Which comes first: good governance or prosperity? A historical experiment from the South African Republic and the Orange Free State

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A historical experiment from the South African Republic and the Orange Free State

Stan du Plessis and Sophia du Plessis[1]

Abstract

Two neighbouring republics, with a common history and culture, followed very different paths of development in the second half of the nineteenth century. Extraordinary mineral wealth was discovered during this period in the South African Republic (ZAR), the neighbour where political and economic stability was fragile compared with the Republic of the Orange Free State (OFS). We connect these divergent development paths to the literature on the resource curse, especially the recent literature on the conditional resource curse where the quality of the institutional structure plays a crucial role in the outcomes of a large resource discovery. By introducing a new objective measure for the quality of institutions, namely the accuracy of boundaries on maps, we provide evidence of the institutional quality in the ZAR prior to the discovery of gold on the Witwatersrand. The statistical technique that we use, Procrustes analysis, is an innovation in economic analysis. The evidence supports Acemoglu and Robinson's account of the development path in the ZAR, and the later Union of South Africa, as compromised by the conditional resource curse.

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[1] We would like to thank our colleague, Johan Fourie, for his valuable comments.

Introduction

Natural resources have long since had an ambiguous impact on economic development. Though abundant resources have sometimes supported rapid development, it has also been associated with economic and social disruption. A large literature on the "resource curse" has emerged on this topic over the last twenty years and more, but there is no consensus on the precise economic mechanism that underlies the phenomenon[2].

Acemoglu and Robinson's (2012) thesis is consistent with the theory of a "conditional recourse curse" as proposed by Mehlun, Moene and Torvik (2006) and Boschini, Pettersson and Roine (2007), whereby the existing institutional structure is critical in the process that yields either prosperity or decline in the wake of a resource discovery. The state has a crucial role in this theory since it is the state that is typically involved in the creation and maintenance of a set of productive institutions, including the protection of property rights (North 1984). For a society to benefit from greater specialization and co-operation in the development process, a legal code and law enforcement are necessary. North even goes as far as stating: 'there are no cases of complex urban societies that do not have an elaborate structure of government' (North 1984: 259).

Although the state is a necessary condition for development, it is not sufficient. The state can become the source of struggle, if it is not strong enough to enforce the protection of property rights[3]. This risk posed by an institutionally weak state is pronounced in the event of a large resources discovery.

In this paper we demonstrate the conditional resource curse theory with a historical example. Two neighbouring 19th century republics, the South African Republic (ZAR) and the Orange Free State (OFS), combined forces to face the British Empire from 1899 to 1902. This was the famous Boer War[4] that ended in total defeat for the Boer Republics and the permanent loss of their independence. We are, however, interested in the highly divergent institutional paths followed by these two republics prior to the war; two republics with a common history and culture and comparable geography, but very different paths of development in the second half of the

[2] A brief essay by Acemoglu and Robinson (2013) on new ideas in this literature can be found at: http://whynationsfail.com/blog/2013/5/23/the-economic-nature-of-the-resource-curse-mechanisms.html, while Van der Ploeg (2010) provides a more extensive survey.
[3] If the gains from trade accrue to the party who controls the state, it can lead to civil war.
[4] Sometimes called the South African War, or the Second South African War.

nineteenth century.

The period under consideration in the paper starts with the founding of the OFS in 1852 until the internal collapse of the ZAR in 1877. During the next decade – after the ZAR had regained its independence in 1881 – one of the most extraordinary deposits of mineral wealth in history was discovered in the ZAR. It is our thesis that the weak institutional development of the ZAR prior to this mineral discovery left it open to a particular form of the resources curse.

We provide an institutional account for the differences in development paths between the OFS and the ZAR, with emphasis on the role of the state to provide formal institutions associated with economic development. We offer a new measure – detail on maps of the same period in the two republics – of the divergent state capacity to provide the institutions associated with economic development. The accuracy of these maps measure institutional development in two ways: first it measures the extent to which the government is able to provide the public service of cartographic services to lower the cost of communication and transport and, second, it measures the extent to which the state could support formal property rights institutions through accurate title deeds.

While the comparative institutional development of the Free State and ZAR has often been discussed in the literature we contribute a rigorous and objective measure of the underlying institutional differences.

Institutions and the resources curse

The resources curse refers to the surprising result that underdeveloped countries often suffer economic decline after the discovery of a large natural resource deposit (Sachs and Warner 2001, Robinson, Torvik et al. 2002). Oil provides striking examples of this in the twentieth century. So widespread has this phenomenon been that the exceptions most notably the development of Botswana since the discovery of large diamond deposits – have been studied as interesting cases (Du Plessis 2005).

There are a number of possible ways in which the discovery of a substantial natural resource might disrupt the development path of an economy. A literature has identified what has become known as the conditional resource curse, which is the theory that resources create especially adverse incentives when the institutional structure is poor, while they can be beneficial in the right

institutional setting.

Acemoglu and Robinson (2012) built on this idea to argue that extractive institutions contribute significantly to the resource curse in poor countries. They are building on the New Institutional Economics literature according to which the prosperity or decline of an economy is greatly influenced by the allocation of rights, both initially and over time, as well as the many other mechanisms that lower transactions costs (North 1991). These so-called institutions provide the rules of the game according to which politicians, the general public and entrepreneurs operate.

Extractive institutions in the language of Acemoglu and Robinson (2012) are defined in contrast to the inclusive institutions that support broad based economic growth and development. These inclusive institutions allow the majority of people in a society to participate in productive economic activities according to their own initiative and require secure property rights, the rule of law, and an adequate provision of public services to provide a sufficiently level playing field that would allow both parties in a contract to act in their own best interest (Acemoglu and Robinson 2012). By contrast, extractive institutions dis-incentivises productive collaboration since they are, in the words of Acemoglu and Robinson (2012) designed to "extract incomes and wealth from one subset of society to benefit a different subset".

