



THE LAND-LABOUR HYPOTHESIS REVISED:  
WEALTH, LABOUR AND HOUSEHOLD COMPOSITION AT THE  
SOUTH AFRICAN FRONTIER

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# The land-labour hypothesis revised: Wealth, labour and household composition on the South

## African Frontier<sup>1</sup>

Jeanne Cilliers and Erik Green\*

### Abstract

Traditional frontier literature identifies a positive correlation between land availability and fertility. A common explanation is that the demand for children as labour is higher in newly established frontier regions compared to older and more densely populated farming regions. In this paper we contribute to the debate by analysing the relationship between household composition and land availability in a closing frontier region, i.e. the Graaff-Reinet district in South Africa's Cape Colony from 1800-28. We show that the number of children present in farming households increased with frontier closure, while the presence of non-family labourers decreased over time. We explain this by, differently from the frontier literature, acknowledging that the demand for family labour was not a function of its marginal productivity and that farmers reacted to differently to diminishing land availability depending on their wealth. Poorer households, which made up the majority of this frontier population, responded to shrinking land availability by employing relatively more family labour, while the wealthiest group underwent capital intensification.

Keywords: South Africa, household composition, agriculture, labour, pre-industrial

JEL Codes: J23, N37, N57

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In the 1960s and '70s, scholars found that the decline in fertility in the nineteenth-century Western world could not be fully understood without considering population dynamics in rural areas. The findings inspired a revision of the mechanisms of demographic transition, as previous research had largely focused on the channels of urbanization and industrialization.<sup>2</sup> Looking then to the fertility decline in nineteenth-century rural US, scholars found that fertility systematically varied with population densities. Fertility levels were on average higher in less densely populated frontier regions compared to the already established and more populous settler regions.<sup>3</sup> This pattern also been found in other parts of the world – past and present.<sup>4</sup>

While the positive correlation between land availability and fertility has received much empirical support, the transmission channels that explain this relationship have not yet been well-established. The most common explanation is the so-called land-labour hypothesis. There are two different versions of the hypothesis. One argues that the positive relationship between land availability and fertility is due to the lower relative costs of having children in frontier regions, and a second claims that the differences in fertility levels are caused by a higher demand for child labour in newly established and less densely populated frontier regions.<sup>5</sup>

In this paper we contribute to the debate by analyzing the relationship between land availability and the presence of children in settler farming households. Since we are interested in frontier dynamics, this paper will consider the settler population of the Graaff-Reinet district at

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<sup>2</sup> Davis, 'The world demographic transition'; Notestein, 'Population'.

<sup>3</sup> Yasuba, *Birth rates*; Easterlin, 'Population change'; Easterlin, 'Factors in the decline of farm family fertility'; Easterlin, Alter, and Conrad, 'Farms and farm families'; Mineau, Bean, and Anderton, 'Migration and fertility'.

<sup>4</sup> Doveri, 'Land, fertility, and family'; Carr, Pan, and Bilsborrow, 'Declining fertility on the frontier'.

<sup>5</sup> See McInnis, 'Childbearing and land availability' for an overview.

the eastern frontier in South Africa's Cape Colony from 1800-28. Different from previous studies, we consider the number of children present in a settler household in a given census year. We believe this to be a more accurate representation of the size of the annual family labour force, rather than children ever-born or completed fertility. Further, we relate the relative use of family and non-family labour to the real value of present household wealth in a given census year, rather than wealth at death, as is often the case with studies that rely on wills or probate inventories. This distinction is important because both fertility and wealth have clear lifecycle trends.

We combine two rich data sources: the Cape of Good Hope Panel (CGHP) and the South African Families database (SAF), which are both unique in their size and scope across time and space. The CGHP is an annual account of household production in colonial South Africa, covering the period 1673-1828, and the SAF register is a genealogical dataset of all settler families in South Africa, covering the period 1652-1910. The combination of these two sources provides the opportunity to model changing household composition over time.

Different from the traditional frontier literature, we find a negative correlation between land availability and family size when the frontier was closing, and call for a revision of the land-labour hypothesis. Data constraints prevent us from empirically identifying causation and we instead rely on theories of agrarian change to interpret our findings. We identify two shortcomings in previous research. Firstly, it fails to differentiate between family and non-family labour. The demand of the former is dependent on the marginal productivity of labour, while the latter is not.<sup>6</sup> The type of labour used, therefore, has a significant impact on how farmers react to shrinking land availability, and the demand for child labour requires a revision of the standard cost-benefit analysis employed by the proponents of the land-labour hypothesis.

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<sup>6</sup> Boserup, *The conditions of agricultural growth*; Huang, *The peasant family*.

Secondly, it treats the rural population as a homogenous group that responds to shrinking land availability in similar ways. We argue that this assumption is not realistic. The way farming households react to diminishing land availability depends on the means available to them to adjust farming systems. We find that different wealth groups responded differently: over time the poor majority reported higher numbers of settler children present, while the wealthiest households reported fewer. Based on our findings, we argue that wealthiest farmers responded to the changing circumstances by increasing the capital share in production, while those who lacked the means to make major capital investments reacted by increasing their relative use of family labour.

## II

While traditional frontier literature finds a positive correlation between land size and demand for children, the rich literature on population and agrarian change in pre-industrial societies gives reasons to believe that it is equally plausible that the relationship was negative. A cornerstone of this body of literature is Boserup's seminal work on population pressure and changes in agricultural systems. Different from the frontier literature, which tries to explain how land availability affects fertility, Boserup develops a model to explain the effect of increased population pressure (caused by increased fertility or migration) on farming practices. Boserup's work is often cited as a response to Malthus's pessimistic account of the effect of population growth on output and rural welfare. Malthus argued that increased population pressure would lead to a decline in production per capita and consequently – in the long run – a reduction in population size.<sup>7</sup> The reason is that without so-called positive or preventive checks, the

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<sup>7</sup> Malthus, *Essay on the principle of population*.

population would increase geometrically because of improved technology while food production would increase arithmetically. An increase in per capita income above an equilibrium level of consumption leads to population growth. Since the latter grows faster, mortality levels would increase until the per capita consumption falls back to its original equilibrium. This is often referred to as the Malthusian trap or low level equilibrium.<sup>8</sup> Malthus never explained why food production only increases arithmetically and it is this assumption that Boserup challenged. In short, Boserup claims that the rural population would respond to increased population pressure by adopting more intensive farming practices and increasing the frequency of cropping. In this way, output per capita could be kept intact or even increase with population growth. Land-use intensification, by way of shorter periods of fallow, for example, leads to increased yields per unit of land, but also requires more labour and/or capital. In the pre-mechanisation period, land-intensification thus came at the cost of declining labour productivity. Different from the land-labour hypothesis, under these conditions, farmers can react to shrinking land availability by having more children that can be put to work in order to maintain output per capita. We expect to find such a relationship only in cases where farmers mainly rely on the use of family labour, as farmers will employ this form of labour even when the marginal productivity is decreasing.<sup>9</sup>

But why would farmers increase labour input instead of moving towards more capital intensive farming systems? One of the most influential theories of technical change (change in farming practices and/or technologies) is Hayami and Ruttan's model of induced innovation.<sup>10</sup> They treat technical change as endogenous. In brief, they argue that as agriculture develops over time, particular resources become scarce, which affects the relative factor prices of inputs. In

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<sup>8</sup> Kögel and Prskawewtz, 'Agricultural Productivity Growth'

<sup>9</sup> Cornia, 'Farm size'; Griffin, 'Poverty and the distribution of land', Austin, *Labour, land and capital*.

<sup>10</sup> Hayami and Ruttan, *Agricultural development*.

cases of land abundance and labour scarcity, farmers would seek innovations that increase land productivity, i.e. yield-increasing technologies. In this regard their model is similar to a Boserupian interpretation of agrarian change. But while Boserup focuses on the land-population relationship, induced-innovation focuses more broadly on all factors of production, including both embodied and disembodied technologies.

Critics have pointed out that Hayami and Ruttan's model depends on the existence of private or public organizations that respond to the changing factor prices by developing new innovations and make them available for farmers.<sup>11</sup> In our case such organizations were clearly missing. The best way to access new technologies was either to produce them on the farm or travel to the market – a journey that could take several weeks. Equally important, and as pointed out in the extensive research on agricultural development in currently developing regions, farmers must have the means to purchase the innovations.<sup>12</sup> In a case of fragmented markets and limited purchasing power, farmers may not respond to changing relative factor prices in the way that the model presupposes. Or to be more precise, farmers may respond differently to changing factor prices according to their wealth and access to markets.

Let us consider an agrarian settler society consisting of two groups: one wealthy group that has the means to develop more capital intensive farms and/or employ additional family or non-family labour, and a poor group that faces capital scarcity and relies solely on family labour. The latter group would respond to shrinking land availability by having more children that could be put to work. For this group we expect a negative correlation between land availability and family size. This relationship may be temporary as Boserup suggests, or long-term as was the case in

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<sup>11</sup> Ellis, *Peasant economics*, pp. 234-35.

<sup>12</sup> Griffin, 'Poverty and the distribution of land'.



pre-industrial Asia and other parts of Africa.<sup>13</sup> The wealthier group would respond by either employing additional labour and/or developing more capital intensive farming methods. For this group we expect to find no correlation or a positive correlation between land availability and family size.

This means that the wealth of farmers has both a direct and indirect impact on the relationship between land availability and family size – direct, as the level of wealth affects the means available to respond to shrinking land availability, and indirect as the wealth affects the type of labour employed as farm workers. In a context where the majority of farmers were poor, we expect the closing of an agrarian frontier to be associated with increased settler children present in farming households.

Although the literature on farming systems and labour is mainly concerned with crop farming, it also has a bearing on pastoral farming. Intensification is a relative measure and while it is true that crop farming in general is more labour intensive, some pastoral farming systems requires more labour input than others. In times of shrinking grazing land availability, pastoral farmers can react in different ways to maintain output and/or income. Wealthier farmers could capital intensify, for example, by investing in more productive, but also more expensive, livestock, while farmers that lack the means to capital intensify could invest in less productive and less land-demanding but more labour intensive livestock. Even in pastoral communities we therefore expect that the wealth of farmers would determine whether the correlation between land availability and fertility is negative or positive. We explore this relationship further in the context of the closing Graaff-Reinet frontier.

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<sup>13</sup> Huang, *The peasant family*; Lopez Jerez, 'Deltas apart'; Green, 'From extensive to involutionary growth.'

### III

The Cape was initially settled by the Dutch East India Company (VOC) as a refreshment station for passing ships. Gradually, the number of European inhabitants increased, and by the early eighteenth century the Cape had established itself as a settler colony, supplying Cape Town and passing ships primarily with wheat, wine, fresh produce, and meat.<sup>14</sup> Most European farmers settled in the southwestern part of the Cape, but by the mid-eighteenth century, expansion into the eastern and northern interior was well underway.<sup>15</sup> The district of Graaff-Reinet, on the eastern frontier of the Cape Colony, was established in 1786. There, agro-climatic conditions favoured pastoralism, and stock farming quickly became the dominant economic activity.<sup>16</sup> While the long distance to major markets in the southwestern Cape limited the degree of commercialization, the sale of cattle and sheep constituted the main source of cash income.<sup>17</sup>

On the inhabitants of the Graaff-Reinet district, it has been remarked that ‘highlights in the lives of the stock farmers were occasional treks to Cape Town, to pay their recognition fees, to marry, to baptize children, to obtain provisions, to redeem their bills. On such occasions the *Boers*<sup>18</sup> took cattle with them to sell in Cape Town, and commodities such as butter and soap’.<sup>19</sup> But the extent to which frontier households were isolated and independent from trade with the domestic market has been the subject of some debate in the South African historiography. While some paint an image of a wayward, solitary, semi-nomadic, and self-sufficient brand of

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<sup>14</sup> Fourie and von Fintel, ‘A history with evidence.’

<sup>15</sup> Guelke, ‘Freehold farmers.’

<sup>16</sup> Guelke, p. 85, estimates that by 1770 two-thirds of inland farmers were engaged in livestock pursuits rather than as cultivators.

<sup>17</sup> Beinart, *The rise of conservation*, p. 10.

<sup>18</sup> *Boers* (translated directly simply means *farmers*) is the collective name given to the settler population group of Dutch and French ancestry.

<sup>19</sup> Smith, ‘From frontier to midlands’, p. 11.

frontiersmen,<sup>20</sup> others maintain that households on the frontier remained relatively orthodox and geared towards production for the market in order to provide for their daily needs.<sup>21</sup> While scattered evidence of the former can be found, the general consensus is that although these households were able to meet some of their basic needs themselves, they were 'never entirely cut off from the exchange economy of the southwestern Cape'.<sup>22</sup> Indeed Guelke acknowledges that the expansion of this group of frontier farmers could not have taken place without 'guns, gunpowder, wagons and other manufactured items obtainable only in exchange for the produce of the interior'.<sup>23</sup>

Sons of the poorer arable farmers of the southwestern Cape likely viewed stock-farming on the interior as an attractive means of survival, since entry requirements were low and the product could walk to market. During its formative years, it was possible for a settler with little to no capital to move into the Graaff-Reinet district and set up a farm. In the late 1770s the Swedish traveller Sparrman wrote,

You have already a wagon, oxen, and saddle horses; these are the chief things requisite in order to set up as a farmer; there are yet uncultivated places in the neighbourhood, proper either for pasturage or tillage, so that you may choose out of an extensive tract of land the spot that pleases you the best.<sup>24</sup>

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<sup>20</sup> Guelke, 'Freehold farmers.'

