Social mobility during South Africa's industrial take-off

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A WORKING PAPER OF THE DEPARTMENT OF ECONOMICS AND THE
BUREAU FOR ECONOMIC RESEARCH AT THE UNIVERSITY OF STELLENBOSCH

www.ekon.sun.ac.za/wpapers

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Abstract

In the absence of historical income or education data, the change in occupations over time can be used as a measure of social mobility. This paper investigates intergenerational occupational mobility using a novel genealogical dataset for settler South Africa, spanning its transition from an agricultural to an early industrialized society (1800–1909). We identify fathers and sons for whom we have complete information on occupational attainment. We follow a two-generation discrete approach to measure changes in both absolute and relative mobility over time. Consistent with qualitative evidence of a shift away from agriculture as the economy's dominant sector, we see the farming class shrinking and the skilled and professional classes growing. Controlling for changes in the structure of the labor market over time, we find increasing social mobility, becoming significant after the discovery of minerals in 1868. We find this mobility particularly for semi-skilled workers but virtually no improved mobility for sons of farmers. We also test hypotheses related to the mobility prospects for first-born sons and sons of immigrants.

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Introduction

Industrialization is expected to maximize the efficiency of human capital by putting the "right man in the right place". As technology advanced, a man would be increasingly likely to be placed "on the basis of what he could do rather than who he was or whom he knew" (Landes 1969, p. 10). Society would now be stratified not by ascription at birth but by personal achievement (Hoogvelt, 1978). We test how far this is true of nineteenth-century South Africa by measuring white social mobility during the country's industrial take-off.

For much of that century, the territories that made up South Africa were largely agricultural. The coastal cities of Cape Town and to a lesser extent Port Elizabeth were the only manufacturing centers. This changed with the discovery of diamonds in 1867, and gold twenty years later, which shifted the locale of economic power from the south and eastern coast to the northern interior. We would like to know more about who benefited from the resulting economic prosperity. We know that the mineral revolution resulted in ethnic inequalities, benefiting mostly whites (Bundy 1979), but we do not really know who the main economic beneficiaries were. Identifying these beneficiaries will help us understand how South Africa's early industrial take-off affected social mobility.

Using a novel dataset of genealogical records, we make the first attempt to measure the social mobility of white South Africans during this revolutionary period in the country's economic history. We find that white farmers were less socially mobile than unskilled and semi-skilled white laborers. It appears that the changes benefited urban, but not necessarily poor, whites more than they benefited farmers.

This finding contributes to four important literatures. The first is the literature on social mobility, to which we contribute new historical evidence of one set of beneficiaries of South Africa's mineral revolution: the semi-skilled laborers, who were mainly middle-class urban whites (Keegan 1987; Van Onselen 2001). Poor whites seem to have largely been left behind. Because we have no evidence on the social mobility of black South Africans during this period yet, we recognize that our finding may be partly a result of the downward (relative) mobility of black farmers into unskilled occupations. But, as we show, not all white South Africans were socially mobile: industrialization in South Africa did not turn white farmers into factory-workers, for example. Urban dwellers experienced upward achievement-based mobility, but

farming remained highly ascriptive, being based on property rights and land ownership. In the rapidly changing South Africa of the late nineteenth century, patrimony, it seems, still mattered.

The second is an emerging literature on intergenerational mobility between and within countries over the past two centuries (Blanden, 2013; Dribe et al., 2015; Long and Ferrie, 2007, 2013; Maas and Van Leeuwen, 2002; Mazumder 2005). Almost all these studies, though, compare the historical intergenerational mobility of present-day developed countries, and for obvious reasons: interest in understanding how these countries grew prosperous, and availability of data. The United States, Britain and Sweden have exceptionally rich data sources to support such high-quality empirical work. Our study is one of the first to measure historical intergenerational mobility in a present-day developing and African country (Piraino et al., 2014; Pérez 2015).

Third, it contributes to the debate on the effects of a mineral boom (Allcott and Keniston, 2014; Van der Ploeg, 2011). As far as we know, we are the first to measure intergenerational mobility during a period of mineral discoveries. The rapid pace of economic transformation, spurred by the discovery of diamonds and gold, makes South Africa a unique case study of mobility during mining development and then industrial take-off. We show that when a society moves rapidly from agriculture to industrialization not everyone benefits equally. The institutional features of the society before industrial take-off – both the formal legislative rules and the informal socio-cultural values – can hold certain groups back.

And fourth, it contributes to debates about the role of settler migration and colonialism in Africa (Acemoglu et al., 2001; Robinson and Heldring, 2014; Meier zu Selhausen and Weisdorf 2016). We find that the main beneficiaries of the mineral revolution were middle-class whites, often emigrants from the colonial ruler. The chance of improving their position in society may largely explain their decision to emigrate to the colonies, and it explains the increasing antagonism between these newcomers and the earlier settlers, who were predominantly rural and of Dutch origin (Dugmore, 1999; Fedorowich, 1991).

To control for the rapid change in the structure of the economy, we use discrete measures of absolute and relative social mobility. Structural changes in the labor market by definition cause intergenerational occupational mobility. Absolute mobility is therefore defined as mobility resulting from changes in the structure of the labor market. Relative mobility, on the other hand, is intergenerational occupational mobility that is net of changes in that structure. Relative

mobility could have various causes, such as a reduction of the barriers to mobility, an expansion of the educational system offering new opportunities to the less affluent, the diminishing importance of social networks, or the growing importance of achievement over ascription by birth – this last influenced by the changing formal and informal institutions of the society.

Both measures, absolute and relative, provide a description of changes in the relationship between occupations across generations and the share of individuals who remain immobile or end up in different classes from their parents; in other words, an overall change in social structure. Measures of intergenerational occupational mobility, however, do not necessarily give us a picture of improvements in living standards from generation to generation. Because there can be considerable variation in income and wealth within occupations, in the absence of occupational mobility there may still be substantial income or wealth mobility.

