of a nationally representative data set that could be used to explore learner mobility in South Africa as a whole, the Bt20 data set was selected for use. Key considerations in the selection of this data set were the availability of data throughout all stages of children's schooling, the availability of residential address, and school enrolment information. Additionally, while this data set does not allow for findings to be generalized across all of South Africa, the study sample was drawn from a large, urban population, and provides data about a major South African urban hub.

Analysis was conducted for 1997 and 2003. 1997 represented the first time point by which the majority of cohort members were enrolled in primary school, while 2003 represented the last time point at which the majority of cohort members were still enrolled in primary school. School enrolment data for 1997 were drawn from the Year 7 data collection wave, and gaps were filled with retrospective data collected in the Year 14 data collection wave. Enrolment data for 2003 were drawn from the Year 13 and 14 data collection waves. Using information on school name, address and grade, each school was then identified by its unique number in the Education Management Information System (EMIS), so that it could be linked to the school-level data from the Gauteng Department of Basic Education (see below). In some cases, schools could not be identified from the available data or children were attending unregistered schools without EMIS numbers. However, schools were identified and matched to EMIS numbers for 1241 of the 1428 study sample members for the 1997 time point, and for 1311 for 2003. A binary phase of schooling variable was generated to indicate whether a child was still attending a primary school (grades 1–7) in 2003, at age 13, or whether he or she had already progressed to high school (grade 8 or higher). Address information was collected for all cohort members during each wave of data collection, as this information was critical to maintaining contact. The final study sample was limited to 1428 cohort members who did not change address between 1996 and 2004, and who were attending normal schools within the Gauteng province at both time points. Due to the nature of sample definition, no participants were missing residential address data, although for 27 cases no GIS coordinates could be derived.

The Bt20 data were supplemented by data from two additional sources, the South Africa National Census 2001 and the Gauteng Department of Education. Census 2001 geography was used to define area boundaries, as it typically corresponds fairly closely to local perceptions of areas. Two different levels of geography were used to explore mobility at different levels. The smaller sub-place (SP) level corresponds with residential suburbs or small but distinct areas of a city, such as Pimville or Diepkloof Zone 2. The larger main-place (MP) level corresponds roughly to small cities or towns, or large but distinct areas within a large city, for example Soweto. Each SP is fully contained within a particular MP. Data from the Gauteng Department of Education 2008 EMIS master list were used to obtain the GIS coordinates of schools, and school resource levels, providing data on 2604 ordinary schools.

Approaches to measuring children's travel to school in Johannesburg-Soweto

As discussed, given the poorly developed state of conceptualization of learner mobility, particularly in the South African context, combined with limited data availability, this paper explores a number of different ways in which children's daily travel to school might be measured. These are detailed below.

Straight-line distance

Straight-line distance is methodologically the simplest way to measure distance between school and home, and is the approach that tends to be used in mobility-related policy and assessment in South Africa. The relationship between straight-line distance and actual distance is quite variable, because travel routes and obstacles to travel are not taken into account. However, as neither historical route data nor road network data were available for use in this paper, calculating straight-line distance was the only feasible option. Although imperfect, data around straight-line distance is valuable, as South African policy relating to school catchment areas and children's travel to school are based on straight-line distance. Understanding the actual straight-line distances between children's homes and schools is particularly important to evaluating the appropriateness of policies governing school funding allocations and parental and community involvement in school governance.

Distance from home to school can be used in analysis as either a policy-consistent binary variable, indicating whether or not mobility is occurring (based on a given cut-off distance), or as a continuous measure, indicating the extent to which mobility is occurring. Results using both of these approaches are presented here. Various distance-based definitions of what constitutes learner mobility have been advanced, ranging from travel of over 2.5 km to travel of over 10 km. In current official policy, a school's catchment area is defined as the area within a 3 km radius of the school, suggesting that this is felt to be the maximum distance a child should travel (Martin 2010). All distances were calculated using the Haversine formula applied to the GIS coordinates of the child's home and the child's school (Sinnott 1984).