<sup>21</sup> Neumark, *Economic influences*; Van Duin and Ross, *The economy of the Cape Colony*; Newton-King, *Masters and servants*.

<sup>22</sup> Newton-King, *Masters and servants*, p. 39.

<sup>23</sup> Guelke, 'Freehold farmers,' p. 88.

<sup>24</sup> Quoted in Neumark, *Economic influences*, p. 37.

Some doubt has been cast on whether it truly was this easy for poor frontiersmen to set up as productive stock farmers,<sup>25</sup> but nevertheless, the steady inflow of new settlers to the district continued into the nineteenth century and the best grazing lands and were quickly snatched up.<sup>26</sup> Allowing for vegetative and seasonal differences, it has been estimated that one sheep or goat required roughly 4 acres of grazing land, whereas one horse or head of cattle required some 80 acres – a fact that likely contributed to the prevalence of small stock over cattle-holding in the frontier districts.<sup>27</sup> While sheep farming is relatively non-labour intensive compared to crop farming, this was less true in the nineteenth century. Shepherds played an invaluable role at a time before fencing was a mainstay and amidst the ever-present threat of predation or theft by raiding Khoi. Daily *kraaling*<sup>28</sup> and season sheering meant that each flock of a few hundred heads required a dedicated shepherd.

Where land was to be had on the frontier, ownership was almost exclusively conferred in accordance with the loan farm system, which offered temporary land-use permits in exchange for annual rents.<sup>29</sup> There is little evidence to suggest that this system created inherent insecurity, since it conferred tenants with exclusive rights to their fixed plot of land. In addition to permits being indefinitely renewable, settlers were free to farm their land without any restrictions or fear of interference from governing authorities.<sup>30</sup> While the land could not technically be sold, settlers

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<sup>25</sup> Newton-King, *Masters and servants*.

<sup>26</sup> A farm of some 6,000 acres could be acquired under the land grant system with relative ease (Guelke, 1979 p. 85).

<sup>27</sup> Dubow, *Land, labour and merchant capital*, p. 2.

<sup>28</sup> The practice whereby the shepherd allows his flock to graze by day and then returns them to their enclosure at night.

<sup>29</sup> Botha, *Early Cape land tenure*.

<sup>30</sup> Applications for licenses and permits were seldom refused. Smith (1974, p. 9) notes that 'while the Company did not legally surrender its right to take back a loan farm, this was so seldom done that the *Boers* came to accept that the farms were their own, until they decided to leave; even the failure to pay recognition fees did not result in the revocation of a permit'.

could transfer the improvements, resulting in a system of de facto permanent property rights.<sup>31</sup>

In contrast with the visible 'affluence and prosperity' of many farmers in the southwestern Cape,<sup>32</sup> a salient feature of life on the frontier was the high proportion of virtually impoverished farmers.<sup>33</sup> That is not to say that a small 'landed gentry' did not exist, but by and large the pastoral farmers of the frontier struggled to make ends meet.<sup>34</sup> Unlike the regions closest to Cape Town, frontier farmers kept comparatively few slaves, and while most carried with them the attitudes of a slave holding community, only the wealthiest landowners could afford to keep a slave or two.<sup>35</sup> Instead, the indigenous Khoisan made up the majority of the agricultural labour force on the eastern frontier.<sup>36</sup> However, in times of acute labour shortage, 'all who could be exploited as labourers, were exploited'.<sup>37</sup> This was true for many colonial economies in Africa<sup>38</sup> where the incorporation of native and child labour, both free and unfree, kin and non-kin was viewed as a necessary and acceptable means of meeting domestic production needs, as well as to supply the ever-expanding European market.<sup>39</sup>

#### IV

The period under investigation in this paper was characterized not only by frontier closure, but

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<sup>31</sup> Mitchell, *Belongings*.

<sup>32</sup> Fourie, 'The remarkable wealth', p. 421.

<sup>33</sup> Newton-King, *Masters and servants*, p. 300.

<sup>34</sup> Dooling, 'The making of a colonial elite'.

<sup>35</sup> Smith, 'From frontier to midlands', p. 336. Smith confirms that a detailed return for the field cornets office of Op Sneeuwberg for 1808 suggests that the distribution of slaves was highly uneven, and that most of the 197 slaves were concentrated in the hands of the wealthiest inhabitants.

<sup>36</sup> Illife, 'The South African economy', p. 90.

<sup>37</sup> Dubow, *Land, labour and merchant capital*, p. 46.

<sup>38</sup> Grier, 'Child labour in Colonial Africa', p. 173.

<sup>39</sup> This was also true for pre-industrial England, where child labour was not perceived negatively. To the contrary, Cunningham argues that 'eighteenth century poor law records saw idleness of children as a problem' (Cunningham 1990, quoted in Burnett, 2012, p. 1078).

by major political and institutional change. Initial European expansion into the eastern frontier was followed by a period of instability and hostility between the European and the indigenous Khoisan population that culminated in the frontier war of 1799-1802.<sup>40</sup> This instability was deepened due to political uncertainty following the decline of the Company, the first British occupation (1795-1802), the Batavian Republic (1803-05), and the second British occupation of the Cape (1806). The tension between the Europeans and the indigenous populations never completely eroded, but the situation gradually stabilized after the second British occupation.<sup>41</sup> The British takeover of the Cape Colony resulted in a major exogenous shock to the settler population, not least due to the arrival of some 4,000 British settlers to the eastern parts of the Colony, but perhaps more importantly, the ban of slave importation in 1808.<sup>42</sup> While the use of slaves was not as widespread as in southwestern Cape, there is evidence suggesting that frontier farmers were nevertheless affected by the increased prices of slaves and the resulting increase in wages for Khoisan labourers.<sup>43</sup>

These changes took place parallel to the closing of the frontier, in both an economic and administrative sense of the term. Administratively, the establishment of the Uitenhage district in 1804 effectively closed the southern border of Graaff-Reinet<sup>44</sup> leaving only the northern border 'open'.<sup>45</sup> More important, the availability of land was substantially reduced during the period of investigation. We lack systematically recorded data to quantify the closing, but all qualitative evidence suggests that although land was initially cheap and plentiful, settlers, particularly those

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<sup>40</sup> Giliomee, 'The Eastern frontier', pp. 439-449.

<sup>41</sup> Smith, 'From frontier to midlands', pp. 54-74.

<sup>42</sup> Neumark, *Economic influences*, pp. 115-116.

<sup>43</sup> Fourie and Green, 'The missing people.'

<sup>44</sup> Smith, 'From frontier to midlands', pp. 75-81.

<sup>45</sup> The Orange River, of course, still divided Graaff-Reinet from the northern interior.

with expanding flocks, soon found sufficient grazing lands more difficult obtain. By 1812 only 39 per cent of married men owned their own farm, and there were no independent Khoisan settlements left in the district.<sup>46</sup> This does not mean that there was a large group of landless *boers* as many occupied land illegally or rented land from relatives or friends.<sup>47</sup> Still, the possibility of accessing land cheaply was becoming more limited. In 1813 the loan farm system was replaced by the quitrent system. Coupled with ineffectual administration, the processing of new land claims became increasingly protracted.

In 1824 the district boundaries were officially extended beyond the Orange River to meet the 'insatiable need of an ever-increasing population for more land'.<sup>48</sup> Increased population pressure further limited access to grazing lands with sufficient water supply. In 1826 the Landrost of Graaff-Reinet, Stockenstrom concluded that, '... when we speak of occupation, there is not even a stagnant pool that keeps rain water for any length of time which is not regularly occupied, so that of course no spring remains vacant'.<sup>49</sup> However, the frontier was never entirely closed. Instead, the increased population pressure and shrinking land availability led to the well documented Great Trek of 1834-38, as farmers crossed the Orange River and moved further into the northeast of present day South Africa.<sup>50</sup>

## V

Until recently most research on historical household formation in South Africa has either been anecdotal, coming from traveller accounts, or based on records that are subject to selection

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<sup>46</sup> Giliomee, 'The Eastern frontier', p. 450.

<sup>47</sup> Smith, 'From frontier to midland', p. 104-107.

<sup>48</sup> *Ibid.*, p. 4.

<sup>49</sup> Extracted from The Cape Papers (1835), p. 118.

<sup>50</sup> Neumark, *Economic influences*.

problems.<sup>51</sup> New research offers a more comprehensive account of the settler fertility transition, the start of which coincides with the country's mineral discoveries and its subsequent transition away from agriculture as the dominant sector of the economy in the second half of the nineteenth century.<sup>52</sup> But very little is known about pre-transitional household composition in this society, and geographically disaggregated micro-level data are needed to better understand the demand for children on frontier farms and how it differed across socio-economic strata.

We combine two newly transcribed datasets. The first is the *opgaafrollen*: annual tax censuses collected between 1663 and 1834 by the Dutch East India administration, and after 1795, by the British colonial administration, of all free households of the Colony. Household-level information includes name and surname of the head of the household and spouse, the number of children present in the household, the number of slaves and indigenous Khoisan employed, and several agricultural inputs and outputs, including cattle, sheep, horses, wheat sown, wheat reaped, vines, and wine produced.<sup>53</sup> The *opgaafrollen* are in the process of being transcribed and linked across years using a probabilistic record linkage strategy to create an annual panel of production across more than a century.<sup>54</sup>

We use a sub-sample of these censuses for the Graaff-Reinet district covering the period 1800-28. The panel contains 23,680 observations over 26 years,<sup>55</sup> comprised of 7,693 unique households. But since these data do not contain information on birth dates (crucial in controlling for, and distinguish between, age, period, and cohort effects) nor death dates (crucial for

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<sup>51</sup> Guelke, 'The anatomy of a colonial settler population'; Simkins and van Heyningen, 'Fertility, mortality, and migration'.

<sup>52</sup> Cilliers and Mariotti, 'Settler fertility in transition.'

<sup>53</sup> All males over the age of 16 were assessed for tax purposes. Unless they headed a household, females were not included.

<sup>54</sup> Rijpma, Fourie, and Cilliers, 'Record linkage'.

<sup>55</sup> Censuses where not taken for 1808 or 1827.



controlling for life-cycle wealth effects) we supplement these data with individual-level demographic data from the South African Families Database (SAF). Obtained from the Genealogical Institute of South Africa (GISA) these data contain complete family registers of all settler families from 1652 to approximately 1830 as well as those of new progenitors of settler families up to 1867 for surnames A-Z, and revised registers complete until 1930 for surnames A-L. The probabilistic record linkage strategy that was used to identify and match households over time is applied to identify and match heads of households across these two sources, resulting in a sample containing 2,856 observations.

Using these data we are able to estimate the components of household wealth.<sup>56</sup> In order to determine the capital component of wealth, we sum all productive assets owned by an individual in a given census year.<sup>57</sup> Through the selection of variables, we have tried to identify those elements necessary to capture productive capital.<sup>58</sup> We estimate the asset component of wealth using the total real value of livestock, using a series of livestock prices from probate inventories (MOOC 8 Series, TANAP 2012).<sup>59</sup> The exchange rate between rixdollars and pounds was adjusted following Denzel,<sup>60</sup> and for years where no information was available, the assumption was made that the price and or exchange rate remained the same as the previous period.

To model the effects of wealth and the use of non-family labour on the presence of settler

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<sup>56</sup> While it is common for self-reported tax records to underestimate the value of household wealth, we are less concerned with this being a potential source of bias in our sample, since census enumerators personally visited all of the farms in a district to take account of what these households owned.

<sup>57</sup> Principal component analysis was also used to estimate a capital wealth score, but the use of nominal capital yielded similar results and their coefficients were simpler to interpret.

<sup>58</sup> This includes horse-wagons, horses, oxen, wagons, carts, wheat, barley, rye, and oats sown in a given year.

<sup>59</sup> Here we were only able to use assets for which the relevant price series were available: cattle, sheep, and goats.

<sup>60</sup> Denzel, *Handbook of World Exchange Rates*.

children in frontier households, negative binomial distribution models were selected over ordinary least-squares as they are designed to analyze count data and account for the fact that the number of children in a family is non-negative. They also account for over-dispersion,<sup>61</sup> common in fertility data, by treating dispersion as a parameter to be estimated from the data.<sup>62</sup> Over-dispersion in our sample results from excess zeros, due to many households being observed before childbearing begins. We run the following specification:

$$y_{it} = \beta_1 \ln(L_{it}) + \beta_2 \ln(C_{it}) + \beta_3 \ln(W_{it}) + \varepsilon_{it} \quad (1)$$

where  $y_{it}$  is the number of settler children present in household  $i$  in year  $t$ .  $\beta_1$ ,  $\beta_2$  and  $\beta_3$  represent the effects of the log of non-family labour,  $L$ , nominal capital,  $C$ , and real livestock wealth,  $W$ , respectively, and are our main variables of interest.  $\varepsilon_{it}$  represents unobservable determinants that vary across time and individuals. We cluster at the individual level to obtain robust standard errors.

To model the relative use of non-family labour in frontier households, we use OLS with the following specification:

$$\frac{y_{it}}{L_{it}} = \beta_1 \ln(C_{it}) + \beta_2 \ln(W_{it}) + \varepsilon_{it} \quad (2)$$

Where  $\frac{y_{it}}{L_{it}}$  represents the ratio of family to non-family labour.  $\beta_1$  and  $\beta_2$  represent the effects of the log of nominal capital and the log of real livestock wealth, respectively, and are again our main

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<sup>61</sup> Where the mean is greater than the variance.

<sup>62</sup> Wang and Famoye, 'Modeling household fertility', p. 274.

variables of interest.

Lastly, to model the relative labour and capital intensification of wealthier versus poorer households we use OLS with the following specification:

$$\frac{L_{it}}{C_{it}} = \beta_1(y_{it}) + \beta_2 \ln(W_{it}) + \varepsilon_{it} \quad (3)$$

Where  $\frac{L_{it}}{C_{it}}$  represents the ratio of labour to capital.  $\beta_1$  represents the effects of the number of settler children present and  $\beta_2$  represents the log of real livestock wealth and is our main variables of interest.

## VI

Before presenting the results of our formal model it is useful to examine the typical household structure and economic circumstances of the population in question. Table 1 shows the characteristics of an average farming household in our population. On average, frontier farms housed two adult settlers (typically a husband and a wife), and two settler children in a given census year. We can see that rearing stock was clearly the dominant economic activity on frontier farms, with the average farm accommodating over 500 heads of sheep and around 50 heads of cattle.

INSERT TABLE 1 HERE

It has been suggested however, that a man with just 50 sheep or 30 cattle would not have been

in a position to support himself, let alone his family.<sup>63</sup> If we consider the proportion of households owning less than 50 sheep or 30 cattle in a given year, shown in Figures 1 and 2, we can indeed see that many stock farmers were barely making ends meet. Important to note too is the degree of variation in both sheep and cattle ownership; one particularly wealthy farmer owned some 12,000 heads of sheep, while another had 2,813 heads of cattle in a given year. But these extremely wealthy individuals appear to be a minority. On average, households owned around six horses and nine oxen, sufficient to pull their carts and wagons to market and to drive their ploughs. Graaff-Reinet was not known for being a grain-producing district, which is evidenced by the low volume of wheat, barley, oats, and rye sown in any given year. That is not to say that farmers did not engage in these activities, if only for subsistence.

INSERT FIGURES 1 AND 2 HERE

From Figure 3, we can see that the average number of settler children in frontier households steadily increased over the period of frontier closure in Graaff-Reinet. From Figure 4 we can see that the presence of children in frontier households has a clearly positive association with wealth if we consider this population across wealth quintiles, before taking into account variation over time.

INSERT FIGURE 3 AND 4 HERE

Given the large variation in livestock and capital holdings as just described it is critical that we

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<sup>63</sup> Newton-King, *Masters and servants*, p. 48.

account for the high degree of inequality in this society. We begin by estimating a Gini co-efficient for every year in our panel, the results of which are shown in Figure 5. In line with findings for the Cape Colony in general,<sup>64</sup> these results confirm that the farming population of Graaff-Reinet was indeed highly unequal, with the Gini co-efficient consistently above 0.6.

INSERT FIGURE 5 HERE

Further evidence of a small but very wealthy elite is presented in Figure 6, which shows that the average total value of assets owned by the wealthiest 5 per cent was 10 times more than the rest of the population. Returning to the relationship between wealth and family size, we find that the wealthiest 5 per cent had a family size 60 per cent larger than the remaining 95 per cent of the population, as shown in Figure 7.

INSERT FIGURE 6 AND 7 HERE

Turning to the outcomes of our regression analysis, Table 2 shows the estimated associations between capital and livestock wealth, non-family labour, and settler children present for all households. Model 1 shows that both livestock wealth and capital wealth are positively associated with the presence of settler children in frontier households.<sup>65</sup>

INSERT TABLE 2 HERE

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<sup>64</sup> Fourie and Von Fintel, 'A history with evidence'.

<sup>65</sup> Given the somewhat noisy prices we use to measure the real value of livestock wealth, the true relationship between assets and children is likely to be stronger than estimated.

However, the strong positive association of wealth and children present might be explained if there is a high correlation between asset wealth and the age of the household head, if we believe that individuals typically accumulate assets and children over the course of their lives. We rule out this possibility using a sub-sample of households matched to the SAF database for which we can determine the age of the head of the household. These results are presented in Table 3, following the same specification as equation (1), with the inclusion of  $\theta$ , which represents the potentially non-linear effects of age ( $a_{it}$ ):

$$y_{it} = \beta_1 \ln(L_{it}) + \beta_2 \ln(C_{it}) + \beta_3 \ln(W_{it}) + \theta(a_{it}) + \varepsilon_{it} \quad (4)$$

Note that since the size of the linked sample is much smaller than the full sample, resulting from the fact that not all household heads were able to be correctly identified and matched to the genealogical registers, we limit the use of the linked sample to checks on model robustness. However, even with reduced sample size, the magnitude and significance of the coefficients of interest remain.<sup>66</sup>

INSERT TABLE 3 HERE

Next, we want to establish how this relationship changed over time in order to determine the effect of a closing frontier. Model 2 shows that as wealth increases, over time, the presence

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<sup>66</sup> The effect on the capital component of wealth becomes insignificant suggesting that lifetime capital accumulation does not matter in farming households' decisions regarding the presence of settler children in the same way that livestock wealth does.

of settler children in frontier households begins to decrease, i.e. the wealthiest members of society begin to limit the number of settler children present in their households. This reduction could be the result of conscious fertility limitation within the wealthiest group, or a feature of higher social mobility for the children of wealthy farmers, i.e. children of the wealthy may have been more likely to pursue opportunities outside the family farm. Again, using the sub-sample of individuals matched to the SAF database, we are able to consider completed births by wealth group in this population as an early guide. We find evidence that the wealthiest did have lower completed fertility than the poor, suggesting some measure of deliberate fertility control for this group.<sup>67</sup>

Finally, we want to see how different wealth groups substitute between family and non-family labour. Model 3 shows the results of a regression where the outcome variable is the ratio of children to non-family labour (slaves plus Khoisan) present on the farm. A higher ratio is indicative of more non-family labour being employed relative to family labour. We see a positive association of both capital and livestock wealth with the use of non-family labour, suggesting that wealthier households could indeed afford to own more slaves and employ more native labourers than poorer households.<sup>68</sup> We can also see that in general, however, the use of non-family labour was declining over time (model 4). The reduction in the ratio of family to non-family labour over time for the wealthy is also larger than for the poor due to the fact that while the use of both family and non-family labour was decreasing for this group, the relative decline of non-family labour was larger.

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<sup>67</sup> We plan to investigate the relationship between changes in the composition of household wealth and the decision to have additional children in a separate paper.

<sup>68</sup> Additionally, we considered the distinction between both male and female settler children and non-family labourers in order to account for the fact that certain agricultural jobs may have been dominated by one gender, but the results revealed no significant gender preferences.

But if we believe that frontier households desired to maintain output amidst frontier closure, we ought to question why the wealthy chose to reduce both family and non-family labour. We therefore consider the ratio of capital to labour over time. Model 5 shows the result of a regression where the outcome variable is the ratio of capital to labour – a larger ratio being indicative of relative capital intensification. For the population in general, we find evidence that the wealthy remained more labour intensive than the poor in absolute terms, but that over time (model 6), intensified their use of capital relative to labour to a greater extent than the poor.

## VII

Since the 1960s, studies have found that fertility declines in the nineteenth century Western world could not be fully understood without considering the population dynamics in the rural areas. Focusing on the rural US and Canada, scholars found that fertility levels systematically differed between newly established frontier regions and older ones. Fertility levels were significantly lower in the established and more densely populated areas compared to the less densely populated frontier regions. Although a lack of data prevents more precise empirical testing, these systematic differences in fertility levels have commonly been explained by the land-labour hypothesis. Fertility levels were higher in frontier regions either because the demand for child labour was larger and/or the cost of having children was lower.

In this paper we contribute to the debate by analyzing the relationship between land availability and children present in settler farming households in the Graaff-Reinet district at the eastern frontier of Cape Colony. Different from the frontier literature, we find for the Graaff-Reinet district that the closing of the frontier was associated with an increased presence of children. Is our chosen case an exception? We do not believe so. Instead, we argue that our



findings call for a revision of the land-labour hypothesis. We identify two weaknesses in the frontier literature: the failure to account for wealth inequalities and the failure to distinguish between family and non-family labour. Rural populations will respond differently to shrinking land availability depending on their wealth because the latter determines the available adaption strategies. A rich farm household may respond to diminishing land availability by substituting labour for capital, while this option is simply not available to a poor household. Wealth inequality in Graaff-Reinet was considerable and the vast majority of frontier farmers struggled to subsist. So, while a small minority did indeed respond to shrinking land availability by developing more capital-intensive methods of production, the poor did not. We find that the poorer farmers who lacked capital responded by increasing their use of family labour.

This strategy makes economic sense if we – different from the frontier literature – make a clear distinction between family and non-family labour. The employment of non-family labour is dependent on the marginal productivity of labour. This is not the case for family labour as shown by development economists, agrarian historians, and economic historians. On the contrary, in pre-industrial societies, farmers will respond to shrinking land availability by adding more labour to land despite decreasing marginal productivity of labour. This Boserupian path was what the majority of the Graaff-Reinet population followed. Lacking alternative means to using family labour, they intensified labour use in light of shrinking land availability, which created a demand for having more children.

This leads us to conclude that for the poor we see a negative correlation between land availability and labour demand, while for the wealthier, the correlation was insignificant. The reason why the Graaff-Reinet households experienced, on average, an increased presence of settler children in the midst of a closing frontier, is that a large majority of the population

consisted of the poor. In that regard, our study does not necessarily contradict previous findings. It may very well be that farmers in nineteenth-century US and Canada were, on average, wealthy enough to respond to shrinking land availability by employing more capital intensive farming methods. The implications of our findings are, however, that the positive relationship between fertility and land availability may not be universal, as previously thought, but largely dependent on levels and distribution of wealth among the rural inhabitants.

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Figure 1. Proportion of settler households owning sheep

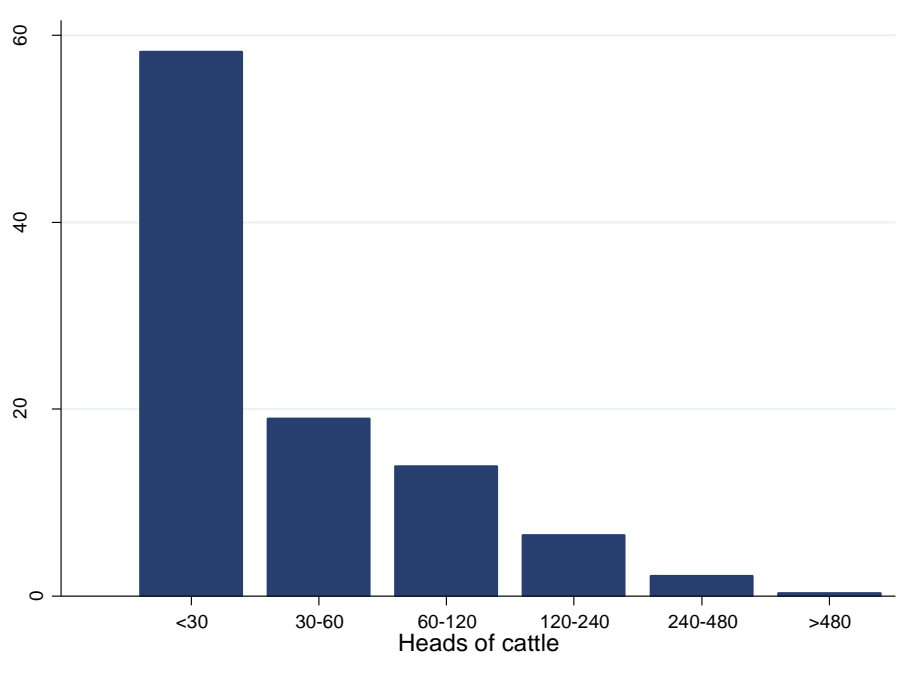


Figure 2. Proportion of settler households owning cattle

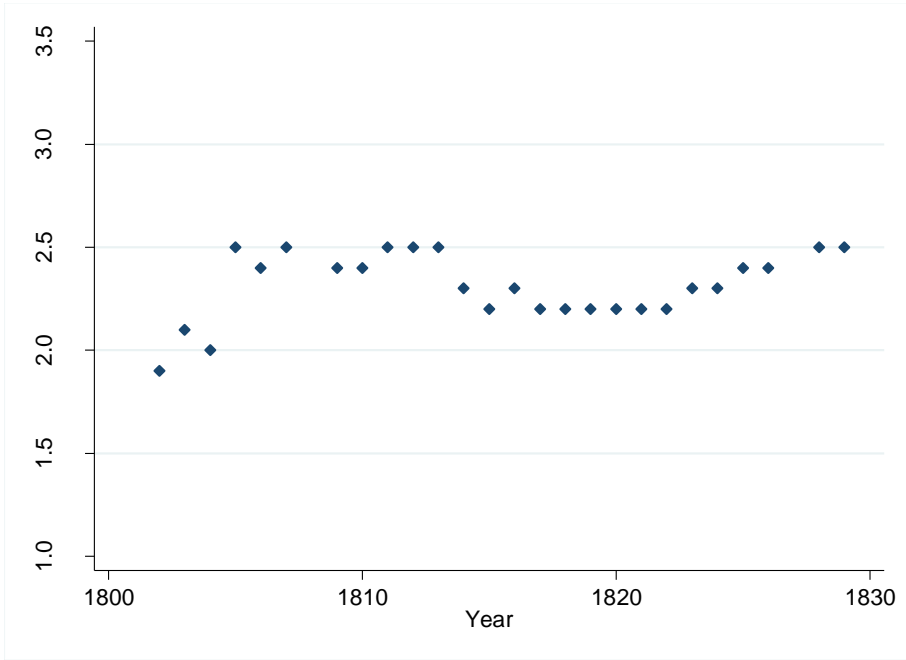


Figure 3. Average number of children present in settler households, 1800-28

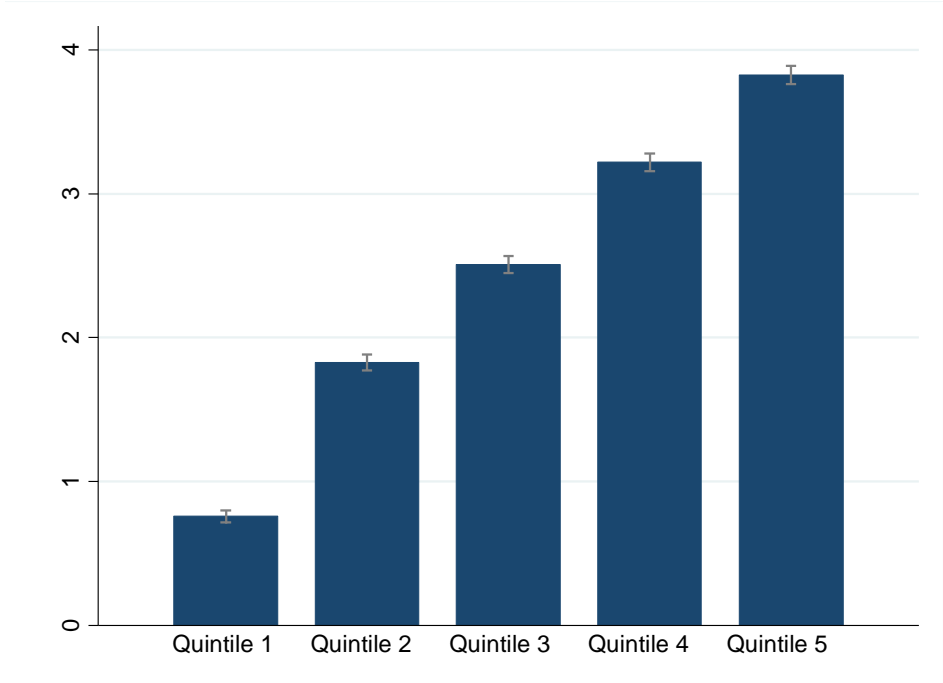


Figure 4. Average number of settler children present in settler households by livestock wealth quintile

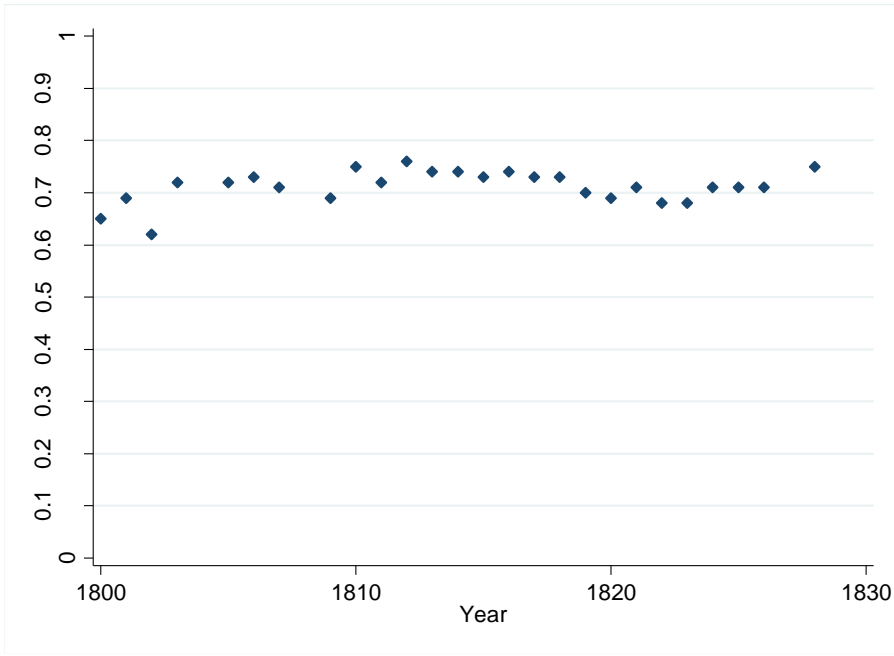




Figure 5. Annual Gini co-efficient, 1800-28

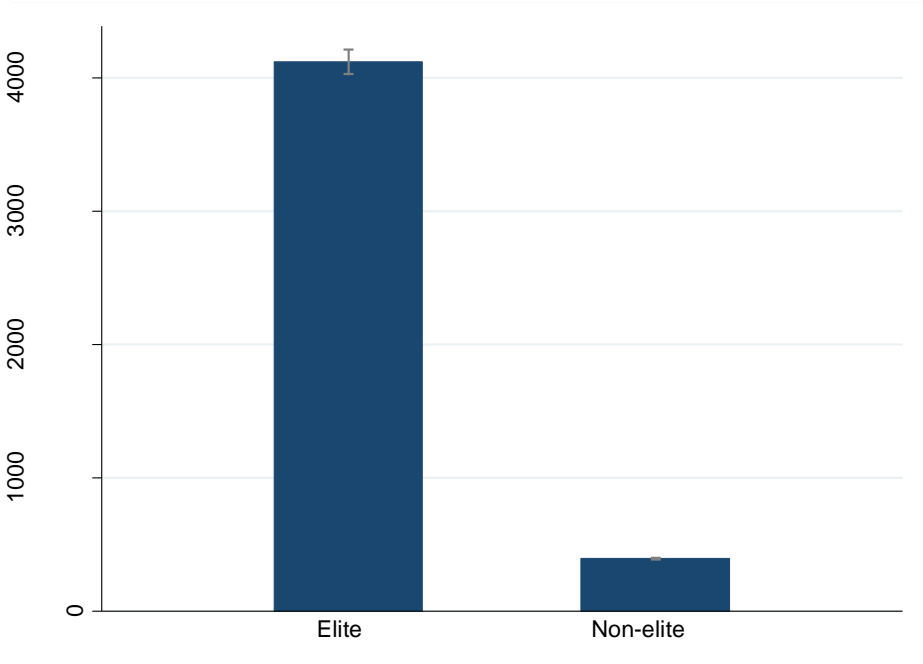


Figure 6. Average real wealth (in *Rixdollars*) for the elite (top 5% of the sample) versus non-elite (bottom 95% of the sample), with 95% confidence bars

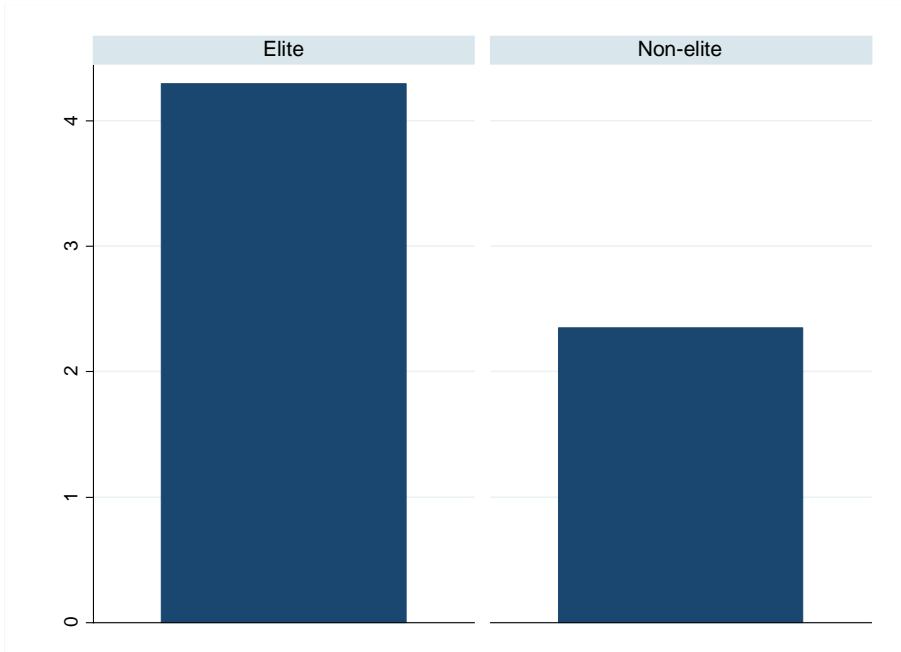


Figure 7. Average number of settler children present in the households of the elite (top 5% of the sample) versus non-elite (bottom 95% of the sample)

Table 1. Characteristics of frontier farms

<i>Variable</i>	<i>Average</i>	<i>Std. Dev</i>	<i>Min</i>	<i>Max</i>	<i>Price</i>
<i>Human capital</i>					
Settler children	2.3	2.6	0	14	n/a
Khoi	3.3	6.3	0	78	n/a
Slaves	1.1	2.9	0	61	266.3
<i>Livestock</i>					
Sheep	495.1	758.7	0	14121	0.3
Cattle	44.7	72.7	0	2813	0.5
Goats	32.0	84.3	0	4326	0.5
Donkeys	<1	3.6	0	400	n/a
Pigs	<1	1.1	0	120	n/a
<i>Capital</i>					
Horses	5.2	13.4	0	1866	11.9
Horse wagons	1.5	2.3	0	31	n/a
Wagons	0.6	1.2	0	186	n/a
Carts	0.0	0.1	0	10	n/a
Oxen	6.7	10.1	0	240	n/a
Wheat sown	<1	1.0	0	62.875	n/a
Barley sown	<1	0.6	0	39	n/a
Rye sown	<1	0.0	0	4	n/a
Oats sown	<1	1.2	0	102	n/a
<i>Output</i>					
Wheat reaped	5.4	21.8	0	1232	n/a
Barley reaped	3.0	16.1	0	1150	n/a
Rye reaped	<1	0.6	0	67	n/a
Oats reaped	<1	0.6	0	80	n/a

Notes: Grains sown in a given year are reported in *muids*, a South African measure of dry capacity equivalent to about 109 litres.

Table 2. Regression output

Specification	Settler children NBREG		Labour ratio OLS		Capital ratio OLS	
	(1)	(2)	(3)	(4)	(5)	(6)
Non-family labour	0.194***	0.190***	n/a	n/a	n/a	n/a
Capital wealth	0.148***	0.151***	0.408***	0.426***	n/a	n/a
Livestock wealth	0.0318***	0.0578***	0.257***	0.774***	12.22***	-0.964***
Settler children	n/a	n/a	n/a	n/a	3.164***	3.244***
1800-1804	ref.	ref.	ref.	ref.	ref.	ref.
1805-1809	-0.641***	-0.583***	-1.365***	1.360***	214.0***	163.8***
1810-1814	-0.500***	-0.383***	-1.234***	1.268***	175.9***	107.6***
1815-1819	-0.559***	-0.418***	-0.890***	1.602***	169.9***	93.37***
1820-1824	-0.466***	-0.341***	-1.327***	1.423***	195.2***	119.4***
1800-1804 x Wealth		ref.		ref.		ref.
1805-1809 x Wealth		-0.00833		-0.627***		7.869***
1810-1814 x Wealth		-0.0327**		-0.570***		14.98***
1815-1819 x Wealth		-0.0441***		-0.553***		18.70***
1820-1824 x Wealth		-0.0365**		-0.692***		18.70***
Constant	0.320***	0.202***	0.678***	-1.836***	-68.74***	-3.497*
Observations	23,680	23,680	15,362	15,362	15,840	15,840
Pseudo R2	0.0312	0.0316	0.203	0.213	0.078	0.08

Notes: \*\*\*p<0.01, \*\*p<0.05, \*p<0.1

Table 3. Reduced sample regression output

Specification	Settler children NBREG	
	(1)	(2)
Non-family labour	0.224***	0.216***
Capital wealth	0.025	0.005
Livestock wealth	0.084***	0.147***
HH head age	0.018***	0.177***
1800-1804	ref.	ref.
1805-1809	-0.303***	-0.595***
1810-1814	-0.210***	-0.391***
1815-1819	-0.230***	-0.565***
1820-1824	-0.312***	-0.616***
1800-1804 x Wealth		ref.
1805-1809 x Wealth		-0.074**
1810-1814 x Wealth		-0.018
1815-1819 x Wealth		-0.102***
1820-1824 x Wealth		-0.086**
Constant	-0.442***	-0.677***
Observations	2,856	2,856
Pseudo R2	0.0415	0.0428

Notes: \*\*\*p<0.01, \*\*p<0.05, \*p<0.1