The history of industrialization in South Africa

To investigate the prospects of social mobility at a time when the South African economy was undergoing substantial transformation, we divide the period into four phases. This gives us four cohorts according to the birth dates of the sons in our father-son pairs, capturing four periods of industrialization, which for simplicity we call the "Slavery" period (1806–1834), the "Stagnation" period (1835–1867), the "Diamonds" period (1868–1886) and the "Gold" period (1887–1909).

Slavery (1806–1834)

European settlement at the southern tip of Africa began in the seventeenth century when the Dutch East India Company established a refreshment station for their ships sailing between Europe and the East Indies. Soon after arrival they released Company servants to become free settlers. Thus began the slow process of territorial expansion and dispossession of the indigenous Khoesan land that, by 1806, would take in most of what is today the Western Cape of South Africa. During its more than 140 years in power, the Company monopolized trade at the Cape. It was never in the VOC's mandate to promote secondary industry: it strongly opposed the establishment of manufacturing operations on the grounds that this would be detrimental to its factories in Holland (Fourie, 2013; Lumby, 1983). Wheat and wine production expanded until the latter part of the eighteenth century, after which pastoralism dominated, particularly on the eastern frontier (Fourie, 2014; Van Duin and Ross, 1987).

When the Cape Colony came under British mercantilist rule in 1795, it was required to supply the mother country with raw materials and agricultural produce in exchange for manufactured goods. A brief interlude between 1803 and 1806 saw the Colony handed back to the Dutch but by 1806 it was once again incorporated into the British imperial economy. In the 1820s some 4,000 British settlers migrated to the eastern regions of the Colony and in the following decades many of them became sheep farmers or worked as traders and artisans in the newly established towns of Grahamstown and Port Elizabeth. Their frequent trade with the native African population and success in stock farming made the region an economic growth point.

The core of the labor force on most settler farms up to the early nineteenth century, especially in the more productive and densely populated areas of the south-western Cape, was made up of slaves imported from the East. But the early decades of the nineteenth century saw a steady trend away from slavery, as wage labor became increasingly prevalent with the employment of the indigenous Khoesan in the frontier regions of the Colony (Newton-King, 1999). Ross (1986) suggests that during this period the slavery system was operated in an increasingly commercialized and capitalist environment and the indigenous Khoesan, who had been much reduced in number since European settlement, had been "sufficiently proletarianized" to form the basis of what would become a wage labor force. The abolition of slavery in 1834 is often cited as one of the causes of the organized mass migration into the South African interior by frontier settlers, known as *voortrekkers*, who had become dissatisfied with British rule. It was these *trekboers* who would establish the two Boer Republics, the Transvaal (1852) and the Orange Free State (1854), beyond the northern borders of the British Cape Colony.

Stagnation (1835–1867)

In the late 1830s, following Britain's loss of its American colonies, a new policy of free trade was gradually coming into effect. Although this policy did not prevent the Cape from trading with other countries, it had a system of preferential duties for the protection of British trade and shipping. By this time, Cape Town was home to some 70 manufacturing concerns, including 15 brickfields, 9 fish-curing firms, 7 steam flour mills, 6 soap and candle factories, 6 snuff mills, and 5 iron and brass foundries. Nearly all the districts of the Colony had some enterprises turning out either agricultural products or manufactures to supply local needs, such as wagon building, furniture making, brick making and stone quarrying (Lumby, 1983).

But the early years of the 1860s saw a period of economic recession in South Africa. Many feared that the opening of the Suez Canal would substantially reduce the profits of international trade at the Cape. In addition, the international price of wool, the Colony's only export of real significance, had dropped dramatically after the end of the American civil war (Goodfellow, 1931). The poor economic outlook was compounded by a severe drought which affected large parts of the country (Nattrass, 1981). According to the census of 1865, the economy was still predominantly agricultural. Of the total working population, only 8.5% were employed in manufacturing and 4.4% in commerce, as opposed to 55% in agriculture.

By the mid-nineteenth century, the necessary market, skill and capital were not yet available for industrialization to truly begin, but Ross (1986) maintains that Cape agriculture, in most parts of the rural areas dominated by settlers, could be characterized as "capitalist" well before the mineral discoveries that were to transform the political economy of the country. Agricultural production throughout the Cape Colony, and to a lesser extent in Natal, a British colony on the east coast of South Africa, and the southern Orange Free State, was largely geared to the market, and indeed to export trade. Substantial amounts of credit were available for agricultural investments, first through merchant firms and wealthier families (Swanepoel and Fourie, 2015) and later through the country banks that were established throughout the territory.

Morris (1976, p. 283), in contrast, has argued that when capitalist mining was introduced in the late nineteenth century, "although a rudimentary exchange economy existed, [with] quasi-feudal peasant relations as the principal means of extracting a surplus in the absence of a strong capitalist farming class, the dominant mode of production in agriculture was not yet capitalist". This may well have been the case for the Transvaal and the northern Orange Free State, which were the backwaters of colonial South Africa before 1870 and had in common a tendency to accumulate land and exercise patronage as a means to higher social status. The manufacturing industry before 1886 in the Transvaal remained small and inefficient because the huge distances between the farms made specialization and commercial trade impractical (Goodfellow, 1931).

Diamonds (1868–1886)

Mineral discoveries marked the beginning of the industrialization of South Africa's agrarian economy. The first discoveries came from the copper mines of Okiep in Namaqualand in 1852 (Webb, 1983), but it was diamonds and later gold that sparked the rapid transformation of the

economy. The first parcel of diamonds was sent to Europe in 1867 and the goldfields of the Witwatersrand were proclaimed in 1886.[4] These discoveries led to the creation of industries directly related to mining, such as those for producing explosives and cement, and to the establishment of certain branches of engineering (Lumby, 1983). Within a year of the 1867 discovery of diamonds in Kimberly there was a burgeoning market not only for labor but for every necessity and convenience of life to support the town's growing population.

