

# Land- and credit-market effects of urban land titling

## Evidence from Lesotho

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## Puzzle and context:

- Limited evidence exists in literature on the impact of land titling on credit access, despite initial hypotheses (de Soto 2006), with notable exceptions in tenure security and female empowerment.

## Reasons for limited impact:

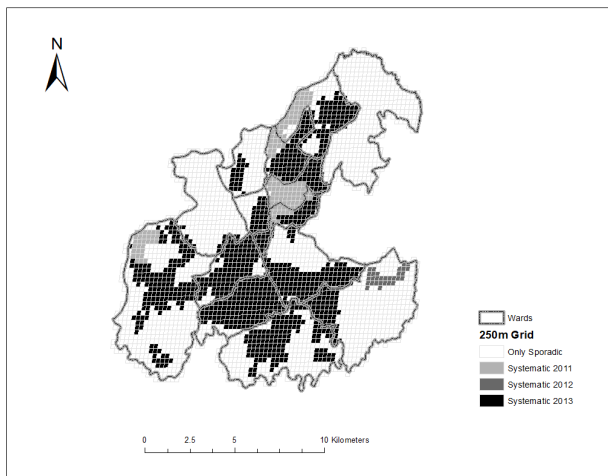
- Project design: Lack of regulatory reform to prevent informality.
- Data quality: Rare registration events and noisy survey data obscure true effects.
- Timing: Insufficient time for effects to materialize or for participants to adapt.

## How the Lesotho Land Reform Project addresses these issues:

- Enacted laws in 2010 and implemented regularization in 2011 enable separate assessment of effects.
- Availability of digitized land registry from 1981 to 2019 mitigates measurement errors.
- The program conducted from 2011 to 2013 facilitates analysis using short- and long-term panel data.

- Legal reforms
  - Building on 2006 LCMPA: Women can own property rights
  - 2010 Land Act & Land Authority Act: Key provisions include female co-ownership as default
- Institutional reforms
  - Thorough revision of workflows (incl. titling) to improve quality & reduce the cost of service delivery
  - Establishment of digital cadaster & registry
  - Elimination of Ministerial Consent to reduce transaction cost for registration
- Systematic titling of some 55,000 properties in Maseru city
  - Rolled out in 2011-13 in three waves
  - Focus on informal areas

# Intervention roll-out: Systematic titling



# Registration modality and parcel characteristics

- In general, parcels registered sporadically tend to be larger and situated closer to the CBD compared to those registered systematically under LTR.
- Parcels newly registered after 2015 through a sporadic process exhibit characteristics similar to those included in the systematic titling.

	Systematic Total	Sporadic Total	1981-2009	Sporadic 2010-14	2015-19
Ln CBD distance (m)	0.137* (0.0733)	-0.216*** (0.0771)	-0.179*** (0.0665)	-0.0896* (0.0512)	0.132** (0.0516)
Ln parcel area ( $m^2$ )	-0.0138*** (0.0030)	0.0251*** (0.0031)	0.0503*** (0.0027)	-0.00183 (0.0021)	-0.0347*** (0.0021)
Mean dep. var.	0.604	0.397	0.209	0.0832	0.104

*Note:* Regression is at parcel level for the 53,432 parcels that passed quality control procedures for inclusion in the cadaster; the dependent variable is a dummy of whether the parcel was first registered by a systematic or a sporadic process. Block fixed effects and constant are included throughout but not reported. Standard errors are in parentheses: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.010$ .

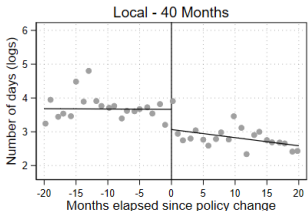
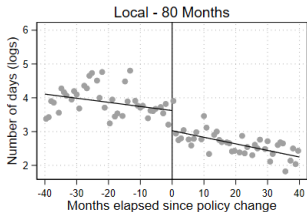
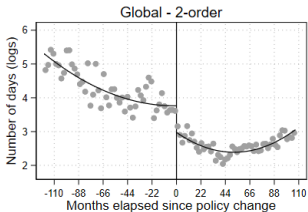
# Descriptive statistics based on administrative data

	Total	1981-99	2000-10	2011-14	2015-19
No. of leases issued	58,582	6,641	5,739	38,295	7,907
per year	1,502	350	522	9,574	1,581
with female ownership <sup>a</sup>	0.736	0.234	0.397	0.858	0.792
Sporadic registrations per year	619	350	522	1,304	1,313
Systematic registrations per year	883			8,270	269
Share of residential property	0.892	0.853	0.926	0.888	0.921
No. of transfers per year	210	51	96	456	871
No. of mortgages per year	168	117	94	322	400

Source: LAA land administration database from 2011 and digitization of paper records, 1981–2011.

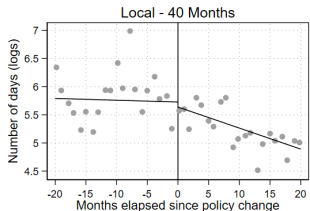
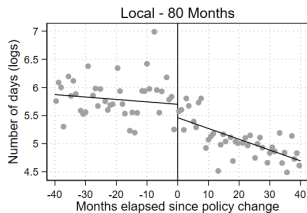
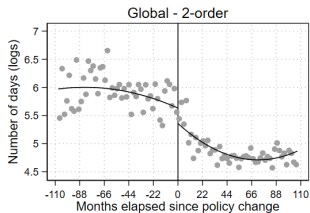
<sup>a</sup>Gender relates to the 94.4 percent of properties registered in the name of natural persons rather than legal entities.

# Change in duration of mortgage reg.: from 150 to 21 days





# Change in duration of land sales reg.: from 456 to 120 days

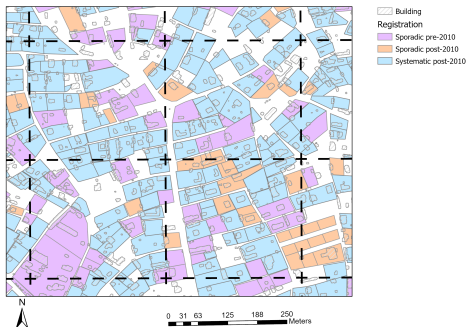


# Identification strategy & key results (1)

**Approach:** Utilizing 250x250m blocks, employing block fixed effects on matched data, and distinguishing between two interventions:

- Policy change: Affects everybody – before/after
- Systematic titling: Affects only eligible parcels
- Outcome variables: Registered parcels (total & women), registered sale and mortgage transactions (total & women)

Illustration of blocks



# Identification strategy & key results (2)

- Short panel (2017-2014)
  - Utilizing eligibility for systematic titling with a matched sample – positive registration & sales but mortgage effect observed only among women
  - Check plausibility with placebo reform
  - Separate out policy effect (interaction with lagged stock of parcels): Sale & credit market effects driven by policy
- Long panel (2000-2019)
  - Observe significant mortgage & land sales market effects – also on women (economic empowerment)
  - Notice clear differences by type of registration

## Effects of systematic land registration:

$$Y_{it} = \alpha_j + \beta_1 T_{it} + \delta X_{it} + \lambda_t + \varepsilon_{it}$$

## Test for policy reform and titling effects:

$$Y_{it} = \alpha_j + \beta_1 T_{it} + \beta_2 R_{it-1} + \beta_3 P \times R_{it-1} + \delta X_{it} + \lambda_t + \varepsilon_{it}$$

where:

- $T_{it}$  = Post-2010 LTR dummy (systematic titling)
- $P$  = Post-2010 policy dummy (land Act and establishment of LAA)
- $R_{it-1}$  = Lagged stock of registered land (all or female)
- $X_{it}$  = Time-varying control variables including population density, share of tree and shrub area at the block level.
- $\alpha_j$  and  $\lambda_t$  are block and time fixed effects.

## **Imbalance between systematic (LTR) and sporadic blocks in pre-treatment indicators**

- Systematic blocks were more densely populated and built, but
- had fewer sporadically registered parcels, and
- fewer registered sales and mortgages transactions.

## **Propensity score matching is used to generate a comparable sample. Pre-treatment matching indicators include:**

- Number of registered parcels, sales and mortgages
- Share of total and registered built-up area
- Share of tree and shrub area
- Population density

# Descriptive statistics at block level: Matched sample

	Year	Total		Matched Sample		t-test
		Total	Treatment	Control		
No. of parcels registered	1990	1.35	1.28	1.27	1.29	
	2000	3.2	3.27	3.27	3.26	
	2010	5.76	5.27	4.99	5.54	
No. of registered transfers	1990	0.04	0.025	0.024	0.026	
	2000	0.03	0.019	0.024	0.014	
	2010	0.06	0.04	0.05	0.03	
No. of registered mortgages	1990	0.097	0.092	0.092	0.092	
	2000	0.011	0.007	0.009	0.005	
	2010	0.076	0.046	0.043	0.05	
Share of total area built	1990	0.382	0.419	0.43	0.407	
	2000	0.445	0.501	0.509	0.493	
	2010	0.476	0.534	0.54	0.528	
Share of registered built area	1990					
	2000	0.052	0.051	0.052	0.049	
	2010	0.085	0.082	0.084	0.08	
Population density (indiv./km <sup>2</sup> )	1990	954	960	918	1001	
	2000	1356	1444	1423	1464	
	2010	1570	1665	1648	1681	
Share tree area (%)	1990					
	2000	0.051	0.05	0.054	0.046	
	2010	0.045	0.047	0.046	0.048	
Share shrub area (%)	1990					
	2000	0.858	0.887	0.884	0.89	
	2010	0.821	0.835	0.845	0.825	**
Number of blocks		1932	1715	995	720	

Source: LAA land administration database from 2011 and digitization of paper records, 1981–2011 for parcels, transfers, and mortgages registered. WSFE for built area; and gridded population of the world v4 (CIESIN) for population density. Landsat 7 and 8 Collection 1 Tier 1 32-Day NDVI Composite provided by google (Landsat-7 and Landsat-8 images courtesy of the U.S. Geological Survey) for share of tree (NDVI>0.5) and shrub (0.2<NDVI≤0.5) area 30 m resolution.

## Econometric concern 2: Endogeneity

- Endogeneity might be a concern in the case of sales and mortgage transactions.
- To address this, spatial instrumental variables are employed, utilizing the distance-weighted average of the treatment variable (i.e., lagged stock of registered parcels) from all other blocks within the ward.
- However, if spatial dependence between units exists, then the exclusion restriction might be violated.
- This is assessed by estimating a spatial autoregressive model with alternative bandwidths: 2-, 5-, and 8-kilometer bands.

# Test for spatial dependence

	Parcels reg. first time		Registered sales		Registered mortgages	
	Total	Female own	Total	Female own	Total	Female own
<b>5-km band</b>						
Titling dummy	7.4292*** (0.6370)	6.7725*** (0.5780)	-0.0301 (0.0520)	0.0306 (0.0320)	-0.0215 (0.0260)	-0.0099 (0.0190)
Stock of reg. parcels (lagged)	-0.2796*** (0.0320)	-0.2555*** (0.0270)	0.0043 (0.0050)	-0.0081 (0.0060)	-0.002 (0.0040)	0.0023 (0.0040)
Reform # stock of reg. parcels	-0.022 (0.0220)	-0.0063 (0.0190)	0.0068** (0.0030)	0.0166*** (0.0050)	0.0069** (0.0030)	0.0022 (0.0040)
<b>Spatial</b>						
Lag of the outcome	1.5718*** (0.0050)	1.1791*** (0.0020)	0.0339 (0.3440)	0.1553 (0.1500)	0.1188 (0.1130)	0.1203 (0.1290)
Autoregressive errors	0.9499*** (0.0270)	0.9337*** (0.0240)	0.1085 (0.3410)	0.1942 (0.1410)	0.2120** (0.0920)	0.3570*** (0.1360)
N	13,720	13,720	13,720	13,720	13,720	13,720

Note: Note: Units of observation are 250m x 250m blocks in the 2007–2014 period (with systematic first-time registration phased in over 2011–2014) and 'reform' denoting regulatory and institutional reforms, i.e., the Land Act and establishment of LAA that were effective from 2011. The estimated model includes both spatial autoregressive and spatial autocorrelation error terms with row normalized inverse distance spatial weighting matrix restricted to nearby areas within [ref:2-km](#), 5-km or [ref:8-km](#) band. Standard errors are in parentheses: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.010$ .



# Titling effect: short-panel (2007-2014)

	Parcels reg. first time		Registered sales		Registered mortgages	
	Total	Female own	Total	Female own	Total	Female own
<b>Panel A: Regression</b>						
Titling dummy	9.0969*** (0.3479)	7.9478*** (0.3108)	0.0655* (0.0382)	0.0913*** (0.0235)	0.0228 (0.0220)	0.0259** (0.0128)
R-squared	0.4625	0.4614	0.0486	0.0485	0.0173	0.0196
Mean dep. var.	0.2485	0.1009	0.0556	0.0234	0.0476	0.0078
SD dep. var.	0.7229	0.4676	0.264	0.1622	0.2395	0.09
<b>Panel B: Placebo</b>						
Pseudo tilting dummy	-0.0563 (0.0527)	-0.0439 (0.0352)	0.0137 (0.0134)	0.0051 (0.0100)	-0.0015 (0.0120)	-0.0041 (0.0051)
R-squared	0.0131	0.0154	0.0047	0.0046	0.0064	0.001
Mean dep. var.	0.17	0.0534	0.0379	0.0121	0.0242	0.0052
SD dep. var.	0.5507	0.2613	0.21	0.1119	0.1636	0.0721

Note: Regressions in panel A are for 2007–2014 with systematic first-time registrations in 2011–14; placebo tests in panel B are for 2003–10 with a pseud-systematic registration four years earlier; dependent variables are as indicated in the table title. The number of observations (i.e., 250m x 250m blocks) is 13,720 (1,715 blocks annually for 8 years) in both panels A and B. Mean and standard deviation for the dependent variable are for the pre-program period. Standard errors are in parentheses: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.010$ .

# Titling and policy effects: short-panel (2007-2014)

	Registered sales		Registered mortgages	
	Total	Female own	Total	Female own
<b>Coefficients</b>				
Titling dummy	-0.1279*** (0.0330)	-0.0313 (0.0260)	-0.0678*** (0.0260)	-0.0102 (0.0170)
Stock of registered parcels (lagged)	0.0117*** (0.0040)	-0.0129 (0.0080)	0.0009 (0.0030)	-0.003 (0.0060)
Reform # stock of reg. parcels	0.0108*** (0.0020)	0.0290*** (0.0070)	0.0098*** (0.0020)	0.0078 (0.0060)
<b>Elasticities (lag of reg. parcels)</b>				
Total effect (policy=1)	1.1392*** (0.1717)	0.6396*** (0.1233)	0.7147*** (0.1805)	0.7759*** (0.2014)
Direct effect	0.5941*** (0.2144)	-0.5125 (0.3163)	0.0619 (0.2254)	0.4442 (0.5164)
Interaction with policy	0.5451*** (0.1188)	1.1521*** (0.2723)	0.6528*** (0.1248)	0.3317 (0.4445)
Mean dep. var.	0.056	0.023	0.048	0.008
SD dep. