

Online Appendix for

“No Taxation without State-Assigned Property Rights: formalization of individual property rights on land and taxation in sub-Saharan Africa”

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Appendix A. Individual-level analysis

Table A1. List of Countries Participated in round 7 of Afrobarometer surveys

Benin	Mauritius
Botswana	Morocco
Burkina Faso	Mozambique
Cabo Verde	Namibia
Cameroon	Niger
Côte d'Ivoire	Nigeria
Swaziland	São Tome and Principe
Gabon	Senegal
Gambia	Sierra Leone
Ghana	South Africa
Guinea	Sudan
Kenya	Tanzania
Lesotho	Togo
Liberia	Tunisia
Madagascar	Uganda
Malawi	Zambia
Mali	Zimbabwe

Note: only data from 32 sub-Saharan countries is included into the analysis, observations for Morocco and Tunisia are excluded.

Table A2. Description of variables and underlying questions from Round 7 Afrobarometer Survey (2019)

DV	
<i>Mustpaytax</i>	Q38c “For each of the following statements, please tell me whether you disagree or agree? The tax authorities always have the right to make people pay taxes”. Answer options [1,5]: Strongly disagree, disagree, neither agree/nor disagree, agree, strongly agree. Refused/don’t know are set as missing.
<i>Mustpaytax_dummy</i>	1 = agree and strongly agree, 0 = otherwise. Refused/don’t know are set as missing.
IV	
<i>Land</i>	Q18b “How likely is it that you could get the following information from government or other public institutions, or haven’t you heard enough to say? If you went to the country government office to find out who owns a piece of land in your community.” Answer options [0,3]: Not at all likely, not very likely, somewhat likely, very likely. Refused/Don’t know/haven’t heard are set as missing.
<i>Land (dummy)</i>	1 = very likely, 0 = otherwise. Refused/Don’t know/haven’t heard are set as missing.
CONTROLS	
<i>Satisfaction with services 1</i>	An equally weighted index of satisfaction with five state provided services: basic health care, education, water and sanitation, electric supply and roads and bridges (Cronbach’s alpha = 0.80). “How well or badly would you say the current government is handling the following matters, or haven’t you heard enough to say”? Q56g: improving basic health care services, Q56h: addressing educational needs, Q56i: providing water and sanitation services, Q56m: providing reliable electric supply and Q56l: maintaining roads and bridges. Answer options [1, 4]: very badly, fairly badly, fairly well, very well. Don’t know/haven’t heard enough are set as missing.
<i>Satisfaction with services 2</i>	An equally weighted index of three scores obtained with the help of principal component analysis (PCA) of eight questions pertaining to the satisfaction with services. PCA analysis revealed three underlying dimensions of state provided services: health and education, infrastructure (water and sanitation, electric supply and roads and bridges) and security (Q56f – reducing crime, Q56o: preventing or resolving violent community conflict, countering violence from armed extremists).
<i>Trust in political institutions</i>	An equal weighted index (first, based on raw scores and, second, based on the first components from PCA) of seven items measuring trust in political institutions (Cronbach’s alpha = 0.88). “How much do you trust each of the following, or haven’t you heard enough about them to say?” Q43a: president, Q43b: national parliament, Q43c: national electoral commission, Q43d: subnational parliament, Q43g: Police, Q43h: army, Q43i: courts. Answer options [0, 3]: not at all, just a little, somewhat, a lot. Refused/don’t know/haven’t heard are set as missing
<i>Partiality</i>	Q85a: “How often, if ever, are [R’s Ethnic Group] treated unfairly by the government?” Answer options [0,3]: always, often, sometimes, never. Not applicable/refused/don’t know/not asked in the country are set as missing.
<i>National political community</i>	Original question Q85b. “Let us suppose that you had to choose between being a [R’s national identity (NI)] and being a [R’s ethnic group (EG)]. Which of the following statements best expresses your feelings? Answer options [1, 5]: I fell only (EG), I fell more (EG) than (NI), I feel equally (NI) and (EG), I feel more (NI) than (EG), I feel only (NI). Not applicable/refused/don’t know/not asked in the country are set as missing
<i>Corruption in land administrations</i>	Q48f “In this country, how likely do you think it is that a rich person could pay a bribe or use personal connections to get away with registering land that does not belong to them?” Answer options [0, 3]: Not at all likely, not very likely,