While the agricultural sector was slow at first in gearing itself to meet the new demand, there were new opportunities for individuals to profit from. A good living could be made for instance by providing ox-wagon transport (Webb, 1983). Indeed, before the railway link connecting Cape Town and Kimberley was completed in 1885 there was no alternative to ox-wagons for transporting equipment and materials to and from the mines, a journey which could take weeks to complete (Gilbert, 1933).

More recent scholarship suggests that the completion of the railway link had important implications not only for the expansion of the interior economy but also for South Africa's ability to compete internationally. Using agricultural prices, Boshoff and Fourie (2016), show that South Africa's integration into the global market had already begun in the 1870s, with local wheat prices beginning to follow international trends. Herranz-Loncán and Fourie (2016) add to this by showing that the railway was responsible for at least half of the increase in labor productivity between 1873 and 1905.

Gold (1887–1909)

Following the discovery of the main Witwatersrand reef in 1886, South African gold mining expanded rapidly. Noted South African historian C.W. de Kiewiet once remarked that: "From 1886 the story of South Africa is the story of gold" (Ally, 1994, p. 1). As early as 1888 there were already 44 gold-producing companies and output increased by 4,000% between 1886 and 1889 (Gilbert, 1933). Breakthroughs continued to be made as new depths were reached with improved machinery and new mining technologies. The completion of a second rail link from the Cape to the Transvaal and thereafter to Delagoa Bay (modern-day Maputo in Mozambique) brought more prosperity. The railways provided a market for coal and a demand for electricity and steel and integrated the regional economies, centering on the Witwatersrand (Illife, 1999).

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[4] For a more detailed analysis of the effects of diamond discoveries on the South African economy, see Worger (1987), and for gold, see Gilbert (1933), Katzen (1964) and Webb (1983).

The remaining years of the nineteenth century, however, saw little expansion in general manufacturing, arguably as a result of the absorption of available capital and labor into the mining sector, coupled with a geographically dispersed population and a lack of markets, which made large-scale manufacturing impossible (Lumby, 1983). By 1896 the economy was in recession and this would continue to the end of the century.

Gold output increased steadily during the last few years of the nineteenth century, but the Second South African War (the Second Anglo-Boer War) halted nearly all mining until 1902. A short-lived post-war boom was followed after 1903 by several years of slow growth and even recession, due largely to the scarcity of mining labor (Gilbert, 1933, p. 560). Despite the war, however, the manufacturing sector grew. From 1890 to 1910 the number of factories increased from 550 to 1,500, and in 1911 the total gross manufacturing output was valued at £17 million (Lumby, 1983, p. 199).

In sum, diamonds at Kimberley and gold on the Witwatersrand transformed the economy in the space of 50 years. The period 1868–1910 saw the country evolve from almost total dependence on agriculture into a modern economy based on a highly profitable mining industry and supported by an infant manufacturing sector and growing commercial and service industries (Nattrass, 1981).[5] This is also reflected in the rudimentary estimates of gross domestic product that are available for the Cape Colony: in the sixty years between 1806 and 1865, Fourie and Van Zanden (2013) estimate a decline in GDP per capita. In the thirty years following the discovery of diamonds (1867–1896), they estimate an increase in GDP per capita of 1.9% per annum.

Constructing the sample

We use a sample of males from the South African Families (SAF) database (Genealogical Institute of South Africa, 2014). The SAF was compiled over several decades by amateur and professional genealogists who relied predominantly on church baptism and marriage records, and civil birth, baptism and death records.[6] This was made easier by the fact that almost all Afrikaner settlers, as the agglomeration of settlers from Dutch, German, French and scattering of other nationalities became known, belonged to the Dutch Reformed Church, at least during the first century of settlement.

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[5] For more detail on South Africa's industrialization, see Illife (1999) and Verhoef (1998).
[6] A full account of the digitization of the data is provided in Cilliers (2016).

The Genealogical Institute of South Africa now maintains the SAF database, expanding it into the twentieth century and making corrections to earlier entries as new information becomes available from probate inventories and tax censuses. Each individual in the database is given a unique genealogical reference code – CILLIERSa1b3c1d4, for example, would be the fourth child (d4) of c1, who was the first child of b3, who was the third child of the first arriver with the surname Cilliers. This allows us to match children, both male and female, to their parents. Our study, however, uses only men, because married women rarely had an occupation recorded for much of the period analyzed.

The database we use contains complete family registers of all settler families and their descendants until 1910 and provides information on demographic events for family members. It must be noted that the genealogies that make up the SAF database are limited to families of European (or white) origin only; black, colored and Indian population groups of South Africa are not recorded in these registers.[7] How this selection affects our results is discussed below.

The common problems associated with the use of genealogical data in demographic research are well documented (Hollingsworth, 1969; Willigan & Lynch, 1982; Zhoa, 2001). Records of this kind are often biased towards the fertile, the marriageable and families who experienced favorable demographic conditions (Zhoa, 2011, p. 181). Partial or incomplete data on individuals is a particular concern when working with genealogical data (Willigan & Lynch 1982, p. 116).While the size and scope of SAF are its greatest advantage, not all entries contain complete information, with many being empty save for a name and surname. Close to two thirds of entries contain a birth or a baptism date, while only one quarter contains a death date, and one tenth list an occupation. As our interest is in intergenerational status attainment, we need to know the occupation of an individual and his father in order for the pair to be selected into the sample.

If there is a systematic relationship between occupational attainment and the likelihood that an individual's information is incomplete, this will introduce additional bias to the study. Such a concern is especially warranted with regard to the under-recording of occupations in the SAF registers since this is the only economic outcome available in the database. We do not, however, believe that such a systematic bias is likely since the data are based on sources that were very similar across time: birth, marriage and death records. After removing individuals whose data

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[7] However, several of these "European" lineages are reported to have slave or Khoisan ancestors. See Heese (2013).

are partial or incomplete we are left with a sample of 9,494 father-son pairs with complete occupation and birth date information during the period of interest.

Occupations are grouped into four categories: white-collar, farmer, skilled and semi-skilled, and unskilled.[8] We chose not to impose any order on these categories as sufficient data on incomes are not available for this period. We also chose not to impute occupational wages to avoid the introduction of additional measurement error and biases. Doing so would also not solve the problem of within-group variation of the farmers.