In a modern economy, the state plays a crucial role in the creation and maintenance of the institutions, whether productive or extractive. Productive collaboration also relies on the state for an effective set of public goods and services, or as Acemoglu and Robinson (2012) summarised the role of the state in productive institutions:

> "The state is thus inexorably intertwined with economic institutions, as the enforcer of law and order, private property, and contracts, and often as a key provider of public services. Inclusive economic institutions need and use the state" (Acemoglu and Robinson 2012)

Extractive institutions are especially pernicious when large natural resources are discovered since the resources will provide the material means by which the extracting elite can extend and expand its power, especially in the absence of the checks and balances of productive institutions. Extractive economic institutions feed extractive political institutions, entrenching the adverse economic incentives. Crucially, the combination of extraction institutions and natural resources raises the

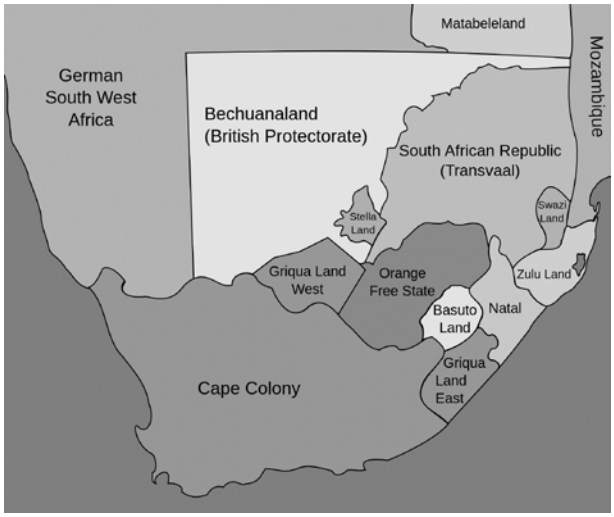
stakes of the political struggle, since "…whoever controls the state becomes the beneficiary of this excessive power and the wealth it generates, extractive institutions create incentives for infighting in order to control power and its beneficiaries" (Acemoglu and Robinson 2012).

Recent empirical research by Couttenier, Grosjean and Sagnier (2014) suggest that major mineral discoveries prior to the establishment of secure states leads to increased interpersonal violence, with very long-lasting effects. Berman et.al. (2014) investigate the impact of mining on conflict by using geo-localized data on conflict events and mining extraction of 27 minerals for all African countries over the 1997-2010 period. Their results show that mining activity increases conflict at the local level and then spreads violence across territory and time by enhancing the financial capacities of fighting groups. In another recently published paper, Bell and Wolford (2015) show that when the state is already powerful, it is more resistant to changes in relative power, deterring challenges from rebels that would otherwise occur in weaker states where power shifts in the government's favour can be more substantial.

We will use maps to demonstrate the relatively poor quality of statehood in the ZAR relative to that of the OFS prior to the discovery of gold in the 1880s, a weakness that, in light of the literature summarised above, would have left the ZAR open to the risk of the resources curse when gold was discovered on the Witwatersrand.

Historical background

Figure 1 Early map of Boer Republics



The Great Trek is the name historians have given to the substantial migration during the 1830s and 1840s of people from European descent into the interior of what is modern day South African (Muller 1993). These Voortrekkers, as they became known, moved in a Northerly direction mainly from the Eastern part of the then Cape Colony across the Orange river and later across the Drakensberg mountains to the Eastern coastal plain of Natal and to the North across the Vaal river to the more distant interior (see Figure 1).

This was never an organised Trek, though there were various attempts, ultimately in vain, to establish common leadership and co-operation. It was between the Orange and Vaal rivers, in what is now the Free State Province of South Africa that a Voortrekker assembly and first attempt at formal governance emerged at the town of Winburg in 1837. Meanwhile the British at the Cape entered into treaties of protection with the Basotho on the Eastern flank and the Griquas on the Western flank of the Voortrekkers across the Orange River. A decade of tension followed which led, in 1849, to the proclamation of British sovereignty by the British Governor at the Cape, Sir Harry Smith over what would be called the Orange River Sovereignty (Muller 1993).

North of Winburg, across the Vaal River, lies the town of Potchefstroom, founded just one year later (1838) and was part of the Republic of Winburg-Potchefstroom, a short-lived political experiment. This republic pulled apart in 1840 as the Voortrekkers in Potchefstroom aligned themselves more closely with another nascent republic, that of Natalia beyond the Drakensburg. The Voortrekkers North of the Vaal would soon be on their own against the British who annexed Natalia in 1843, causing many of its Voortrekker residents to re-cross the Drakensberg to the Free State or move further North across the Vaal River, to Potchefstroom and beyond.

While the territory between the Orange and Vaal rivers became more closely aligned with the British, the emerging republics at Potchefstroom, further North at Soutpansberg and further East at Lydenburg remained fiercely independent. Another republic would emerge from the remnants of Natalia at Utrecht, due South of Lydenburg. Eventually these republics would all merge into the South African (or Transvaal) Republic (ZAR), but it would be twenty years before this consolidation had run its course.

The break between the independent republics beyond the Vaal River and the Orange River Sovereignty was sealed by the Sand River Convention of 1852 whereby the British government

recognised the independence of the republics north of the Vaal river subject to their guarantee of non-interference in the Orange River Sovereignty. Two years later the Orange River Convention granted independence to the Republic of the Orange Free State (Muller 1993). It is the subsequent difference between the institutional histories of the Orange Free State and the South African Republic that interests us here.

Both Republics emerged from the traditions of the Winburg-Potchefstroom Republic but chartered very different courses from the late 1840s onwards and especially after their independence was recognised in the 1850s. There is a wealth of historical evidence to suggest that there was broad public support within the Free State for closer co-operation with the Cape Colony; for example, the Volksraad (Parliament) voted in favour of a confederation with the Cape Colony in 1858, though that was ultimately judged unfeasible by the British. Sentiments were very different in the ZAR, partly due to the self-selection of those who migrated further north with the motivation to break permanently from British political influence. As the Free State moved closer to the British sphere, many of those in the OFS who were more independently minded crossed the Vaal causing greater political uniformity on the British question within both republics: pro-British in the Free State and anti-British in the ZAR.

These differences contributed to lasting tension between the republics which ended in armed conflict in 1857 and a number of attempts by the ZAR's political elite to incorporate the Free State into a new political dispensation that would be dominated from the ZAR. For example, the ZAR's president MW Pretorius tried to advance the goal of a confederation with the Free State by running for, and wining, the presidential election of the Free State in 1859. But this created intolerable political strain and he resigned the ZAR's presidency in 1860, leaving him as the Free State's president until 1863.

With Pretorius' resignation in 1863 the Free State had the good fortune to elect Johannes Brand[5] as President in 1864, who would govern until 1888[6], and would govern with extraordinary success. While the Free State had already built the rudiments of sound government prior to Brand, he advanced that cause dramatically. An efficient public service was established and delivered to a high

[5] Brand's background was auspicious, including a doctorate in law from the University of Leiden and a spell as advocate in the Supreme Court in Cape Town and as Professor of Law before he immigrated to the Free State.
[6] Brand won re-election in 1869, 1874, 1879 and 1884.

degree of efficiency measured against the standards of the 19th century. This was especially true in the domain of public education where Brand placed the Free State not just in a better position than he found it, but at the international forefront in the public provision of education.

The political and institutional development of the ZAR assumed a much lower trajectory after the failed attempts to merge with the Free State. While the ZAR was recognised by Britain at the Sand River Convention of 1852, the territory effectively under the control of the newly established state was only a fragment of what would later become the ZAR. At least three other Boer Republics – those of Lydenburg, Utrecht and Soutpansberg – maintained their independence at this point and would do so for some time yet. These republics rejected the Constitution of 1856 which formally created a state called the ZAR. The subsequent political conflict led to a blockade of Soutpansberg, the declaration by the ZAR that the citizens of the smaller republics were rebels as well as the ill-fated attempt to merge the Free State with the ZAR.

While the ZAR's strong-arm politics worked to the North and East, where it eventually incorporated the three smaller republics it failed in the South with the Free State asserting its independence in closer contact with the British at the Cape. During the 1860s the Free State enjoyed the benefits of steadily improving governance under President Brand, while the government of the ZAR had trouble to maintain the geographical integrity of the state, especially in the Soutspansberg and experienced distressing fiscal pressures which led to a rapidly inflated paper money issuance.

In the late 1860s President Pretorius embarked on a series of territorial expansions to the North in Bechuanaland - to seize recently discovered gold deposits on the Tai River and to the East to seize Delagoa Bay on the Indian Ocean. Within a year Pretorius had to abandon his claim to Delagoa Bay and another year later the land grab in Bechuanaland was also lost. Governance did not improve and by 1877 the British annexed the ZAR. The annexation was unopposed, and it wasn't until 1880 that the Burgers of the ZAR proclaimed, and subsequently, fought for and regained their independence.

The significance of maps

In this paper we study a measure of public goods provision in the form of the accuracy of official maps. There is a large post-colonial literature on the ideological interpretation of maps and the willingness of populations to have their territories mapped, which focuses on power and political

coercion, with an underling sympathy for those who reject being mapped (see for instance the review essay by Schwartz 2004 and also Smith 1994). This ideological interpretation is not at stake in this paper.

Instead we interpret the differential detail of maps in the two states as information about (i) the capacity of the two states to obtain and provide accurate information about their geography; (ii) the willingness of the populations to be mapped and hence be constrained by the central government in what might be thought of as abstract collaboration with the rest of the republic and (iii) the institution of property rights, especially the ability to sell property which requires a low cost centralised database of the dimensions of the property at stake. Maps support institutions such as property rights by facilitating a public record of property deeds.

Maps of the South African interior developed very unevenly as the Great Trek proceeded and left substantial European populations in what would become the Free State, Transvaal and Natal. In Natal for example, the newly settled Boers resisted maps and their "Volksraad (general council) had allocated farms without any survey or registration and the absence of boundaries had allowed Boer farmers a great deal of license as to land use. They therefore resented the formal constraints, perhaps even taxation, which survey might bring" (Carruthers 2003: 958).

Maps of the Orange River Sovereignty were published in Edinburgh between 1849 and 1852, showing the exterior of that British dependency (Carruthers 2003: 958). At the same time maps of the Transvaal were highly uncertain. While the Sand River Convention settled the creation of the Transvaal Republic as a state, it did not define its boundaries, except in the South. Nor were map-makers welcome in the various republics that would merge to form the ZAR, as Thomas Baines (a famous British explorer) discovered in 1850 when he was detained in Potchefstroom and only released after he agreed not to make maps and sketches (Carruthers 2003: 959, 965).

Pelzer (1950: 56, 172) ascribe this hostility towards mapmakers to two reasons: an unwillingness to pay taxes and the hard-headedness of the farmers. In 1858 it was agreed in the House of Assembly in the Transvaal that each farmer will be taxed a fixed amount and an additional amount according to the value of the farm. The size of the farm was therefore important to determine the value. Pelzer regarded this tax evasion as a means by which the farmers kept control over the state, since a fiscally weak state would have to adhere to their grievances. Pelzer also describes these farmers as

individualistic and unwilling to accept the state's control over them and their political leaders risked a rapid loss of support if they agreed to taxation.

The first comprehensive maps of the ZAR emerged from the efforts of Friedrich Jeppe in the 1860s. Jeppe, a German immigrant, became postmaster general and realised the need for maps to fulfil his duties efficiently. However, he also ran into considerable local opposition to his project of mapping the Transvaal and had to provide an armed escort for his surveyors to protect them from the recently settled citizens of the ZAR. Jeppe's first macro map of the Transvaal was published in 1867 (15 years after the Free State map) and shows the exterior of the Transvaal. This map was published in Germany and was followed in 1868 by a map with commentary (Carruthers 2003: 964). When President MW Pretorius proclaimed the external boundaries of the ZAR in the same year his borders did not correspond to the Jeppe map and the President had to make some important reversals (Carruthers 2003: 965).

In this paper we use the development of maps and their detail in the two Boer republics as evidence of the institutional histories of these states. To this end we compare maps of the ZAR and the Free State during the period under consideration as an indication of the public goods dimension of a competent government that can enforce good institutions.

Data generation and method

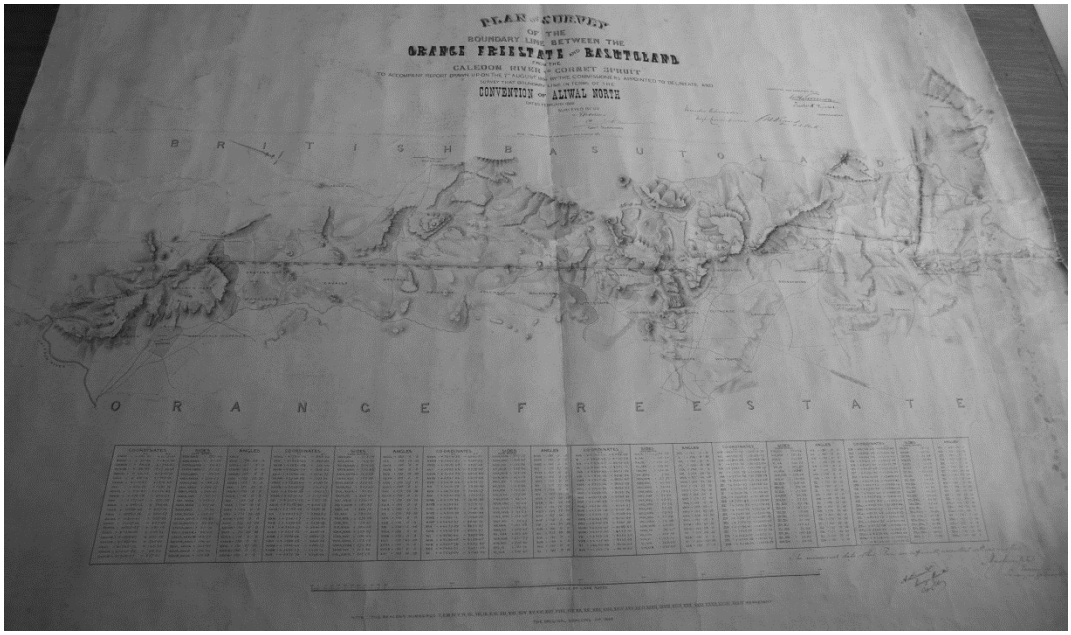
As a proxy for institutional quality we read the details of farm boundaries on the maps of the two republics. Land ownership in the Free State was formalised according to the erfpag system, which the British authorities adopted from preceding Dutch practice, according to which a land commissioner measured a farm with a horse walking in four different directions in a given time. The location and farm boundaries were published in the Government Gazette for six weeks. If there were no complaints the ownership of the farm was registered (Jacobs 1967: 36).

We use three sets of maps: the first set (Images 1 and 2) are the oldest maps available (1869 and 1892) with farms indicated on them. These maps represent the period of discussion in the paper. As a control we also use two additional sets of maps; the first being the Imperial Maps which dates back to the end of the 19th century and the last set of maps is current maps for the same areas.

For the Free Sate we use a map of the border with Basutoland (modern Lesotho) from 1869 shown

in image 1, while the ZAR map was drawn later in 1892, shown in image 2. We argue that the 1892 map of the ZAR provides an upper bound for the detail that could have been mapped by 1877.

Image 1: Orange Free State on the 1869 map[7]



[7] Boundary line between the Orange Free State and Basutuland. 1869. South African Archive, Cape Town, Reference nr M3/114.

Image 2: Transvaal (Nylstroom region) on the 1892 map[8]

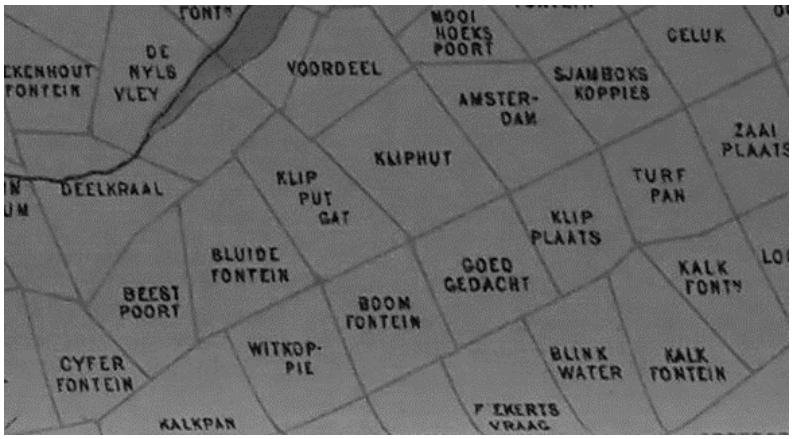
As evidence of institutional quality we use the details of farm boundaries on these maps of the two republics. For the Free State 35 farms were identified on the map of 1869 and 30 farms were identified in the Nylstroom district of the ZAR for the 1892 maps[9]. Images 3 and 4 show a selection of farm boundaries from these maps.

[8] Troye's map of the Transvaal Colony 1892. Africana Library, Stellenbosch University.

[9] The area in the OFS was chosen because it was the earliest map with farms indicated on that we could find. Nylstroom (ZAR) was chosen as a town that lies more or less the same distance from the state capital (Pretoria) than Ladybrand is from Bloemfontein. As a reference, we also included maps of the Soutpansberg region, as this is one where the farmers had even a higher resistance to central control.

Image 3: Sample of OFS farms on the 1869 map

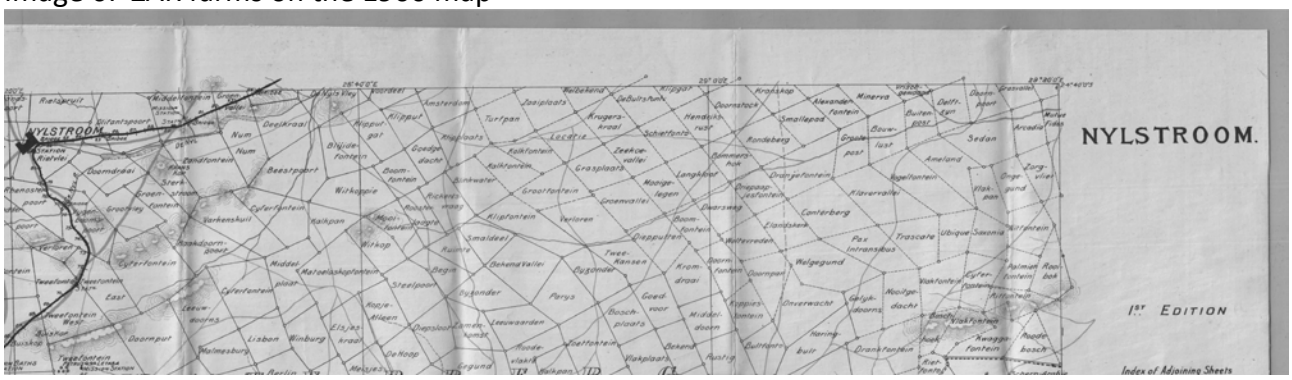
Image 4: Sample of ZAR farms on the 1892 map



The University of Cape Town archive hosts the Imperial Maps of Southern Africa (drawn in 1900). These maps were drawn by the Field Intelligence Department of the British Empire during the Boer War. Since these maps are directly comparable with one another, by virtue of originating from the same source, we use this as a control for the results obtained from the older maps. We have selected the same areas as for the previous maps. Images 5 and 6 show a selection of farm boundaries from these maps.

Image 5: OFS farms on the 1900 map

Image 6: ZAR farms on the 1900 map



Our intuition is that the detail showed on these maps provide a proxy for the quality of property rights institutions in the two republics as well as the capacity of the state to supply the public goods associated with the delivery of those institutions. Our assumption is that the actual shape of a farm will only be square or rectangular by accident, and more typically deviate from this shape due to topographic and other features of the landscape. Given this assumption a map that presents most farms as squares or rectangular is assumed to be less accurate than map where farms shapes are

irregular. This crucial assumption would be false if a square shape had an advantage in terms of efficiency in the former OFS or ZAR. However, the more accurate imperial and modern maps we used for our control samples reveal no proliferation of square-shaped farms in these regions, suggesting that there was no natural advantage for squared-shaped farms.

The method used to compare the shapes of the farms from the different areas statistically is called Procrustes analysis[10]. To compare the shape of two or more objects, the objects have to be "superimposed" optimally, by translating, rotating and uniformly scaling the objects. In this way, both the placement in space and the size of the objects are freely adjusted. The aim is to obtain a similar placement and size, by minimizing a measure of shape difference called the Procrustes distance between the objects.

The alignment part involves four steps:

1. Compute the centroid of each shape.
2. Re-scale each shape to have equal size.
3. Align w.r.t. position the two shapes at their centroids.
4. Align w.r.t. orientation by rotation.

Now, the squared Procrustes distance between two shapes is simply the sum of the squared point distances (Gower 1975; Steggmann & Gomez 2002).

Each farm was individually photographed (e.g. Image 7), digitized and converted into a black and white diagram (e.g. Image 8) that only indicates the shape of the farm. This shape was resized to a standard size and also to fit into a standard frame (e.g. Image 9). The shape was then turned to make the primary axis horizontal (e.g. Image 10). This shape was correlated with a standard square (e.g. Image 11). Image 12 shows the comparison between the farm's outline and the standard square. We then calculated the correlation and squared correlation between the actual farm's outline and the hypothetical square as a measure of the extent to which the map included potential real world features of the terrain that deviated from a square.

[10] "Procrustes": after the name of the bandit from Greek mythology who made his victims fit his bed either by stretching or cutting their limbs.

Image 7: An example of a farm

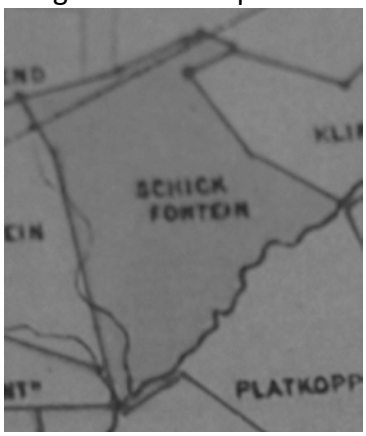


Image 8: Compute the centroid of the shape

Image 9: Re-scale the shapes to have equal size

Image 10: Align with reference to position and orientation

Image 11: Diagram of a standard square

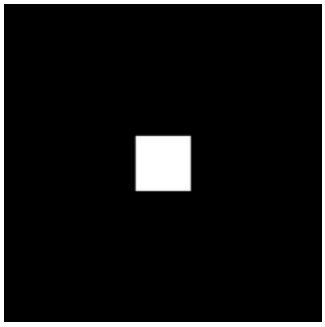
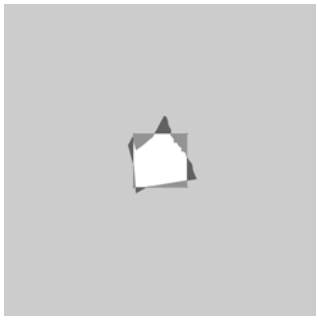


Image 12: Diagram of our example farm superimposed on the standard square



Results

The tables below show the correlation between the farms as mapped and the hypothetical squares imposed by the Procrustrian method. Tables 1 and 2 correspond with the first set of maps, whereas tables 3 and 4 show the results for the Imperial maps. Tables 5 and 6 show the results for the same analysis for 2015 maps.

Table 1: Calculation between farm shape and standard square for the earliest maps

Orange Free State (border with Lesotho) 1869		Transvaal (Nylstroom region) 1892		Transvaal (Lydenburg region) 1892	
Farm name	**Correlation**	**Farm name**	**Correlation**	**Farm name**	**Correlation**
01 Flodder	0.87	01 Middelfontein	0.95	01 Dundee	0.99
02 Banockburn	0.96	02 Groenvlei	0.90	02 London	0.99
03 Finlays hope	0.88	03Boekenhoutfontein	0.90	03 Dover	0.99
04 Ventershoek	0.89	04 De Nylsvley	0.90	04 Durhan	0.98
05 Cavello	0.91	05 Deelkraal	0.81	05 Northum-	0.99
06 Littleton	0.79	06 Beestpoort	0.89	06 Aroyle	0.99
07 Breypaal	0.85	07 Bluidefontein	0.89	07 Tife	0.99
08 Yokohama	0.96	08 Kliphut	0.96	08 Brazilie	1.00
09 Holywell	0.98	09 Amsterdam	0.93	09 Peru	0.99
10 Balmacara	0.97	10 Sjambokskoppies	1.00	10 Batavia	0.99
11 Littlecote	0.95	11 Geluk	1.00	11 Sumatra	0.99
12 Windfell	0.80	12 Vogelstruispan	0.99	12 Rictvlei	0.99
13 Runnymead	0.94	13 Voordeel	0.90	13Houtboschrand	0.99
14 Wahnatta	0.84	14 Nooihoekspoort	0.84	14 Roodekrans	1.00
15 Preshute	0.91	15 Gruisfontein	0.99	15 Op Goede	0.99
16 Sedgemoor	0.79	16 Vogelstruispan	1.00	16 Welgelegen	0.99
17 Clitheroe	0.99	17 Mooipan	0.98	17 Peru 2	1.00
18 Whitewell	0.90	18 Zandfonteinsoog	0.99	18 Robertshoop	0.99
19 Langworld	0.99	19 Welbekend	1.00	19 Grootlaagte	0.99
20 Bunkershill	0.87	20 Zaaiplaants	0.98	20 Brussels	0.99
21 Brandywine	0.92	21 Turfpan	0.98	21 Versailles	0.99
22 no name	0.97	22 Klipplaats	0.98	22Goedgevonden	0.99
23 Klaarwater	0.86	23 Krugerskraal	1.00	23 Rietfontein	0.99
24 Cornunna	0.97	24 Locatie	0.99	24 Mooiplaats	0.99
25 Croonstad	0.90	25 Malmesbury	0.97	25 Juis Getroffea	0.99
26 Holland	0.83	26 Lisbon	0.98	26 Ruglin	0.99
27 Houtnonstant	0.96	27 Winburg	0.97	27 Evirsham	1.00
28 Bismarck	0.98	28 Elsjeskraal	0.99	28 Rauch	0.99
29 Nantes	0.71	29 Koppiealleen	0.96	square.png	1
30 Olifantsbeen	0.99	30 Steelpoort	0.98		
31 Tilly	1.00	square.png	1		
32 Portersdale	0.83				
33 Maghalleen	0.86				
34 Vincennes	0.92				
35 Kotzingen	0.98				
square.png	1				
Average	**0.91**	**Average**	**0.95**	**Average**	**0.99**
Median	**0.91**	**Median**	**0.98**	**Median**	**0.99**
Standard deviation	**0.07**	**Standard Deviation**	**0.05**	**Standard**	**0.003**

Table 2: Calculation between farm shape and standard square for the Imperial Maps

Orange Free State farms: Ladybrand 1900		Transvaal farms: Nylstroom 1900	
Farm name	**Correlation**	**Farm name**	**Correlation**
01 Olot	0.94	01 Klipputgat	0.96
02 Altona	0.88	02 Klipput	0.96
03 Wynberg	0.89	03 Klipplaats	0.98
04 Caledonsdraai	0.93	04 Turfpan	0.97
05 Bankies	0.94	05 Locatie	0.99
06 Heldenmoed	0.95	06 Krugerskraal	0.99
07 Mainland	0.90	07 Schierfontein	0.99
08 Fortuin	0.93	08 Hendriksrust	0.99
09 Vechthoek	0.87	09 Langkloof	0.99
10 Aardenburg	0.89	10 Zeekoevallei	0.99
11 Kopfontein	0.99	11 Grasplaats	0.98
12 Hexriver	0.90	12 Kalkfontein	0.91
13 Welgestreden	0.95	13 Kalkfontein b	0.91
14 Koelenhof	0.90	14 Blinkwater	0.97
15 Roodebult	0.95	15 Goedgedacht	0.96
16 Zwartlaagte	0.94	16 Boomfontein	0.99
17 Bunkerheid	0.82	17 Witkop	0.96
18 Twyfelfontein	0.94	18 Mooifontein	0.88
19 Geoenkloof	0.93	19 Roosterlaagte	0.99
20 Zwartberg	0.90	20 Rickertsvraag	0.98
21 Zaaiplaats	0.93	21 Klipfontein	0.91
22 Klipnek	0.86	22 Grootfontein	0.92
23 Citaskraal	0.93	23 Groenvallei	0.99
24 Verona	0.90	24 Mooigelegen	0.98
25 Villefort	0.96	25 Boomfontein	0.98
26 Zonderzorg	0.87	26 Verloren	0.95
27 Newlands	0.94	27 Smaldeel	0.89
28 Platberg	0.93	28 Ruimte	0.86
29 De hoop	0.92	29 Begin	0.88
30 Trafalgar	0.95	30 Steelpoort	0.93
square.png	1.00	square.png	1.00
Average	**0.92**	**Average**	**0.95**
Median	**0.93**	**Median**	**0.97**
Standard Deviation	**0.04**	**Standard deviation**	**0.04**

Table 3 Calculation between farm shape and standard square for recent maps

Ladybrand 2015		Nylstroom 2015		Lydenburg 2015	
Farm name	**Correlation**	**Farm name**	**Correlation**	**Farm name**	**Correlation**
01 Greenock	0.79	01 Doorndraai	0.93	01 Koppieskraal	0.98
02 De Hoek	0.97	02 Groenfontein	0.87	02 Boschfontein	0.96
03 Lusthof	0.82	03 Zandfontein	0.98	03 Diepgezet	0.99
04 Nababeep	0.88	04 Varkenskuil	0.92	04 Beetgekraal	0.95
05 Mizpah	0.87	05 Kalkpan	0.82	05 Boschhoek	0.70
06 Penhurst	0.98	06 Beestpoort	0.89	06 Waterval	0.99
07 Pinekloof	0.93	07 Witkoppie	0.89	07 Frischgewaagd	0.83
08 Newvale	0.91	08 Blindefontein	0.93	08 Enkeldedoorns	0.95
09 Palmyra	0.88	09 Deelkraal	0.94	09 Sterkspruit	0.92
10 DeLuc	0.84	10 Klipputgat	0.89	10 Goedverwachting	0.94
11 De Hoop	0.91	11 Klipput	0.99	11 Boomplaats	0.85
12 Exceksior	0.91	12 Goedgedacht	0.99	12 Doornhoek	0.93
13 Arcadia	0.98	13 Rickertsvraag	0.96	13 Plaas 349	0.86
14 Platberg	0.87	14 Roosterlaagte	0.98	14 Klipkloof	0.85
15 Pleasant	0.92	15 Witkop	0.93	15 Sterkstroom	0.94
16 Plaas 107	0.76	16 Klipplaats	0.98	16 Wildebeeskraal	0.91
17 Plaas 305	0.91	17 Blinkwater	0.99	17 Plaas 481	0.86
18 Plaas 87	0.86	18 Kalkfontein	0.90	17 Plaas 491	0.91
19 Plaas 446	0.76	19 Grootfontein	0.85	18 Plaas 484	0.83
20 Plaas 327	0.86	20 Verloren	0.91	19 Plaas 518	0.79
21 Plaas 1006	0.99	square.png	1	20 Nooitgedacht	0.86
22 Plaas 39	0.95			square.png	1
23 Plaas 1024	0.90				
24 Plaas 1070	0.84				
25 Plaas 739	0.84				
26 Plaas 635	0.81				
27 Plaas 634	0.88				
28 Plaas 343	0.83				
29 Plaas 1070	0.85				
30 Plaas 304	0.93				
square.png	1				
Average	**0.88**	**Average**	**0.93**	**Average**	**0.90**
Mean	**0.88**	**Mean**	**0.93**	**Mean**	**0.89**
Standard deviation	**0.061**	**Standard deviation**	**0.05**	**Standard deviation**	**0.073**

From the tables it is evident that the mapped boundaries of the ZAR farms have a very strong resemblance to natural squares on the oldest maps. The results from the first set of maps (Table 1) do not differ much from the second set of maps (Table 2). The small difference between the older two sets of maps compared with the more recent maps, is consistent with the slow rate of change of the institutions and state quality we are trying to proxy here.

The resemblance to natural squares can be seen in the high correlation between the farms and the superimposed squares and in the low standard deviation of this measure, which suggests that most of the farms boundaries share this feature. We argue that this correspondence with squares indicates that the map was not an accurate depiction of the relevant boundaries, but rather drawn with information absent about the real measures and location. The ZAR government had evidently less knowledge of its territory, not just the frontier of the State, but even boundaries relevant to property rights.

Table 3 shows recent farm boundaries. Even the area that were closest to a square in Table 1 (Lydenburg) now shows results that look similar to those for the Free State – indicating that the results are not driven by an intrinsic advantage for square-shaped farms.

To determine the significance of the linear mean of the average correlations in the two states, a main effects ANOVA was conducted with province as the one main effect, and year as the second (thus controlling for year)[11]. Normality assumptions were checked by inspecting normal probability plots and found to be satisfactory to the point that it would not affect the outcome of the results. Levine's test indicated homogeneity of variance for the province effect. The results indicated a significantly higher mean correlation ($F(1, 220)=12.1$, $p<0.01$) in the ZAR. Figure 1 shows a comparison of the areas for the earliest maps, Figure 2 compares the 19th century maps for the two states and Figure 3 shows that the results were not driven by difference in the geology of the two states.

[11] An independent statistician, Prof Martin Kidd, Department of Statistics, Stellenbosch University, undertook the statistical tests.

Figure 2: Comparison of the earliest maps

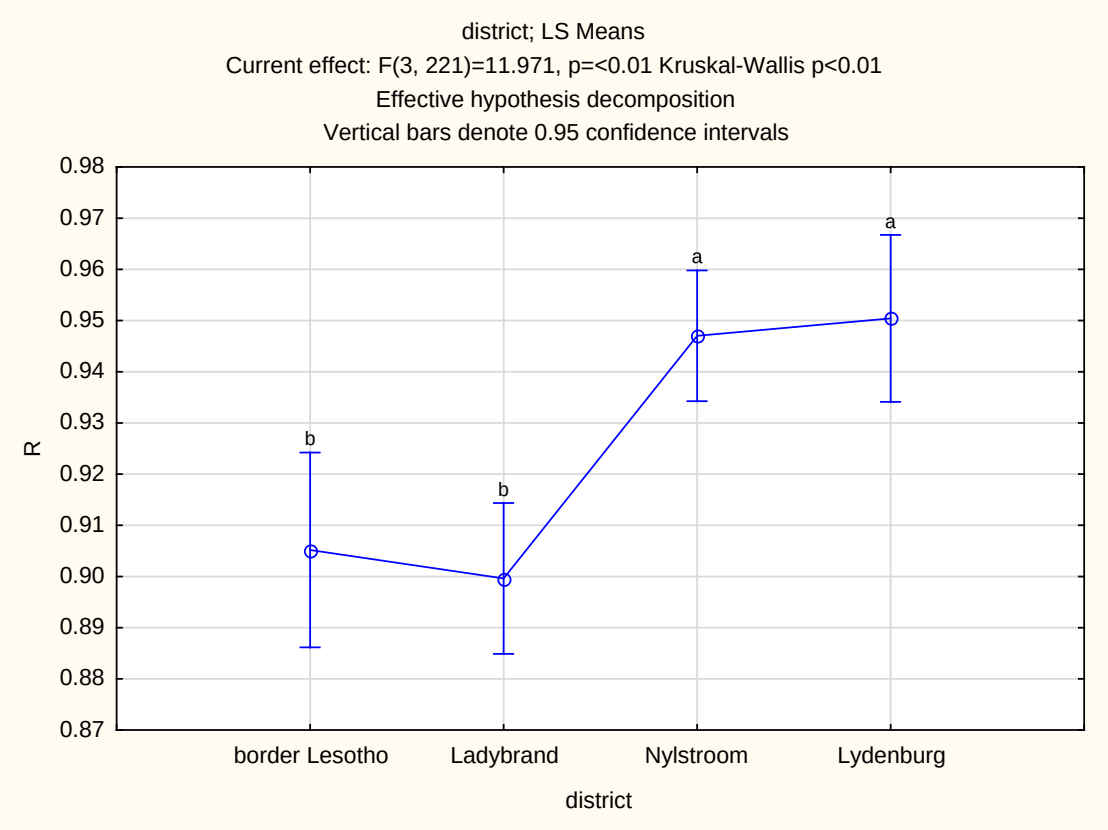


Figure 3: Comparison of the 19th century maps for the ZAR and OFS

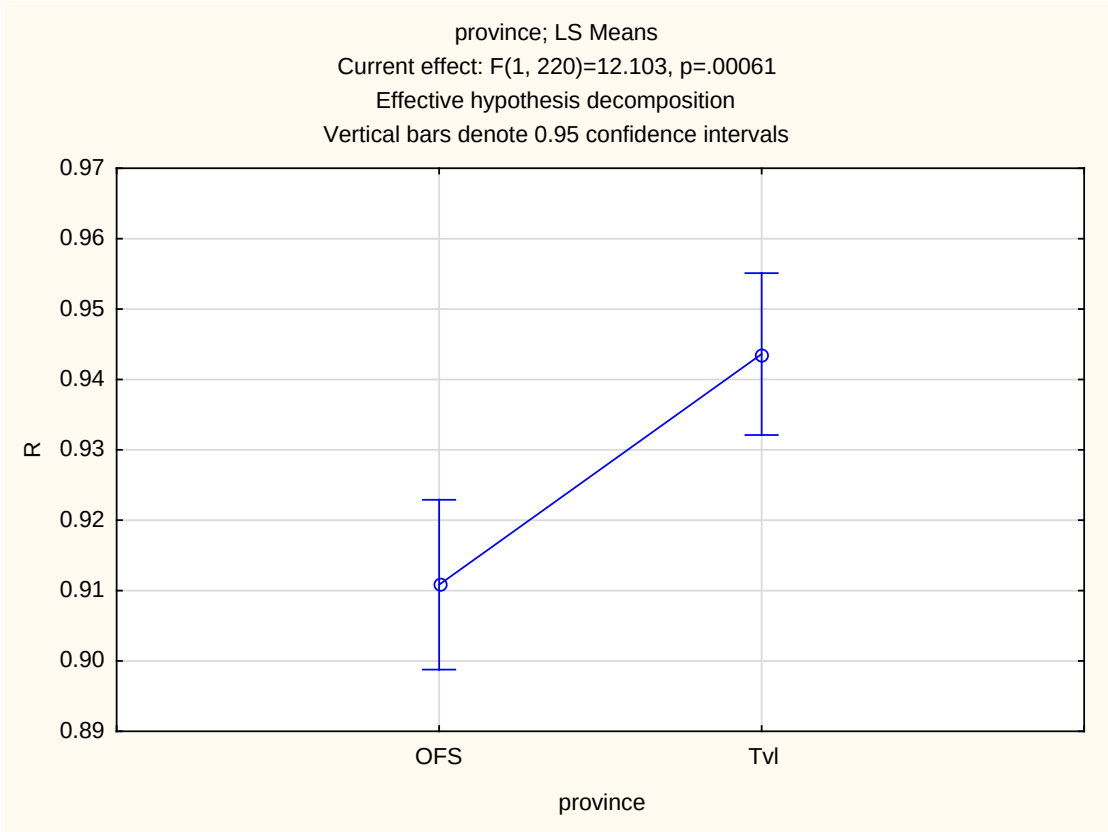
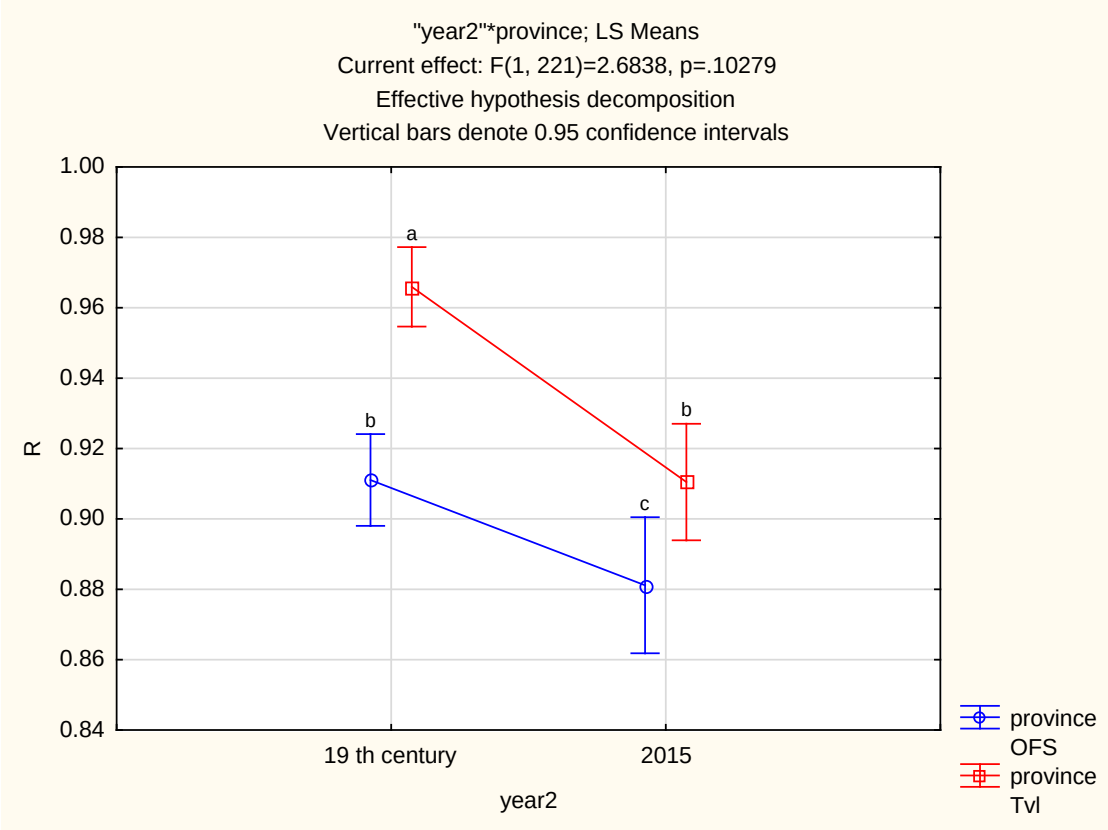


Figure 4: Comparison of 19th century maps with 2015 maps



The demonstration of differences in detail on rural maps in the republics is consistent with the argument of qualitatively different institutions with respect to state capacity in the Free State and ZAR. The evidence presented here on the ZAR prior to the discovery of mineral wealth is consistent with the normative account of a state with severe institutional shortcomings. The recent literature on institutions pertaining to the resources curse suggests that these are the circumstances where extractive institutions can easily turn a resources boom into a political and economic liability. That, indeed, was the story of the ZAR from the 1880s, subsequent to the discovery of mineral wealth until its final absorption into the British Empire in 1902.

The idea that the economic impact of natural resources is conditional on the quality of institutions was raised in a paper by Moene, Mehlum and Torvik (2006), where they showed that there is only a 'conditional resource curse' in the sense that there is a negative correlation between the discovery of resource abundance and subsequent economic growth for countries with low institutional quality (what Acemoglu, Johnson and Robinson call extractive institutions). But the same correlation is

positive for countries with strong institutions (or inclusive institutions). Weak institutions create an opportunity for unproductive economic decisions. We provide an objective measurement for state capacity. If a state does not have the capacity (transparent, honest and effective governance), it may be open to state capture during resource discovery.

Some examples of unproductive economic decisions in the ZAR are described in an article by Heydenrych (2017). He provides evidence of serious shortcomings in the police, the mines and the election administration and sketches a picture of the Johannesburg Police Department, which operated in the absence of any legal framework; within the Department of Mines, patriots were appointed who were not qualified for the tasks. Even after a scandal about housing and business premises that were illegally allocated to people, the Head of Mining was not relieved of his position because he was a supporter of the President and a prominent member of the Hervormde Church. President Kruger appointed people to positions to secure his government. In the presidential election of 1893, Kruger won with a very narrow margin. Both the Dutch and English press condemned the poor handling of the election.

It seems that the ZAR did display a lack of good governance – as our measure indicates – and that it resulted in economic decisions that were to the disadvantage of the ZAR economy after the discovery of minerals.

Conclusion

Statistical analysis allows us an objective comparison of the shapes of farms randomly selected from the rural areas of the two provinces. Historical accounts present the OFS government as much advanced in terms of organization compared with the Transvaal. We used the comparative accuracy of maps of the same period in the two republics as one objective measure of the divergent capacity of the state in the two republics. The consequences of the weak ZAR state were especially grave given the extraordinary mineral discoveries during the last quarter of the 19th century which increased the risk of the resources curse.

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