	somewhat likely, very likely. Missing/refused/don't know/haven't heard are set as missing.
<i>Corruption in tax administration</i>	Q48d "And in this country how likely do you think it is that a rich person could pay a bribe or use personal connections to get away with: Avoiding paying taxes they owe to government?". Answer options [0, 3]: Not at all likely, not very likely, somewhat likely, very likely. Missing/refused/don't know/haven't heard are set as missing.
<i>Satisfaction with democracy</i>	Q36 "Overall, how satisfied are you with the way democracy works in [country name]? Answer options [1, 4]: Not at all satisfied, not very satisfied, fairly satisfied, very satisfied. The country is not a democracy/refused/don't know are set as missing.
<i>Contract traditional leader</i>	Q25E "During the past year, how often have you contacted any of the following persons about some important problems or to give them your views: traditional leaders? Answer options [0, 3]: Never, only once, a few times, often. Don't know, refused to answer are set as missing.
<i>Wealth</i>	An equally weighted index of six items respondents have in their possession (Cronbach's alpha = 0.73). "Which of these things do you or anyone in your household own?" Q89A: radio, Q89B: tv, Q89C: car or motorcycle, Q89D: computer, Q89E: bank account, Q89F: mobile phone. Answer options [0, 2]: no, don't own; yes, someone else (in the household) owns; yes, do own. Missing/refused/don't know are set as missing. The variables that entered into the index were recorded as follows: 1 = "yes, do own"; 0 = otherwise.
<i>Lived Poverty Index</i>	Average index of 5 poverty items, constructed by the Eurobarometer.
<i>Working</i>	Original question Q95A (occupation) – 13 categories [0, 12], where 0 = never had a job, 1 = student, 2 = housewife/housemaker and 3-12 are different occupational categories – was recorded into <i>Working</i> where 1 = 0,1 and 2, and 0 is otherwise. Other/refused/don't know/missing are set as missing.
<i>Working formal</i>	Original question Q95A (employer) – four categories [1,4]: work for self, private sector, NGOs/civil society sector, government – recorded into <i>Working formal</i> where 0 = 1 and 1 = 2,3 and 4. Not applicable/refused/don't know are set as missing.
<i>Urban</i>	Original question URBRUR (urban = 1 , rural = 2, semi-urban = 3, peri-urban =460) is recorded into Urban where 1 = urban, semi- and peri-urban and 0 is otherwise.
<i>Education</i>	Ten categories [0, 9]: No formal schooling, informal schooling only, some primary, primary school complete, some secondary/high schooling, secondary/high school complete, post-secondary, some university, university completed, post-graduate. Refused/don't know are set as missing.
<i>Female</i>	Q101 respondent's gender: Male = 1, Female = 2.
<i>Age</i>	Q1 "How old are you?". Refused/don't know are dropped. $c.age\#c.age$ is the squared term of Age.

Note: Source: [Data Codebook for a Round 7 Afrobarometer Survey](#).

Table A3. Summary Statistics

<u>Variable</u>	<u>N</u>	<u>mean</u>	<u>sd</u>	<u>min</u>	<u>max</u>
Mustpaytax	41,939	3.81	1.23	1	5
Mustpaytax (dummy)	41,939			0	1
Land	39,155	1.36	1.15	0	3
Land (dummy)	39,155			0	1
Satisfaction with services 1	40,140	2.36	0.73	1	4
Satisfaction with services 2	36,957	-.01	1.08	-2.24	2.49
Trust in political institutions 1	37,281	1.61	0.87	0	3
Trust in political institutions 2	37,281	1.29e-08	2.03	-3.75	3.27
Partiality	37,714	0.51	0.87	0	3
National political community	38,209	3.54	1.2	1	5
Corruption in land administration	41,731	2.35	1	0	3
Corruption in tax administration	41,566	2.24	1.06	0	3
Contact traditional leader	38,408	0.7	1.09	1	3
Satisfaction with democracy	40,749	2.4	1	1	4
Wealth	42,362	.40	.29	0	1
Lived Poverty Index	42,990	1.22	0.91	0	4
Working	40,838			0	1
Working formal	28,236			0	1
Urban	43,424			0	1
Education	43,156	3.44	2.22	0	9
Female	43,417			1	2
Age	43,389	36.99	14.91	18	106

Table A4. Individual-level analysis: marginal effects from Model 5 Table 2 (ordred probit regression, outcome = strongly agree)

	1
Land	.053*** [.0299, .0769]
Satisfaction with services	.013* [.0007, .0268]
Trust in political institutions	.023*** [.0175, .0275]
Partiality	-.034** [-.06, -.005]
Female	-.0097* [-.02, .0007]
Age	--
Age2	--
Education	.079*** [.06, .108]
Working (dummy)	--
Urban (dummy)	--
Wealth	.047*** [.018, -.074]
Country fixed effects	yes
Observations (n)	24,060
Countries (N)	32

Note: coefficients are as follows: for *land*, 'very likely' (reference category 'not at all likely'); for *partiality*, 'always' (reference category 'never'); for *education*, 'secondary/high school completed' (reference category 'no formal education'); for *partiality*, 'often' (reference category 'never'); 95 percent confidence intervals in brackets; *** p<0.01, ** p<0.05, * p<0.1.

A5. Individual-level analysis: robustness (ordered probit estimates)

To ascertain the robustness of the results reported in Table 2 of the manuscript, we re-run the analysis using additional control variables and different measures for the same underlying concepts.

Additional control variables capture: 1) the horizontal dimension of the fiscal contract theory—an argument that the existence of a broad national political community is conducive to high levels of tax compliance (for a review, see author reference); 2) corruption in both tax and land administrations; 3) satisfaction with democracy. We measure the concept of *national political community* with the question on the strength of respondents' national rather than ethnic identification (Q85b), *corruption* with two relevant questions (Q48d and Q48f), and *satisfaction with democracy* with a corresponding question from the survey (Q36).

We decided against the inclusion of confounders, which effect on both IV and DV is not evidenced in the literature, because it has been shown that the inclusion of a larger number of potential confounders may not only decrease bias, but also increase it (Clarke 2005). However, we take advantage of linktest – a test for model specification, which is often interpreted as “a test that, conditional on the specification, the independent variables are specified incorrectly” (Stata n/d). Performed after each probit and logistic regressions, the hat-squared enters statistically not significant in all models (for example, p-values of hatsq for Model 1 and Model 5 Table 2 of the manuscript are .894 and .426 correspondently), suggesting that we are unlikely to find any addition statistically significant predictor except for by chance.

The alternative measures are: 1) an index of satisfaction with state-provided services, which includes three additional items on security (government success in prevention of crime, violent conflict, and armed extremism). The new index is built with the help of principal component analysis (PCA), which reveals three underlying dimensions of satisfaction: services, infrastructure, and safety. The resulting index is an equally weighted index of first components from three PCA scores (Cronbach's alpha = 0.77); 2) since not all countries have subnational legislatures, the alternative measure for trust in political institutions is a composite measure of six political institutions, excluding subnational elected bodies; 3) we also use an alternative measure for wealth—an index of lived poverty, provided by Afrobarometer.

Table A5 reports the results of this analysis, which employs an ordered probit regression estimator. Models 1–8 report regression coefficients. Similarly to the main analysis, the coefficient for *land* is statistically significant (at the 99 per cent confidence level) across all models and positively signed. The quantitative impact of this factor is also stable: those who find it very likely that they will find proof of land ownership from the government are 5.7 percentage points \pm 2.2 more likely to strongly agree that authorities have a right to make people pay tax. This is larger than the average marginal effect of *satisfaction with services* (1 percentage points) and *partiality/always* (–3 percentage points) and on a par with the average effect of *trust in political institutions* (5 percentage points \pm 0.9 per cent).

Of the additional control variables, only *satisfaction with democracy* enters statistically significant, but at the 90 per cent confidence level, contributing to a large margin of error for the marginal effect (2.4 percentage points \pm 2.6). Variables capturing the strength of the *national political community* and *corruption* on land and tax administrations are not statistically significant.

The socioeconomic characteristics of respondents (not reported for brevity) behave as in the main analysis in terms of both direction and the magnitude of their effects. The only difference is that *urban* is consistently statistically significant (and negatively signed). Model 8 Table A5 reports the results of probit estimates on a sample of respondents in employment (i.e. excluding respondents who never worked, students, and homemakers), controlling for the sector of employment (formal or informal), with the results substantively the same as reported in the main and robustness analyses with the full sample.

Table A5. Access to information on land ownership and citizen assent to pay taxes: ordered probit regression estimates

	1	2	3	4	5	6	7	8
Land	0.17*** (0.03)	0.17*** (0.03)	0.17*** (0.03)	0.17*** (0.03)	0.17*** (0.03)	0.17*** (0.03)	0.17*** (0.03)	0.16*** (0.04)
Satisfaction with services	0.04** (0.02)	0.05** (0.02)	0.04* (0.02)	0.03** (0.02)	0.03** (0.02)	0.03** (0.02)	0.03* (0.02)	0.05** (0.02)
Partiality	-0.09** (0.04)	-0.09** (0.04)	-0.09* (0.05)	-0.09* (0.05)	-0.09* (0.05)	-0.09* (0.05)	-0.08* (0.05)	-0.07 (0.06)
Trust in political institutions	0.07*** (0.01)	0.07*** (0.01)	0.07*** (0.01)	0.06*** (0.01)	0.06*** (0.01)	0.15*** (0.01)	0.15*** (0.01)	0.14*** (0.02)
National political community	0.04 (0.06)	0.05 (0.06)	0.04 (0.06)					
Corruption in land administration		0.06 (0.05)	0.05 (0.05)					
Corruption in tax authorities		-0.01 (0.04)	-0.00 (0.05)					
Satisfaction with democracy			0.07* (0.04)	0.07* (0.04)	0.07* (0.04)	0.07* (0.04)	0.06 (0.04)	0.10*** (0.04)
Respondent SES	yes	yes	yes	yes	yes	yes	yes	yes
Country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Pseudo R2	.051	.051	0.051	0.051	0.051	0.051	0.052	0.056
Observations (n)	26,273	25,788	25,036	24,580	24,580	24,920	25,224	16,442
Countries (N)	32	32	32	32	32	32	32	32

Note: Coefficients: for Land is “Very likely” category (reference “Not at all likely”); for Partiality is the “Always” category (reference is “Never”); for Education is for the “Secondary/high school completed” (reference “No formal education”); for NPC is “National identity only” (reference “Ethnic identify only”); for corruption variables is “Very likely” category (reference “Not at all likely”); for satisfaction with democracy is “Very satisfied” category (reference “Not at all”). Models 4-8 Satisfaction with services is an index of 8 items; Model 6 Political trust is trust in six political institutions; Model 7 wealth is measured through LivedPoverty_CAT variable; Model 8 is limited to working respondents only with a control for employment in formal sector; Respondent SES: age, age2, female, urban, working and wealth; robust standard errors are in parentheses, clustered at country level; *** p<0.01, ** p<0.05, * p<0.1

A6. Individual-level analysis: robustness (logistic estimates)

To ascertain the robustness of the results reported in Table 2 of the manuscript, we re-run the analysis using logistic maximum likelihood estimator after dichotomizing the outcome variable as follows:

1 = ‘strongly agree’ and ‘agree’ of Q38c (people must pay taxes) and 0 = otherwise.

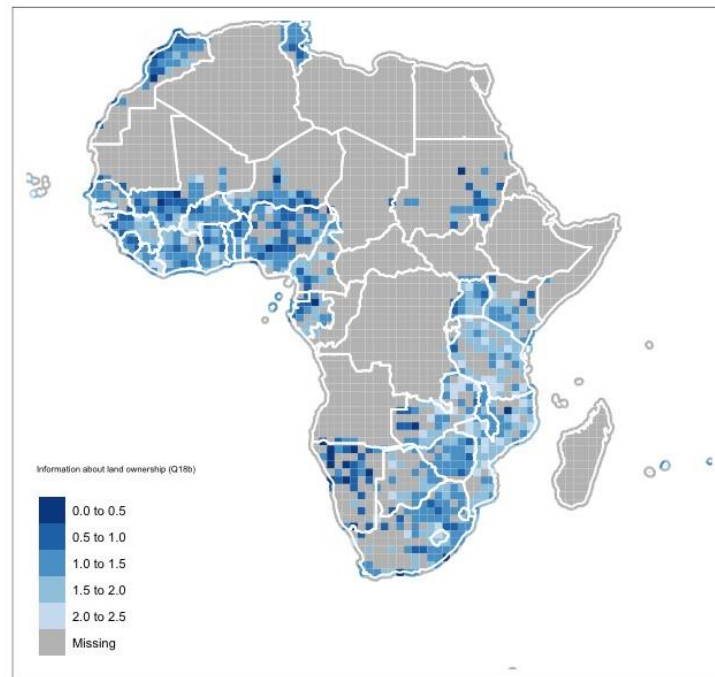
Table A6 reports the results of the logistic analysis, which are substantively similar to the results from the probit analysis. Specifically, the coefficient for *land* enters statistically significant (at the 99 per cent confidence level) across all the models and is signed positively as expected. Those individuals who find it *very likely* that they will find information on land ownership from government are 3.5 percentage points more likely to agree that authorities have a right to make people paying tax, compared with those who find access to land information most difficult. The average marginal effects for other factors are – 3.7 percentage point for *partiality*, two percentage points for *trust in political institutions*, and one percentage point for *satisfaction with government-provided services*. *Education* remains the strongest predictor of all, with the average marginal effect of four percentage points for the category of ‘complete school education’ (compared with the reference category ‘no formal education’).

Table A6. Access to information on land ownership and citizen assent to pay taxes:
logistic regression estimates

	1	2	3
Land	0.22*** (0.05)	0.21*** (0.05)	
Land (dummy)			0.19*** (0.04)
Satisfaction with services	0.07* (0.04)	0.08** (0.04)	0.08** (0.04)
Trust in political institutions	0.12*** (0.01)	0.13*** (0.01)	0.13*** (0.01)
Partiality	-0.22** (0.09)	-0.27*** (0.09)	-0.26*** (0.09)
National political community	0.1 (0.11)		
Corruption in land administration	0.09 (0.11)		
Corruption in tax authorities	0.06 (0.09)		
Satisfaction with democracy	0.11 (0.08)		
Female	-0.03 (0.03)	-0.01 (0.03)	-0.01 (0.03)
Age	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)
Age2	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Education	0.41*** (0.11)	0.41*** (0.10)	0.41*** (0.10)
Working (dummy)	-0.03 (0.06)	-0.03 (0.06)	-0.03 (0.06)
Urban (dummy)	-0.15** (0.07)	-0.15** (0.07)	-0.15** (0.07)
Wealth	0.30*** (0.07)	0.34*** (0.07)	0.34*** (0.07)
Country fixed effects	yes	yes	yes
Constant	-0.35 (0.24)	-0.11 (0.18)	-0.10 (0.17)
Pseudo R2	0.094	0.096	0.095
Observations (n)	25,021	26,538	26,538
Countries (N)	31	31	31

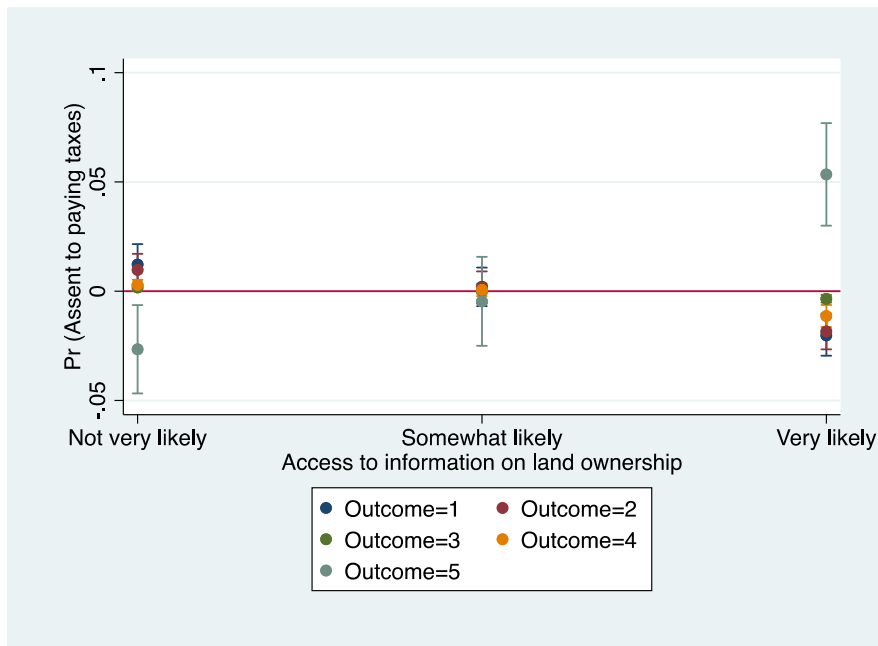
Note: DV: mustpaytax (dummy); Models 1-3 report coefficients estimated with regard to the same reference categories as in the ordered probit main analysis; Swaziland is omitted; robust standard errors in parentheses, clustered at country level; *** p<0.01, ** p<0.05, * p<0.1

Figure A1: Distribution of values for the ‘information on land ownership’ variable in SSA



Note: Q18b from the merged dataset of Afrobarometer Round 7 (2019), ‘How likely is it that you could get the following information from government or other public institutions, or haven’t you heard enough to say? If you went to the country government office to find out who owns a piece of land in your community’; answer options [0, 3]: not at all likely, not very likely, somewhat likely, very likely, don’t know/haven’t heard (set as missing); the values are plotted by 150 km polygons for all 34 countries. Lighter colours stand for higher levels of state-led formalization of property rights on land. We thank Magnus Åsblad for his help with drawing the map.

Figure A2. Marginal effects of access to information on land ownership on assent to pay taxes to government



Note: outcome 1 = strongly disagree; 2 = disagree; 3 = neither; 4 = agree; 5 = strongly agree. Marginal effects from Model 5 Table 2. Estimates for “Strongly agree” are reported in Table A4.

Appendix B. Constructing the *Cadaster* indicator

Introduction

Cadasters are methodically arranged records of interests in land, which includes a presentation of land assets (their location, boundaries, dimension and features) and a description of interests – rights, responsibilities and restrictions – associated with these land holdings (Williamson and Enemark 1996). Although cadasters could be arranged by private actors (for example, large land holders), this paper focuses on state-administered cadasters.

Sub-Saharan African states initiated cadastral records at different points in time and achieved differing degrees of geographical reach in the recording of such. For example, Egypt has one of the oldest state-administered cadasters in the world, going back to 1000 CE (Kark 1997), while many countries, such as Angola, Benin, Burkina Faso, Liberia or Sierra Leone lack any system of land surveying and registration of land rights even today. In our sample Mauritius has currently the most developed system of state-administer cadaster, followed by Rwanda, South Africa, Eswatini (former Swaziland) and Kenya.

There are two main methods of land identification and representation: narrative or cartographic (maps). Cartographic (mapped) cadaster identifies a land asset – namely, location of the land parcel, its dimensions and features – based on systematic observations and instrumental measurements and represented as a drawing/sketch, linked to a register, containing information about the interests associated with the land asset. Narrative cadaster is a record that identifies a land asset (location, dimensions and features), based on observations and measurements of a less systematic character and represented in sentences of natural language (narrative description). While the overwhelming majority of SSA countries today use cartographic methods of land description, some – as, for example, Ethiopia or Guinea – continue to rely on the narrative method. Figure A1 shows examples of narrative and cartographic cadaster from Ethiopia.

Assigning scores

To create the Cadaster variable we assigned a score for each country/year, based on the answers to the following questions:

- “Was there a state-administered cadaster?” Country/year receives 1 point if “yes” and 0 points if “no”, yielding score component 1 ($z1_{it}$);
- “Was the cadaster narrative or cartographic?”. Country/year receives 1 if cartographic and 0.75 if narrative, yielding score component 2 ($z2_{it}$)
- “How much of the country's territory was covered by the cadaster?”. Country/year receives a score based on the proportion of the country's territory covered by the cadaster, yielding score component 3 ($z3_{it}$).¹

¹ For this paper the term $z3_{it}$ excludes cadastrified communal and state land. For example, although Mauritius's cadaster covers 100% of the country's territory, 22% of the land is state land (Truth and Justice Commission 2011, 31), resulting in the score of .78. Similarly, although Ethiopia has had a wide-ranging cadastrification programme of rural land since 1998, all rural land is state property, resulting in the score of “0” for the rural land component of Ethiopia's $z3_{it}$ term.

These coding principals went through a peer review process of the professional association of land surveyors (author reference). The coding principles allow us to account for spatial and temporal change, as, for instance, slight deterioration in the cadastral coverage in Namibia after its independence from South Africa, or rapid deterioration of cadaster in Zimbabwe in the 2000s. Special care was taken in documenting the presence and attributes – type of cadaster and the spatial coverage – of cadasters at every t of the period. Instances of cadaster gradual decay are, unfortunately, not discussed in reputable literature in sufficient detail to allow us to account for this, quite plausible, scenario. This limitation, caused by the paucity of sources and research on the evaluation of cadaster systems, should be kept in mind.

By reviewing numerous primary sources and reputable secondary literature,² as well as consulting experts on cadasters, we record the answers to the above discussed questions, documenting supporting sources for each coding decision. A reference document with dates and sources for each SSA country for 1980-2015 is available upon request.

After this, we compute the Cadaster indicator for every country/year by multiplying all three score components by one another:

$$\text{Cadaster}_{it} = z1_{it} * z2_{it} * z3_{it}$$

The possible range of values is 0 to 1, where “0” stands for the absence of state-administered cadaster at all and “1” stands for a full (covering at least 90 percent of the territory) mapped cadaster.

A note on $z3_{it}$

For cadasters of the 20 and 21st centuries we have to account for different dynamics of cadastrification of urban and rural land, impelled by rapid urbanization in the 20th century. The case of Ethiopia typifies the situation in SSA, where cadaster was initiated in the early 20th century in Addis Ababa and was limited to urban areas before the late 1990s when a large successful program of cadatrification of rural land began (Deininger et al 2008; Shibashi 2011). As of 2011, 30% of all urban parcels were properly surveyed and registered,³ and about 60% of all rural parcels were registered using narrative description of land holdings (Shibeshi 2011).

To calculate $z3_{it}$, we multiply the share of cadastrified rural/urban parcels by the share of rural/urban population and sum the products. To illustrate, after independence in 1990, Namibia's effort to maintain the cadaster inherited from the times under the South African's mandate resulted in 20 percent of rural parcels and 60 percent of urban parcels being properly registered and surveyed (Owolabi 2004). We multiply 20 and 60 by the shares of rural and urban population (64.3 and 35.7 percent correspondingly) and sum the terms to obtain $z3_{\text{Namibia}1990-2004} = 0.343$.

While parcel-based measure of the coverage – share of the surveyed and registered parcels in the total number of parcels – is the most accurate measure, it is not available for all country/years. For most of the remaining country/years we have data on the implementation of

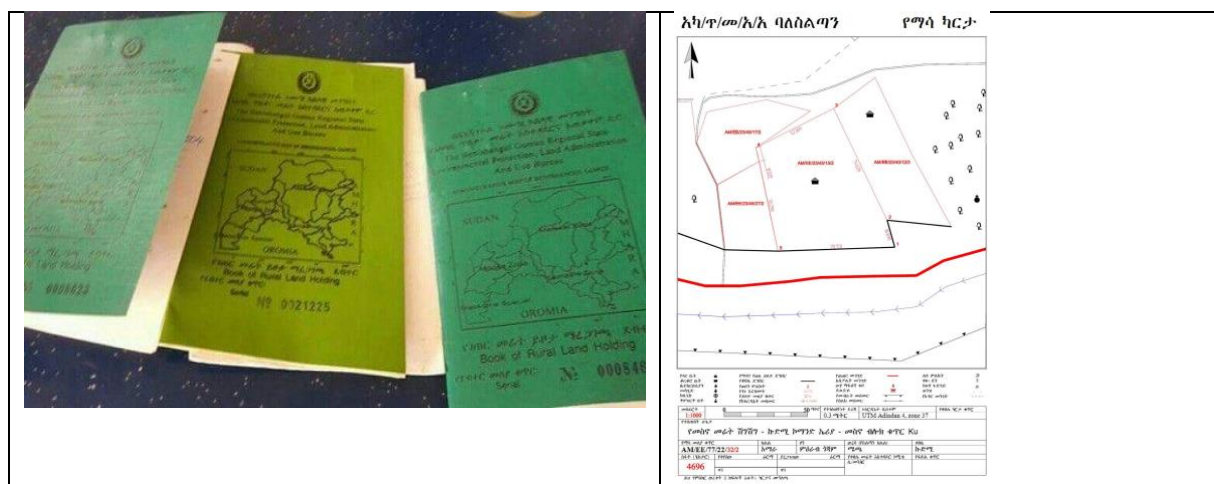
² There are three major sources of information on cadasters in SSA: 1) the UN-sponsored Cadastral Template Project, run by the International Federation of Land Surveyors (FIG) and 2) specialized academic literature and 3) documentation of international organizations (such as World Bank, USAID, SIDA and other international organizations) involved in cadastral reforms in SSA.

³³ The term “properly surveyed and registered” is a jargon expression of the of the International Federation of Surveyors (FIG), which refers to a process through which land parcels are surveyed using modern methods of measurement and cartographic method of presentation and linked to the register of rights and obligations on this land.

rural cadasters, but the data comes in a number of different forms. First, it comes as the share of regularized agricultural land over the total agricultural land. For example, USAID (2011: 7) estimates that today in Cameroon only about 3% of rural land is regularized. Second, data on the coverage of rural cadasters comes as the share of the total land, which needs to be normalized through the share of agricultural land in the total land to calculate the coverage. For example, USAID (2010: 3) estimates that in Uganda c. 17.5% of all land is registered. Assuming that urban cadaster exists in at least some minimal form,⁴ to accommodate the uncertainty related to urban cadaster in our estimate of the cadaster coverage, we divide 17.5% by share of agricultural land in the total land (c. 72%), arriving at the $z3_{Uganda2010-2015} = 24.3$.

Finally, for a number of country/years the available coverage data is even less specific. For example, the coverage is reported in the number of owners having full set of legal documents to land. For example, in 1975 Algeria began a program of cadastrification of the territory suitable for agriculture --- north of the 34th parallel (World Bank 1992: 7). However, in 1992 only “5 percent of private rural and urban owners have legal evidence of their property rights” (World Bank 1992, 6; see also World Bank 1992, 9; World Bank 2001, 2). In such cases we assume the share of “owners” to be equivalent to the share of “properly surveyed and registered” parcels in the total number of parcels}. In the case of Algeria $z3_{Algeria1992} = 0.05$.

Figure B1. Examples of Narrative and Cartographic Cadasters



Note: Left panel: certificates of land holding that have been issued in Ethiopia since 1999, containing narrative descriptions of land holdings. Image: [Fana Broadcasting Company](#). Right panel: model parcel map, which will complement certificates of land holding in the second level of land registration. Source: Shibeshi 2011.

⁴ In 2010, the share of urban population in Uganda was c. 19% (World Bank n.d.).

Appendix C. Country-level analysis

Table C1. Description of variables and of data sources

DV	
Tax on Individuals	<p>Total income, capital gains and profit taxes on individuals (always exclusive of resource revenues in available sources) as % of GDP. 1980-2015, log transformed. Source: <i>Government Revenue Dataset</i> (UNU-WIDER 2021).</p> <p>This variable is a subset of data capturing taxes on income, profits, and capital gains of both individuals and corporations and other entities. Parsing out individuals from corporations and other entities removes taxes on profits from the data we employ. Furthermore, we assume that capital gains tax, which is paid on income derived from the sale/exchange of an asset, such as a stock or property, is unlikely to be a high grossing tax in sub-Saharan Africa, as this is a tax on high-income individuals and even in developed countries capital gains taxes account for a modest portion of tax revenue. For example, in the USA in 2019, the most recent year for which data are not affected by temporary distortions resulting from the Covid-19 pandemic, taxes from capital gains constituted about 11 percent of individual income tax revenues or 0.9 percent of GDP (The Peter Peterson Foundation 2021). Therefore, this variable predominantly reflects income taxes.</p>
IV	
<i>Cadaster</i>	Constructed by authors. 1980-2015.
CONTROLS	
<i>Population</i>	Total population are midyear estimates, based on the de facto definition of population, counting all residents regardless of legal status or citizenship. 1980-2015, log transformed. Source: World Bank Development Indicators, the QoG standard dataset (wdi_pop), version Jan 2020.
<i>Impartial bureaucracy</i>	Impartial public administration, 1980-2015. “The extent to which public officials generally abide by the law and treat like cases alike, or conversely, the extent to which public administration is characterized by arbitrariness and biases (i.e., nepotism, cronyism, or discrimination)”. Source: V-Dem Institute, the QoG standard dataset, version Jan 2020.
<i>Democracy</i>	fh_ipolity2: average of Freedom House and Polity with imputed values. Scale ranges from 0-10 where 0 is least democratic and 10 most democratic. 1980-2015. Source: the QoG standard dataset, version Jan 2020.
	Vdem_polyarchy: index of the five components: Elected Officials, Clean Elections, Associational Autonomy, Inclusive Citizenship, and Freedom of Expression and Alternative Sources of Information. 1980-2015. Source: V-Dem Institute, the QoG standard dataset, version Jan 2020.
	vdem_libdem: index, including constitutionally protected civil liberties, strong rule of law, independent judiciary, effective checks and balances and the level of electoral democracy. 1980-2015. Source: V-Dem Institute, the QoG standard dataset, version Jan 2020.
<i>Index of Economic Complexity</i>	Structural sophistication of economy, 1995-2015. Source: The Growth Lab at Harvard University. 2021. Growth Projections and Complexity Rankings, V2 [Data set]. https://doi.org/10.7910/dvn/xtaqmc
<i>Terrain Ruggedness</i>	An indicator capturing the difference in elevation between adjacent cells of a digital elevation model (DEM). Source: Nunn and Puga 2012.

Table C2. Summary Statistics

<u>Variable</u>	<u>N</u>	<u>mean</u>	<u>sd</u>	<u>min</u>	<u>max</u>
<i>Tax on individuals</i>	818	2.02	2.16	0.03	13.4
<i>Tax on individuals (log)</i>	818	.21	1.03	-3.69	2.59
<i>Cadaster</i>	1,436	.124	.205	0	.78
Population (log)	1,426	15.85	1.27	12.64	19.01
Democracy (fh_ipolity2)	1,387	4.26	2.63	.25	10
Impartial bureaucracy	1,430	-.252	1.08	-3.03	2.83
Index of Economic Complexity	594	-.91	.58	-2.42	1.22
Alternative indicators					
Democracy (vdem_polyarchy)	1,426	.362	.20	.077	.82
Democtacy (vdem_libdem)	1,426	.25	.18	.02	.71

Table C3. Cadastre and revenue from taxes on individuals: panel data estimates with time-varying covariates

	DV: (log) revenue from taxes on individuals				
	1	2	3	4	5
Cadastre	0.81*** (0.17)	0.76* (0.37)	0.96* (0.51)	1.52** (0.55)	1.28* (0.63)
Democracy	0.02 (0.03)	-0.01 (0.03)	-0.01 (0.04)	-0.02 (0.05)	0.14 (0.22)
Impartial bureaucracy	0.15* (0.08)	0.16 (0.13)	0.28 (0.19)	0.41* (0.24)	-0.04 (0.05)
Population (log)	0.04 (0.21)	0.04 (0.16)	0.52 (0.60)	1.01 (1.03)	0.66** (0.32)
Economic Complexity	-0.07 (0.07)	0.08 (0.05)	0.05 (0.08)	0.02 (0.11)	1.44 (1.34)
y_t , lagged	0.79*** (0.03)	0.78*** (0.04)	0.53*** (0.11)	0.32* (0.16)	0.78*** (0.04)
Observations	361	339	309	280	253
Number of ccode	27	27	27	27	26

Note: the table reports the within estimates of Cadastre on (log) revenue from taxes on individuals. Unbalanced panel of 26 to 27 countries. Model 1 includes unlagged covariates and one lag of the dependent variable. Model 2 includes all covariates, including the dependent variable, at $t-1$, Model 3 at $t-2$, Model 4 at $t-3$ and Model 5 at $t-4$. All models include a full set of country and year fixed effects. Standard errors clustered at the country level (in parentheses). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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