One difficulty we encountered when attempting to determine the representativeness of the SAF database was finding sufficient evidence against which to compare it. The only available population figures are those reported in the Blue Books for the Cape of Good Hope, for the years 1845, 1865, 1875, 1891, and the Census of the Union of South Africa for 1911. The Blue Books provide a crude gauge of the share of individuals employed in different sectors of the economy, but they apply only to the Cape Colony and not the country as a whole. It was also difficult to compare the sample with these censuses accurately for any occupational category other than farmers because these categories changed over time and it is not possible in some instances to identify which occupations made up certain categories.

Fortunately the category "agriculture", defined in the census as "persons engaged in agricultural employment: possessing, working, or cultivating land, or raising and dealing in livestock", is reported consistently over time. We can therefore compare this group directly with the "farmers" group in our sample if we restrict the sample to father-son pairs who lived in the Cape Colony and not in other parts of the country. The 1845 census of the Cape of Good Hope offers only a rough estimate of the number of persons engaged in agriculture, reported as two thirds of the European working-age population. Later censuses are slightly more reliable. According to those for 1865 and 1875, the economy was still predominantly agricultural. Of the total working population of European men, 55% and 54% were employed in agriculture for those two years respectively. By 1911, this figure had fallen to 46%. These

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[8] We follow the same categorization as Ferrie (2005), Bourdieu (2009) and Long and Ferrie (2013) to allow for comparison of our results. Occupations were also coded into the Historical International Standard Classification of Occupations (HISCO) (Van Leeuwen et al., 2002) and then classified according to the Historical International Social Class Scheme (HISCLASS) (Van Leeuven and Maas, 2011). Although this classification was initially developed for Europe, it has been applied in other colonial settings as well (Meier zu Selhausen 2014). The twelve HISCLASS groups were re-categorized into five broad skill classes: professionals, skilled and semi-skilled workers, medium skilled workers, farmers and fishermen, and low and unskilled workers. Choice of classification scheme, however, did not systematically alter our results.

figures appear to be in line with the proportions of farmers reported in the SAF sample for the four periods under observation (see Table 1).

Table 1
European or white males in working-age population with specified occupations employed in agriculture

Period (Cape Colony)	SAF (Cape Colony) sample	Cape of Good Hope	
		census year	census estimate
1806–1834	67%	n/a	n/a
1835–1867	61%	1845	67%
1868–1886	56%	1875	54%
1887–1909	51%	1911	46%

The occupational structure for the rest of the country is only available in the 1911 census and although this falls at the end of our period of interest, we conduct a comparison against these figures in order to judge the representativeness of the full SAF sample for at least a single point in time. The estimates in Table 2 make us confident that the structure of the labor market as represented in the SAF data for the whole country is a good reflection of the entire white population[9].

Table 2
Proportion of European or white males in working age population with specified occupations, by skill group

	Census of the Union of South Africa 1911	SAF sample 1887–1909
White collar	29.3%	34.8%
Farmer	47.8%	49.7%
Skilled/semi-skilled	19.0%	12.5%
Unskilled	3.8%	3.0%
Total (%)	100%	100%

Our concern, though, is that by focusing the analysis on whites only, we may over- or under-estimate the extent of mobility across all population groups. Table 3 provides a breakdown, by race, of the number and proportion in each of our four occupational classifications. By 1911, at the end of our period, non-white males were still predominantly employed in subsistence agriculture (80% of all farmers) or unskilled (mining) labor (87.5% of all unskilled labor). This

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[9] A further limitation is that the data do not follow individuals who emigrated from South Africa. The socio-economic mobility of these geographically mobile individuals may have differed from those who remained behind, and ought therefore to be considered separately.

suggests that most of the mobility they would have experienced would have been limited to moving out of farming and into unskilled labor. Upward mobility of black, colored and Indian males, because of segregation, job reservation and other discriminatory policies, was severely suppressed.

Table 3
Structure of the labor market by race according to the Census of the Union of South Africa, 1911

	European/white working age males	Non-European working age males	Total population of working age males
White collar	70.7%	29.3%	100%
	144 648	59 975	204 623
Farmer	20.6%	79.4%	100%
	236 057	912 152	1 148 209
Skilled/semi-skilled	52.7%	47.3%	100%
	93 945	84 346	178 291
Unskilled	12.5%	87.5%	100%
	18 912	132 802	151 714
Total	29.3%	70.7%	100%
Total (n)	493 562	1 189 275	1 682 837

The sample sizes for all occupational groups according to period are shown in Table 4. We see overall growth in the size of the white-collar group matched by a reduction in the size of the farming class over time, gradually at first, from roughly two thirds of the sample in the "Slavery" period to around half in the "Gold" period. The unskilled class unsurprisingly makes up only a small proportion of the labor market for whites, as these positions were generally filled by other race groups.

Even so, we see a reduction in the size of this group over time. This is possibly an indication of the upward occupational mobility that would have taken place as a result of the changing structure of the labor market. Although we do not rank the occupational groups, we use the term "upward" mobility here since a movement from the unskilled into any of the other categories almost certainly constituted an improvement in socio-economic status.

In some cases several occupations were recorded for an individual throughout his life but no dates or ages were associated with these entries. Occupations are, however, listed chronologically, so it is possible to distinguish between the different occupations an individual may have held over his working life, but not to assign occupational attainment to a specific

time in an individual's life (for example, between the ages of 25 and 45, as is typically the case).

Table 4
Size of occupational groups by period (percentages)

	Slavery 1806–1834	Stagnation 1835–1867	Diamonds 1868–1886	Gold 1887–1909	Overall change in proportion*
White collar	17.2	20.6	26.6	34.8	17.6
Famer	64.6	61.7	60.2	49.7	-14.9
Skilled/semi-skilled	9.9	8.1	9.0	12.5	2.6
Unskilled	8.3	9.6	4.2	3.0	-5.3
Total	100.0	100.0	100.0	100.0	
Cohort size	1,289	3,181	2,293	2,731	9,494

*Positive values indicate that the class grew.

To discover whether any life-cycle effects are likely to confound the results, we compare individuals' first and last occupations (Table 5). We observe a small degree of intra-generational mobility: a slightly larger proportion of individuals start their careers as farmers than end up as farmers. To avoid ranking lifetime occupational attainment we have chosen to focus simply on the last occupation held by an individual.[10]

Table 5
Intra-generational occupational mobility (percentages)

	Percentage of the sample	
	First occupation	Last occupation
White collar	22.1	25.7
Farmers	68.7	58.3
Skilled/Semi-skilled	7.6	9.8
Unskilled	1.7	6.2
Total	100.0	100.0
N	9,494	9.494

The method of measurement

Studies of intergenerational occupational mobility, usually calculated between fathers and sons, use the increased probability of moving from one discrete occupational category to another as evidence of increased social mobility. To get an accurate picture of intergenerational

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[10] It should be noted that the use of fathers' and sons' first occupations, or the combination of the father's last occupation and son's first occupation, did not significantly alter the results.

mobility across different periods we must compare contingency tables which contain the occupations of sons relative to their fathers for each of the four periods, with each period containing a different sample of father-son pairs. While this comparison reveals how much mobility actually occurred between successive generations, it cannot answer two other important questions: how much mobility would have occurred if the distribution of occupations remained the same across time, and how strong is the overall relationship between fathers' and sons' occupations?

To answer the first question, Altham and Ferrie (2007) suggest adjusting the marginal frequencies of one table to match those of another. To answer the second, they suggest adopting a summary measure of overall mobility and a measure of how mobility differs across two tables. The cross-product ratio for a two-dimensional table, or a function of multiple cross-product ratios in a table of more than two rows or columns, is the measure of association in the table, and this measure is invariant to the multiplication of entire rows or columns by arbitrary constants. This allows us to multiply the rows and columns of a table by arbitrary constants without altering the underlying association between rows and columns in the table. Deming and Stephan (1940) showed how this mechanism could be adapted for tables with more than two rows and columns, and the Deming and Stephan algorithm can easily be applied to each cohort so that each subsequent period will have the occupational structure of the earliest period imposed on it. Any mobility observed in the subsequent periods can only be the result of differences in relative mobility.

Even after adjusting the marginal frequencies and finding (theoretically) that the difference between two periods is 0, there may still be differences in mobility between two tables. For a table with more than two rows or columns, there will be many cross-product ratios, so a summary measure of association is needed to take account of all of them. The Altham statistic is one such measure[11] (Altham, 1970; Altham and Ferrie 2007).

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[11] The Altham statistic is equal to the sum of the squares of the difference between the logs of the cross-product ratios in tables P and Q. It ranges from zero (in which case the association between rows and columns is identical in the two tables) to ∞, and is given by:

$$d(P,Q) = \left\{ \sum_{i=1}^{r} \sum_{j=1}^{s} \sum_{l=1}^{r} \sum_{m=1}^{s} |\log[(p_{ij} p_{lm} q_{im} q_{lj})/ (p_{im} p_{lj} q_{ij} q_{lm})]|^2 \right\}^{1/2}$$

Our full empirical analysis that follows is carried out in four steps: absolute mobility is calculated using discrete category contingency tables; relative mobility is distinguished from absolute mobility by adjusting the marginal frequencies of the tables to see how much mobility would have occurred if the distribution of occupations remained the same over time; Altham statistics are calculated to measure the strength of the overall relationship between fathers' and sons' occupations; and binomial logistic regressions are performed to allow for the inclusion of additional control variables.

Analysis of intergenerational mobility in nineteenth-century South Africa

Table 6 shows the 4 by 4 contingency tables for each period. In the "Slavery" cohort, a surprising 78% of sons of farmers are farmers themselves. Immobility amongst sons of farmers decreased by 13% over the entire period in absolute terms, with over a third of the sons of farmers ending up in occupations different from those of their fathers. This is, however, perhaps not as large a difference as we would expect given the transformation that was going on in the economy.

For sons of white-collar worker, immobility increased by 20% over the period in absolute terms. By the "Gold" period less than a third of sons of white-collar workers had moved into occupations different from those of their fathers and a mere 1% of these ended up in the unskilled class. Our results show that those who stood to increase their chances of mobility most dramatically over time were the sons of skilled and semi-skilled workers, with 47% being employed as white-collar workers by the "Gold" period. Sons of unskilled workers also experienced increased upward mobility, with 13% more being employed as white-collar workers in the "Gold" than in the "Slavery" period.

Only part of these changes can be attributed to a shift in the structure of the labor market making new high-skilled jobs available. The other part of the changes is unrelated to the structural change. In Table 7 we again compare mobility over time, but now holding the occupational structure of the society constant. Overall relative mobility does not increase dramatically over this period. In fact, we see sons of farmers experiencing virtually no improvements in relative mobility throughout the four periods. Within the farming community, it seems that ascription by birth trumped personal achievement, possibly because of the importance of social networks, but much more probably because of land ownership. The possession of physical capital in the form of land may have been far more important than human capital.

Table 6

Absolute intergenerational mobility, summarized by birth cohort (percentages)

Slavery 1806–1834	Son's occupation				
Father's occupation	White collar	Farmers	Skilled/semi-skilled	Unskilled	Row total (n)
White collar	47.3	36.2	10.7	5.8	224
Farmers	9.1	78.1	5.9	6.9	869
Skilled/semi-skilled	22.6	29.3	39.6	8.5	106
Unskilled	14.4	46.7	11.1	27.8	90
Column total	17.2	64.6	9.9	8.3	1,289

Stagnation 1835–1867	Son's occupation				
Father's occupation	White collar	Farmers	Skilled/semi-skilled	Unskilled	Row total (n)
White collar	57.2	30.9	8.1	3.9	570
Farmers	10.7	76.9	4.7	7.7	1,939
Skilled/semi-skilled	25.5	36.9	30.9	6.7	314
Unskilled	11.7	50.6	6.4	31.3	358
Column total	20.6	61.7	8.1	9.6	3,181

Diamonds 1868–1886	Son's occupation				
Father's occupation	White collar	Farmers	Skilled/semi-skilled	Unskilled	Row total (n)
White collar	55.7	32.5	10.0	1.8	499
Farmers	15.6	75.2	5.6	3.6	1,389
Skilled/semi-skilled	38.8	29.0	29.5	2.7	183
Unskilled	19.8	54.5	11.3	14.4	222
Column total	26.6	60.2	9.0	4.2	2,293

Gold 1887–1910	Son's occupation				
Father's occupation	White collar	Farmers	Skilled/semi-skilled	Unskilled	Row total (n)
White collar	67.9	18.1	12.7	1.3	598
Farmers	22.6	65.1	9.5	2.9	1,756
Skilled/semi-skilled	46.9	17.4	34.8	0.9	224
Unskilled	27.5	44.4	13.1	15.0	153
Column total	34.8	49.7	12.5	3.0	2,731

Table 7
Relative intergenerational mobility, summarized by birth cohort (percentages)
Marginal frequencies adjusted to match first birth cohort

Slavery 1806–1834	Son's occupation				
Father's occupation	White collar	Farmers	Skilled/semi-skilled	Unskilled	Row total (n)
White collar	47.3	36.2	10.7	5.8	224
Farmers	9.1	78.1	5.9	6.9	869
Skilled/semi-skilled	22.6	29.2	39.6	8.5	106
Unskilled	14.4	46.7	11.1	27.8	90
Column total %	17.2	64.6	9.9	8.3	1,289

Stagnation 1835–1867	Son's occupation				
Father's occupation	White collar	Farmers	Skilled/semi-skilled	Unskilled	Row total (n)
White collar	51.2	33.5	11.3	4.0	224
Farmers	8.9	77.6	6.2	7.4	869
Skilled/semi-skilled	20.2	35.5	38.2	6.1	106
Unskilled	9.8	51.4	8.4	30.4	90
Column total %	17.2	64.6	9.9	8.3	1,289

Diamonds 1868–1886	Son's occupation				
Father's occupation	White collar	Farmers	Skilled/semi-skilled	Unskilled	Row total (n)
White collar	42.9	39.7	12.8	4.5	224
Farmers	10.0	76.5	6.0	7.5	869
Skilled/semi-skilled	27.1	32.2	34.4	6.3	106
Unskilled	11.5	50.2	10.9	27.5	90
Column total %	17.2	64.6	9.9	8.3	1,289

Gold 1887-1910	Son's occupation				
Father's occupation	White collar	Farmers	Skilled/semi-skilled	Unskilled	Row total (n)
White collar	45.5	35.6	13.5	5.4	224
Farmers	9.2	77.7	6.1	7.0	870
Skilled/semi-skilled	29.5	32.2	34.8	3.4	106
Unskilled	10.1	48.2	7.7	34.1	90
Column total %	17.2	64.6	9.9	8.3	1,289

Those born into the farming class were on the one hand fortunate because they were saved from joining the ranks of wage laborers, but unfortunate on the other because they were deterred from seeking to improve their lot. But variation in income and wealth within occupations, particularly within the farming class, is likely to have been quite large (Giliomee 1987), so in the absence of occupational mobility there may still have been substantial income or wealth mobility. There were certainly great differences in how much land farmers owned. Some were able to accumulate large stretches of land and, with it, influence and patronage. Others owned only small subdivisions of farms that by themselves were insufficient to ensure families their independence. The situation of farmers in those days is well described by Keegan (1987, p. 20):

> By no means were all Boers landowners in the nineteenth century, or wished to be given the fluidity of the pastoral and hunting economy. Non-landownership was not necessarily an economically disadvantageous condition while the Boer economy required and allowed great mobility and an ill-defined sense of proprietary right. Land was always a highly desirable commodity in speculative terms, and land accumulation was a road to status and office in the Boer state, but absentee proprietorship was extensive, farms were ill-defined and un-surveyed, and fencing was non-existent before the final decade or two of the nineteenth century. Non-landownership did not initially entail any disabling economic disadvantages. It was only later – towards the end of the century – that landlessness became a decisive determining factor in the process of class differentiation in Boer society.

The small changes in relative mobility we find seem to be driven by sons of semi-skilled workers. Barriers to entry into white-collar positions, which required formal training or schooling, must therefore have been low for individuals from semi-skilled class origins. This is characteristic of an attainment system based on achievement, where employers were recruiting people for these positions on the basis of merit. Semi-skilled workers, on the other hand, presumably began to invest in the education of their children, enabling them to take advantage of opportunities for upward mobility.

The growth of the professional sector meant that formal education became increasingly important for status attainment as compared with transfer of parents' status or resources (Treiman, 1970). The expansion of public education meant that skills could be acquired through formal schooling. Adult literacy, however, was fairly low in the Cape throughout the century:

by 1860 only two thirds of the white population was literate. The Department of Education introduced a number of policies during the 1870s and 1880s to increase white children's access to education, but standards of education remained low and schools were poorly attended. By 1878 more than half of the Colony's white children were still not attending school. Those who did receive a formal education would probably have come from the urban middle class. The situation is explained by Duff (2011, p. 267):

> The Cape's system of education did not cater to the needs or lifestyle of a rural population, which was poor, widely scattered, frequently nomadic, and occasionally suspicious of the motives of the colonial government. This education system was designed to suit a relatively affluent population which was settled for long periods of time, in or near urban centers. This was a model suited for middle-class living – to middle-class parents who were deferential to the authority of civil servants, and who saw the education of their children, and particularly their sons, as absolutely crucial for preparing them for middle-class occupations.

Members of the lowest classes of society rarely had access to this type of formal education and barely literate parents were unlikely to send their children to school (Duff, 2011, p. 266). This is even more likely to have been the case in the two Boer Republics, which had more rural populations. These arguments are supported by our finding that the prospects for upward mobility for sons of unskilled laborers actually declined over time in relative terms. Although this was a fairly small group, low-skilled and unskilled white laborers were essentially excluded from the general increase in mobility opportunities that existed for other members of white society.