Movement between areas

The second approach to measuring mobility determines whether a learner attends a school in the same area in which he or she lives. This approach is motivated by the concern that in some cases, a child's 'local' school may not be the closest school, but the school that is located in the same community in which a child lives. Additionally, in some cases, barriers such as rivers, hills, busy roads, or train tracks may mean that a child is cut off from the school that is closest to home on the basis of straight-line distance. In these cases, it would also be more natural for a child to attend a school that is slightly further away, but is located in the same geographic community. For both the SP and MP levels of geography, from Census 2001, a binary variable was created for each point in time, indicating whether or not home and school were in the same area.

Attendance at the nearest school

The final measurement of mobility presented here is based on whether or not a child attends his or her nearest school. This measure, unlike the previous two, shifts the focus away from those children travelling more substantial distances to all of those travelling further than necessary. While this is not a perfect measure of school choice, it does broaden the analysis to include those who may be engaging in school choice, but do not have the resources to move outside of their area of residence. This type of measure is particularly relevant in an area such as Soweto, in which most

children live within easy walking distance of a number of schools. However, as a measure of school choice, it does remain imprecise. Children likely to be miscategorized include those explicitly choosing to attend the school closest to their home, rather than attending it because it is closest, and those who would like to attend their nearest school, but are unable to do so, perhaps because the closest school is over-enrolled, the child is discouraged by higher school fees at this school, or the child is (illegally) refused admission due to poor academic performance. Additionally, as alluded to previously, for reasons of geography the closest school on the basis of a straight-line distance calculation may not always be the closest school for a child travelling on foot. Nonetheless, given the available data, this nearest-school analysis provides a more accurate reflection of the extent of school choice than any other available definition. A binary indicator showing whether or not the child attended his or her nearest grade-appropriate school was generated for each time point.

Comparing approaches

Calculating straight-line distance from home to school provided the clearest indication of approximately how far children travel and provides data that can be easily compared to policy recommendations and local and international guidelines. Straight-line distance can be used as either a continuous or a binary measure, making it useable in a range of different analyses, and allowing for exploration of different aspects of mobility. Determining whether children attend school in the same area in which they live provides less clear data about how far they travel, but more data about whether they are attending a 'local' school or not. In addition, in the South African context, it assists in determining whether children are travelling between areas historically designated for different racial groups. This sheds a lot of light on the socio-economic dimensions of children's travel to school. Finally, exploring whether or not children attend their nearest grade-appropriate school provides information about the extent to which more local forms of school choice are occurring, and whether children are actually attending the schools that educational policy is predicated on their attending. It can also provide insight into the extent to which parents in different areas are satisfied with the quality of local schools. As each approach to measurement highlights different aspects of school choice and children's travel to school, there is clear value in combining these three different approaches to measurement.

Data management and analysis

Data management was conducted using Microsoft Access. GIS analysis was done with gvSIG and statistical analysis with Stata Standard Edition 11. As most variables were non-normally distributed, non-parametric analyses were used for most analyses presented here, including chi-square tests, Fisher exact tests, Mann–Whitney Wilcoxon rank-sum tests, Kruskal–Wallis, and Spearman rank correlation. For multivariate analysis, a multiple regression approach was used.

Results

Study sample representativeness

For reasons related to both unavoidable cohort attrition over time and initial under-enrolment, the Bt20 cohort as a whole is known to under-represent children from more affluent backgrounds, and white and Indian children more generally, although there is also some under-representation at the lowest extremes of the socio-economic scale. Additionally, due to in-migration in the study area, the cohort has become less representative over time (Richter, Norris, and De Wet 2004; Richter et al. 2009).