It is thus not surprising that a class of "poor whites" emerged during the last decade of the nineteenth century. Our results support an older historiography that points to the emergence of the "poor white problem" around this time (De Kock, 1924; Grosskopf, 1932; Fourie 2007), even though these same individuals had perhaps previously been "hidden" as unskilled laborers in rural towns or on farms (Bundy, 1984). The rise of larger urban industrial areas made poverty more visible, as the industrial revolution in England had done a century earlier.

The next step of our analysis was to calculate Altham statistics to determine how strong the overall relationship was between fathers' and sons' occupations. The results are shown in Table 8. For simplicity we split the periods into "before 1868" and "after 1868". For both periods we

reject the null hypothesis that the occupations of fathers and sons are independent. We also reject the null hypothesis that the relationship between fathers' and sons' occupations is identical. The relationship between fathers' and sons' occupations in the period after 1868 (Q) is marginally closer to independence than before 1868 (P), which means that the period after 1868 saw greater relative mobility in occupations across generations than the period preceding it, but the magnitude of this difference is fairly low.[12] The last statistic, d^i(P, Q), tests the difference between the two tables but now considering mobility off the diagonal. The result is not statistically significant, implying that we cannot reject the null hypothesis of no difference between before 1868 and after 1868 when only considering cells off the diagonal.

Table 8
Altham statistics

	d(P, I)	d(Q, I)	d(P, Q)	d^i(P, Q)
Before 1868 (P) compared with after 1868 (Q)	19.20***	18.78***	3.70*	2.39

*** p<0.01, ** p<0.05, * p<0.1

Are these results being driven by the changing size of the farming class over this period? To determine the amount of mobility after eliminating the effect of selective mobility in and out of farming, we re-estimate Altham statistics and exclude the farming class. If we ignore mobility in and out of farming, the differences in mobility still go in the same direction, though the magnitude of the difference is smaller: d(P, I) = 13,92***, d(Q, I) = 10,57***, d(P, Q) = 2,37*.

An alternative way to measure relative mobility that allows for the inclusion of additional control variables is to run a binary logistic regression model with the estimated parameters being presented as odds ratios or relative risks. Mobility and no mobility are competing outcomes in the model. Controls are included for period of birth and we are able to distinguish relative from absolute mobility by including a variable measuring the relative size of the origin class. This variable measures the share of the population that was observed in the individual's origin class (i.e. his father's occupational class). Originating from a large or growing class is expected to lower the chances of ending up in a different class, because of the larger number of opportunities in the origin class. Table 9 shows the results of the models, which further ratify

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[12] When five occupational categories are used rather than four, the results are: d(**P, I**) = 33.83***, d(**Q, I**) = 33.96***, **d(P, Q)** = 13.19***, d^i(**P, Q**) = 12.54***.

our discrete table and Altham statistic results. They confirm the increasing absolute and relative mobility over time, becoming statistically significant for sons born after 1868 (the start of the mineral revolution).

The binary logistic regressions also provide information about the individuals most likely to benefit from the mineral revolution. We include some additional explanatory variables: a migrant status dummy taking the value of 1 if the father is a first-generation immigrant (migrant fathers are the reference group) and a sibling rank dummy, taking the value of 1 if the son was first-born (first-born sons are the reference group). The coefficient on migrant status is large, positive and significant in all specifications. This implies that the sons of immigrants were more likely to experience social mobility during the mineral revolution than their white compatriots, who had been in the country longer. There are various possible reasons for this. Immigrants may have been better educated and thus able to take advantage of the demand for skilled positions opening up in and around the mines. They may have had more access to capital through links to bigger cities. They may have had wider social networks. And non-immigrants may have owned assets that delayed their transition into other occupations, as in the case of farmers' career opportunities being limited by land ownership.

To test whether first-born sons, who may have been more likely to inherit land, were less likely to move up in society, we look to our sibling variable. The results are insignificant: we found that later-born sons were neither more nor less likely to be socially mobile than first-born sons. The partible inheritance system, in which the spouse of the deceased inherited half of the estate and the children split the other half, may explain this result. Sons of farmers were likely to stay on farms whatever their rank in the family.

To test for regional effects we include a categorical variable for son's birth province which distinguishes the Cape Colony from the interior Boer republics of the Orange Free State and the Transvaal and the coastal English colony of Natal. We acknowledge that there is a high likelihood that genealogical information was less thoroughly recorded in some parts of these frontier districts, which may introduce sample selection bias into our analysis. But the results nicely illustrate the effects of the resource boom – even considering the fact that we only include whites. Those in the immediate vicinity of the diamond mines in Kimberly seemed to benefit the most in terms of increased mobility, while those further afield appeared to be largely unaffected.

Finally, we include dummies for settler heritage. This variable is constructed entirely on the basis of the origin of the individual's surname. Individuals with Huguenot surnames, for example, are classified as French, even if their ancestors arrived in South Africa four or five generations earlier, in other words more than a century earlier. Those with Dutch surnames (the largest group) are the reference group. We find that with the exception of the French, all other origin groups experienced more absolute mobility than the Dutch. Considering that the Huguenots had completely inter-married with Dutch settlers within two generations after their first arrival, the lack of difference between these groups is unsurprising. Further, a simple cross-tabulation of origin country and occupational group reveals that Dutch and French individuals dominated the farming class, which we have demonstrated to be the least mobile.

Table 9

Binary logistic regression with origin country and provincial dummies.
No mobility as base outcome. Estimates expressed as relative risks

	Model 1	Model 2	Model 3
Period (Slavery ref.)	1.000	1.000	1.000
Stagnation	1.108	0.963	1.009
Diamonds	1.220***	1.119	1.156*
Gold	1.297***	1.298***	1.303***
Migrant status (Migrant father ref.)	1.497***	1.014	1.015
Origin country (Netherlands ref.)	1.000	1.000	1.000
France	1.018	1.107	1.101
Germany	1.169*	1.385***	1.392***
UK	1.449***	1.098	1.099
Other west Europe	1.344***	1.067	1.067
Other east Europe	1.494*	1.34	1.344
Sib rank (First born son ref.)	1.031	1.077	1.080
Province (Cape ref.)	1.000	1.000	1.000
Natal	1.046	1.243	1.240
OFS	1.229***	1.101	1.098
Transvaal	1.013	1.084	1.080
Father's class (White collar ref.)		1.000	1.000
Farmer		0.532***	0.444***
Skilled/semi-skilled		3.084***	2.202***
Unskilled		4.949***	4.591***
Origin class size			1.033**
Pseudo R2	0.009	0.095	0.096
Prob>chi2	0.000	0.000	0.000
Observations	9,494	9,494	9,494

*** p<0.01, ** p<0.05, * p<0.1

Comparison of our results with other regions

Studies comparing occupational mobility across the industrial societies of various Western countries have found mixed results, with early studies, notably Lipzet and Zetterberg (1959) and Erikson and Goldthorpe (1992), finding no real difference in mobility across countries (see Van Leeuwen, 2010 for a review). Ganzeboom et al. (1989) conclude the opposite, finding substantial differences in relative mobility between countries. More recent work by Long and Ferrie (2013) compares intergenerational occupational mobility in Britain and the United States and also find significant differences, even after accounting for differences in these countries' occupational structures during the second half of the nineteenth and the first half of the twentieth century. For the nineteenth century, the United States was found to be more mobile than Britain but by the second half of the twentieth century had lost its mobility advantage. They attribute these differences to the difference in economic development between the two countries, which had disappeared by the second half of the twentieth century.

Bourdieu et al. (2009, p. 526), in a similar analysis comparing France and the United States, also find significantly higher mobility rates for the United States during the mid-nineteenth century. This they suggest, could be attributed to the differences in political systems, movement of wealth from one generation to the next, the composition of the population, and willingness to invest publicly in education.

The complex nature of intergenerational occupational mobility during periods of rapid economic change, coupled with often inadequate data, makes comparisons of this kind somewhat problematic. Both the Long and Ferrie and Bourdieu *et al.* studies use samples of linked census data, and have recently come under fire for the accuracy with which they are able to match individuals across time and space (Eriksson, 2016).

We nevertheless compare our estimates of social mobility for white males in South Africa with those of the United States, Britain and France. Table 10 shows that both the United States and France experienced higher rates of mobility than South African white males during the second half of the nineteenth century.[13] Interestingly, South African white males appear to have had similar levels of mobility to white males in Britain, which was already fully industrialized by 1851.

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[13] The US (1880–1910) is only more mobile than SA when considering considering mobility off the diagonal.

Table 10

Altham statistics compared across regions

	d(P, I)	d(Q, I)	d(P, Q)	d^i(P, Q)
SA 1868–1886 (P) compared with US 1850-1880 (Q)	17.63***	11.91***	8.69***	6.00**
SA 1868–1886 (P) compared with Britain 1851-1881 (Q)	17.63***	22.71***	12.28	4.49
Britain (P) 1851–1881 compared with US 1850-1880 (Q)	22.71***	11.91***	13.24***	4.50
SA 1887–1910 (P) compared with US 1880-1910 (Q)	20.81***	14.04***	13.94	6.28***
SA 1887–1910 (P) compared with France 1875-1905 (Q)	20.81***	15.59***	11.78***	7.31**
France 1875–1905 (P) compared with US 1880-1910 (Q)	15.59***	14.04***	4.38*	2.57

*** p<0.01, ** p<0.05, * p<0.1
Data for Britain and US taken from Long and Ferrie (2013), data for France and US taken from Bourdieu et al., (2009)

Conclusions

In this study we investigated absolute and relative social mobility during the early phase of South Africa's transition from an agricultural to industrialized society. To do this we employed several methods in order to provide a comprehensive account of intergenerational social mobility and class attainment during South Africa's nineteenth century.

We found increasing upward social mobility for white males over time, becoming significant after 1868, the beginning of the mineral revolution. Consistent with the qualitative evidence of a shift away from agriculture as the dominant sector in the economy, the results showed a general shrinking of the farming class and concomitantly an expansion of the skilled and professional class.

Sons of farmers, however, experienced virtually no improvements in mobility over time, net of these structural changes in the labor market. This is not entirely surprising given the value of the productive land which they would not have parted with easily. It is difficult to imagine that the son of a farmer, who stood to inherit at least some portion of his father's land, would seek out a formal education in order to pursue a career as a doctor or lawyer. Rather, it was the declining role of agriculture in the economy that obliged some sons of farmers to take up new occupations.

Whereas almost all of the mobility for sons of farmers was as a result of the structural changes in the labor market, much of the mobility for the sons of skilled and semi-skilled workers was net of these changes. Sons of skilled and semi-skilled workers were able to substantially improve their occupational status compared with that of their fathers, as barriers to entry into the upper classes were low for this group.

We also investigated possible explanations for these heterogeneous effects. In absolute terms, location seemed to matter. Residents of regions closer to the diamond mines, notably those in the Orange Free State, seemed to enjoy higher rates of mobility in absolute terms than the rest of the population. In relative terms, geographic variation did not appear to be a determinant of mobility.

Immigrant status is another important predictor of social mobility. Sons of immigrants were likely to experience higher rates of social mobility than sons of established fathers. There could be several reasons for this, such as lower levels of land ownership, higher levels of human capital and greater access to capital and networks. Looking for the precise reasons for this greater mobility of middle-class immigrants is a task for future research.

Finally, we acknowledge that this was only a study of *white* males. Mobility within the white population may, therefore, not only be an overestimation of mobility within the total population, but a consequence of the immobility of non-white labor. Although we can only speculate about what caused the social mobility of white males, the discriminatory and repressive policies of the late nineteenth and early twentieth centuries seem a plausible possibility to investigate in future.

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