Sample selection for this study was non-random, based on an unchanged residential address from 1996 to 2003. A number of tests on study sample representativity were conducted, and are documented in de Kadt (2011). The key finding is that when the group of cohort members not lost to attrition ($n = 2158$) is examined, and those included in the study sub-sample ($n = 1428$) are compared to those excluded for reasons of residential mobility ($n = 730$), little difference is found. There are no significant differences with regard to race, hospital of birth, place of birth, household SES, and maternal education ($p < 0.05$). This suggests that selecting the study sub-sample on the basis of residential mobility did not introduce substantial bias beyond that which is an unavoidable result of sample composition and attrition.

Study sample descriptive statistics

Descriptive data for the study sample are presented in Table 2, along with demographic data for the population of the Gauteng province as a whole, drawn from Census 2001 (Statistics South Africa 2003). While the sample was evenly split between genders, black African, coloured, and Indian children were over-represented at 80%, 13%, and 3%, respectively, while white children were under-represented.[6] By 2003, just under one-third of sample members had progressed to high school, while just over two-thirds remained in primary school. As SES was represented by quintiles based on an asset index, children were evenly distributed across these groupings. It is not possible to compare the study sample to the provincial population using the available SES data, but previous studies have suggested that the Bt20 cohort tends to under-represent both the most affluent and the most disadvantaged members of the population (Richter et al. 2006; Richter, Panday, and Norris 2009).

Analysis and results

The first aim of this paper is to explore various approaches to the measurement of children's travel to school, within the confines of available data in South Africa. Three different approaches to measuring mobility were used: distance from home to school; whether children attended school in the same area they lived; and whether children attended their nearest grade-appropriate school. Each of these approaches provided a slightly different type of information, indicating that all three have a useful role to play in understanding children's travel to school in the Johannesburg-Soweto context.

Distance from home to school

The distance data for both 1997 and 2003 show a high concentration of learners at the lowest levels of mobility (Figure 2). At both points in time, roughly a quarter of children travel less than half a

Table 2. Study sample and Gauteng province demographics.

Variable		Number in study sample ($N = 1428$)	Per cent in study sample	Gauteng province population (Census 2001)
Race	Black African	1145	80.2%	73.8%
	White	41	2.9%	19.9%
	Coloured	192	13.5%	3.8%
	Indian	50	3.5%	2.5%
Gender	Male	711	49.8%	50.3%
	Female	717	50.2%	49.7%

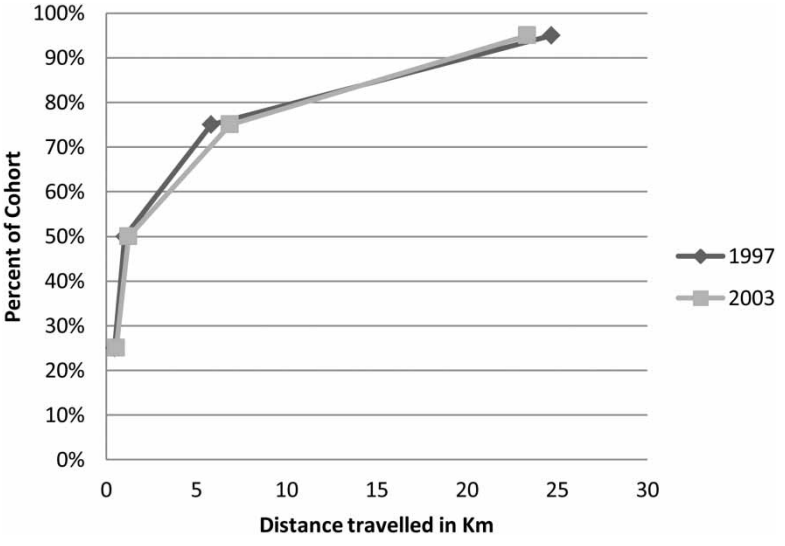

Figure 2. Distribution of distances travelled by sample members.

kilometre, one way, to school, with slightly less than half travelling a full kilometre. As distance increases above 1 km, however, the distributions begin to spread out substantially. The 75th percentile is reached around 6 km, and the remaining 25% of the sample travels greater distances. The 95th percentile falls at about 25 km, but some children travel as far as 60 km. In practical terms, this means that although almost half of the learners attend a school that is extremely close to their home, there are also roughly a quarter of learners travelling over 6 km one way. This is a substantial distance for a young child, and one that almost certainly indicates that these children or their families are making school choices, and are investing some financial resources into this choice, at the very least in terms of paying for transportation. These children are also likely to be travelling to schools in communities that differ substantially from those in which they live, particularly with regards to community affluence, resource levels, and historical racial designation.

While examining the actual distances between children's homes and their schools provides detailed information about how far children are travelling, the use of binary definitions of learner mobility can facilitate the development of policy on learner mobility and school catchment areas, as well as the assessment of the implementation of existing policies. While some information is lost in moving from a continuous measure to a binary definition, analysis and interpretation are also simplified. Various cut-off points for binary definitions of learner mobility are suggested by existing data and literature, and a number of these are presented here. Three kilometre is used as this is the maximum distance a learner can travel and still be considered to attend a local school according to South African policy (Martin 2010). It is also easily the maximum distance that a young child can be expected to walk to school. Five and ten kilometre cut-offs are also used, as they are frequently encountered in the local and international literature (Sekete, Shilubane, and Moila 2001; South African Human Rights Commission 2004). Working with these definitions and exploring cumulative density plots suggested that various other definitions, particularly around 1 and 2 km, would also provide useful information. In all instances, the variable is defined by coding all children travelling up to and including the cut-off distance as zero (not mobile), and all those travelling more than the cut-off distance as one (mobile). Table 3 provides the numbers and percentages of children who are classified as mobile at each time point for each of the binary definitions of mobility considered.

Table 3. Numbers and percentages of children classified as mobile in 1997 and 2003, for various binary definitions of mobility.

	1997		2003	
Mobility definition	Number mobile	Per cent mobile	Number mobile	Per cent mobile
Travel more than 1 km	613	50.49%	727	56.75%
Travel more than 2 km	451	37.15%	503	39.27%
Travel more than 2.5 km	418	34.43%	458	35.75%
Travel more than 3 km	407	33.53%	435	33.96%
Travel more than 5 km	335	27.59%	371	28.96%
Travel more than 10 km	226	18.62%	239	18.66%

The results of these analyses suggest that the interval between 2 and 3 km is particularly important (Figure 3). The initial, parabolic distribution ends here, and the long flat tail begins. Similarly, the slope of the cumulative density function shifts from steep to flat during this interval. That this shift in distributions occurs in the interval between 2 and 3 km is fairly compelling for both empirical and theoretical reasons. Empirically, 2 km corresponds roughly to the maximum distance that a young, school-aged child could be expected to walk to school on a regular basis. Schools are considered too far if they are over 30-minute walk away from a child's home (De Lannoy, Pendlebury, and Hall 2010). Two kilometre is at the upper bound of the distance a young, school-aged child should be able to walk in this time. Theoretically, the 3 km endpoint of this interval corresponds to the South African definition of a local school as being within a 3 km radius of a child's home.

These analyses also indicate that for any of the proposed definitions of mobility, a substantial proportion of children are actually mobile. In particular, roughly one-third of children are travelling more than 3 km. This is a clear indication that they are not attending local schools. This is particularly true for those living in Soweto, with its extremely high density of public schools. It also suggests that at least a third of children are making use of transportation, whether public or independent, to access schooling. This entails a substantial additional level of family investment in the schooling of these children.

Movement between areas

The numbers and proportions of children who are mobile at the SP and MP levels are shown in Table 4, for both 1997 and 2003. Just over 40% of children attended school in the same SP as they lived in 1997,

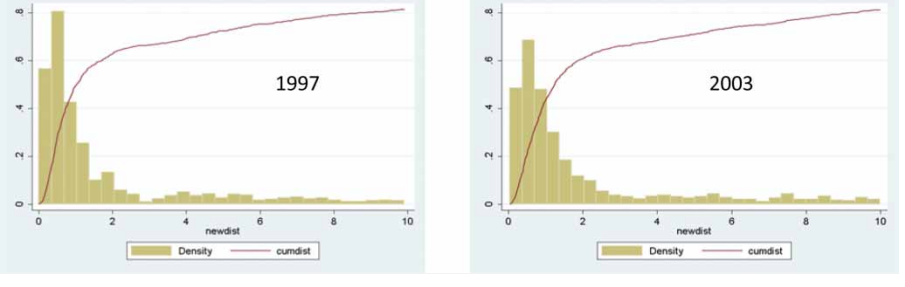

Figure 3. Cumulative density plot of distance between home and school, up to 10 km, laid over a histogram illustrating the density distribution of distance.

Table 4. Number and per cent of children whose homes and schools are in different SP and MP areas (1997 and 2003).

	1997: Mobile (i.e. school and home not in same area)		2003: Mobile (i.e. school and home not in same area)	
	Number	Per cent	Number	Per cent
SP	722	59.38%	809	63.10%
MP	334	27.47%	381	29.72%

and just below 37% in 2003. Given that SP geography is roughly equivalent to residential suburbs, this indicates that around 40% of children are attending a local school within their suburb, while the other 60% are travelling to schools outside their suburb. At the MP level, the proportion of children attending school within the MP where they live rises to over 70% for both 1997 and 2003. Interestingly, the proportion of children travelling across MP boundaries is very similar to the proportion travelling over 5 km. Correlations indicate these two measures are identifying roughly the same group of children, those travelling fairly substantial distances to attend historically more advantaged schools.

Mobility at the MP level is particularly significant in the South African context, because the boundaries of the MP level of geography correspond most closely to the historical boundaries between areas designated for different race groups. This is critical, because, as discussed previously, the historical racial designation of a school remains one of the strongest predictors of school performance in contemporary South Africa, and is likely to be one of the major influences on school choice. Additionally, historical racial group is also a strong predictor of the cost of attending a school. For this reason, those black children still resident in township areas and crossing MP boundaries can be roughly equated to the group that are choosing to attend schools that were historically restricted to white, Indian, or coloured children. Those children crossing SP, but not MP, boundaries can by contrast be roughly equated to those children exercising some degree of school choice but without travelling to areas that were historically designated for other racial groups.

Attendance at the nearest school

The final approach to measuring learner mobility involves determining whether or not children are enrolled at their nearest school. In both 1997 and 2003, fewer than 20% of children are actually attending the school nearest to their homes, regardless of whether or not independent schools are included in the analysis (Table 5). This suggests that over 80% of children are travelling further than strictly necessary in order to attend school. One possible explanation for such high

Table 5. Number and percentage of learners attending the school closest to their home in 1997 and 2003, and the mean and maximum distances to the schools nearest to sample members' homes.

	Number (%) of learners attending the school closest to their home	Mean distance to nearest school	Maximum distance to nearest school
1997	217 (17.76%)	0.398 km	2.767 km
2003	222 (17.40%)	0.466 km	4.230 km
2003; primary-school learners only	131 (15.32%)	0.410 km	2.767 km
2003; high-school learners only	91 (21.62%)	0.583 km	4.230 km

Note: All figures are calculated using both public and independent schools.

levels of fairly local mobility is that children and families, particularly at the earlier grades, are seeking out instruction in their home language. In Gauteng, six different languages are each reported as home language by over 5% of the population (Statistics South Africa 2003), highlighting the diverse language needs of children living in Soweto. However, the strength of this argument weakens as children progress beyond grade four, when either English or Afrikaans becomes the language of instruction.

There is some variation in attendance at the nearest school on the basis of schooling phase in 2003. Despite hypotheses that mobility should be higher amongst secondary school children, these children are actually more likely to be attending their nearest school. The overall proportion of children attending the nearest school in 2003 remains the same as in 1997 only because the proportion of primary-school children attending the nearest primary school actually falls fairly markedly to just over 15%. While the higher proportion of children attending the closest secondary school is likely to be due to the smaller number of these schools in the Gauteng province, the lower proportion of primary-school children attending their closest school at age 13 is more puzzling, particularly given that language is a less plausible motivator for mobility by this stage. One potential explanation is that children who are attending schools further afield perform more poorly or enrol at a later age, making them more likely to still be in primary school at age 13. An alternative may be that when children fail a grade, their parents are more likely to try sending them to different schools, which may be further from their homes.

The data on the distance from children's homes to their nearest schools provide an additional finding: the mean distance a child needs to travel to attend their nearest primary-phase school is approximately 400 m, and less than 5% of children need to travel more than 1 km. When contrasted to the actual distances children are travelling – previous calculations indicated over 50% of children travelling more than 1 km – this highlights the extent to which travel, even of moderate levels, appears to be due to children attending schools further from home than is strictly necessary.[7] In 2003, 95% of children still needed to travel less than 1.15 km to reach their nearest school, but there are a small number who needed to travel over 3 km. Disaggregating the data by schooling phase indicates that these are all children who have reached secondary schooling, suggesting that this change is due to the smaller number of high schools than primary schools in the Johannesburg-Soweto area.

Discussion and conclusion

Overview of findings

This paper pursued two aims. First, it explored three different approaches to the measurement of school choice in a context of limited data availability, by looking at the distance of children's travel to school. This has significantly enhanced the methodological tools available for work in this area. Second, it has, for the first time, provided population-based data on the extent of learner mobility in contemporary urban South Africa. These data suggest that levels of learner mobility are extremely high, and that there appear to be two patterns of school choice and mobility in operation in Johannesburg-Soweto. First, there is a group of approximately 25% of the sample who are engaged in substantial travel from home to school on a daily basis, and whose families seem likely to be making significant investments in this mobility. Second, there is also evidence that a large proportion of children who are not travelling substantial distances to school are still engaging in school choice. Even though they are attending schools relatively close to home, they are not attending their nearest school, and are often travelling to schools that are not located in the same suburbs as their homes. Given the persistence of this pattern until the end of primary school and the beginning of secondary school, it does not seem likely that this is due to language

requirements, as education after Grade 4 is largely in English. Additionally, given the prevalence of under-enrolment in township schools, it is unlikely that this is due to children being refused places in nearer schools. It therefore seems most likely that these children and families are choosing to attend schools other than those closest to their homes.

Methodological contributions

This paper makes a contribution to the exploration of possible approaches to the measurement of travel to school in a developing country context, where the availability of geospatial data is fairly limited. In the developed world, where road network data and public transportation route data are typically available, these can be used to generate accurate estimates of children's travel distance to school (Wilson, Wilson, and Krizek 2007). Travel can also be tracked directly by monitoring GPS-enabled cell phones (Wiehe et al. 2008). By contrast, in a context where geospatial data are less available and financial or technical constraints limit data collection, somewhat cruder approaches to the measurement of mobility are necessary. Indeed, in both South Africa and other developing countries, existing work is largely based on self-reported travel times and distances (Paterson and Kruss 1998; Colclough, Rose, and Tembon 2000; Sekete, Shilubane, and Moila 2001; Glick and Sahn 2006; De Lannoy, Pendlebury, and Hall 2010), and when researchers have been able to calculate actual distances, these have been based on more highly aggregated data than those used here (Huisman and Smits 2009). In providing ways to measure educational mobility geographically in a developing country context, this paper also lays the groundwork for future work documenting not only mobility itself, but also its implications and consequences. In a global environment of increasing levels of school choice, and a strong focus on enhancing access to education in the developing world, answers to these questions will become increasingly important.

This paper explored three different approaches to defining and measuring learner mobility, each with different strengths, and has provided data about the extent of learner mobility in Johannesburg-Soweto on the basis of each of these definitions. Using a distance-based measure provides both a binary and a continuous measure of mobility, and is particularly useful in assessing the appropriateness or applicability of policy, as well as documenting the actual extent of mobility. While straight-line distance is a problematic proxy for actual distance travelled, as routes are not taken into account, given the available data it is the only way to provide an estimate of distance, which is important for policy. First, policy around how far children should live from their school is specified in terms of straight-line distance (Martin 2010); so providing this data illustrates clearly that travel greater than this distance is widespread. Second, other policies, notably those around school funding and parental engagement in school governance, are based on the assumption that children live within this radius.

The area-based approach is helpful in identifying whether learners are travelling between areas historically designated for different race groups, and thereby significantly enhancing the quality of education they are likely to receive. Finally, the definition based on whether or not the learner is attending the age-appropriate school closest to his or her home is useful in highlighting the extent to which even learners with relatively low levels of mobility may be engaging in more travel than strictly necessary or anticipated.

We argue that in addition to the contributions our paper has made relating to the measurement of travel to school, it also feeds into understandings of ways to measure school choice in the absence of data speaking directly to this issue. As discussed previously, while mobility is not an exact proxy for school choice, in the South African context there is substantial overlap, and the different measures of mobility presented here each provide insight into levels and forms of school choice in Johannesburg-Soweto. For example, straight-line distance provides some

understanding of how much further than strictly necessary children are travelling, and allows for rough approximations around travel time or distance. The area-based measure provides some information about the scale on which school choice operates, as well as providing information about the types of areas children are moving between. Documenting whether children attend their nearest school provides insight into the possibility of choice at a very local level. While some degree of the mobility documented is bound to derive from different types of necessity rather than choice, the overlap between the different approaches to measurement documented here provides compelling evidence that levels of school choice in Johannesburg-Soweto are high.

Empirical contributions

The data provided about the extent of travel to school and school choice in Johannesburg-Soweto emphasize the extent to which school choice and educational mobility can become widespread even in a context in which it is not explicitly permitted by policy. In fact, even those families who do not have the resources to travel long distances and pay high school fees still engage in school choice in a more local context, and appear to use this as a tool to improve the educational opportunities available to their children. This stands in sharp contrast to findings from other contexts that less-advantaged parents are often less engaged in school choice, raising additional questions about the implications of school choice for equality of access to educational opportunities.

The extent to which children engage in school choice, and travel substantial distances to school, has important implications for educational equality. Existing South African work on educational equality has tended to focus on resource and quality differentials across schools, which often remain strongly connected to racial inequality (Chisholm 2004; Fiske and Ladd 2004; Nkomo, Mckinney, and Chisholm 2004; Kanjee 2007). However, as socio-economic inequalities within race groups grow (Van der Berg, Wood, and Le Roux 2002; Van der Berg et al. 2011), direct attention to the implications of socio-economic status for education becomes increasingly important (Bell and Morton McKay 2011). Learner mobility has the potential to simultaneously decrease racial segregation of schools, but increase socio-economic segregation, with substantial implications for educational access and equality. This is because the costs associated with learner mobility tend to be fairly substantial, meaning that it is likely to be shaped primarily by socio-economic status, rather than race.

Additionally, learner mobility in South Africa has practical implications for a number of areas of educational policy, including school financing and governance. For example, schools are funded on a redistributive basis, with schools educating poorer children receiving more funding than those educating their more-affluent peers (Kanjee and Chudgar 2009). However, the poverty level of children attending a school is estimated on the basis of poverty level of children living in the area around a school. The high levels of mobility shown in this paper suggest that this approach is likely to be highly inaccurate, and may result in the misdirection of funding. The information provided by this paper suggests the need to revisit South African educational policy based on the assumption of limited or no learner mobility, and highlights the practical questions that need to be asked about South Africa's current approach to school choice.

This paper does not contribute to the debate about the value of school choice, and is not an evaluation of the efficacy of a conscious and deliberate choice strategy adopted by the newly elected government in the immediate period after the political transition. Rather, it documents the existence of unintended but extensive levels of school choice in a policy environment that did, de facto, facilitate a moderate degree of school choice. This de facto school choice practice emerged from the interaction between policy change and the racial geography of the Apartheid city, rather than emerging from a neo liberal policy agenda (Woolman and Fleisch 2006).

Limitations

While being population-based, the Bt20 cohort is not representative of urban South Africa as a whole. Additional work with more representative samples of urban populations would be useful in strengthening the findings of this study, and work drawing on rural populations would provide an interesting counterpoint. In the absence of this additional work, the extent to which the findings presented here can be generalized to other areas of South Africa remains unclear. Of course, with more sophisticated data, more advanced approaches to measuring school travel and choice could also be implemented. With the growing availability of reliable open source geographical data, for example through openstreetmap.org, future work could experiment with the use of road and public transportation networks to create more sophisticated models of mobility. The findings of this paper would also be strengthened by the inclusion of more detailed information about exactly who is engaged in mobility, and how travel to school varies with socio-economic status, race, and parental education. This information would feed particularly valuably into discussions around the implications of travel to school and school choice both for individual children and for the schooling system more broadly. If data were available on children's home language, this would also help with understanding the extent to which more local forms of mobility are linked to the pursuit of education in the home language. Finally, while the current paper documents the extent of mobility, it can say little about the reasons for mobility or for engagement in school choice. This could be provided by the inclusion of a qualitative component in the research.

Conclusion

This paper has provided two contributions to the literature around school choice and the geography of education. First, it has illustrated three different approaches to measuring children's travel to school and school choice in a context of limited data availability. It has shown that each of these three approaches can be used effectively, and that each sheds light on a different component of school choice and mobility. Second, it has provided one of the only quantitative explorations of the extent of school choice and children's travel to school in a low- or middle-income country. The data presented have illustrated that even in a context of limited resource availability, children and families are willing to make substantial investments to access higher-quality educational opportunities. As school choice becomes more accepted globally, the importance of understanding the patterns of the extent to which children are travelling to attend schools of their choosing becomes increasingly important.

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Notes

1. In this paper, the four race groups defined by the Apartheid-era government (White, Indian, Coloured, and Black) will be used to categorize individuals, due to South Africa's unique historical context, and the ongoing relevance of these categories to the life experiences and educational opportunities of young South Africans.

2. Under Apartheid's Group Areas Act (1966), people of each race group were required to live and attend school in specifically designated urban areas. Areas designated for white people, and the schools those areas contained, were far better resourced than areas and schools designated for other groups.
3. Very little information is publicly available as to how exactly the poverty quintile ratings for schools were arrived at or why the quintiles are so variable in size.
4. The introduction of the no-fee school policy in 2007 is likely to have resulted in some changes in the incentives faced by children and families in choosing schools as well as by schools in making enrolment decisions. However, as the data considered in this study cover the period from 1997 to 2003 only, this policy change is not relevant here.
5. The Federal-Wide Assurance registration number of the Committee is FWA00000715. The analysis presented in this paper received additional clearance from the University of the Witwatersrand. All data used in this paper were made available on the basis of unique identifying numbers attached to each individual, with all identifying information with the exception of residential address removed. Care has been taken to ensure that exact residential addresses of individuals are not disclosed in any of the description or graphics accompanying this paper.
6. Data on children's home languages or ethnic groups are unfortunately not available, and therefore cannot be presented.
7. Unfortunately, the data required to explore how much of this local-level mobility is related to language issues are not available.

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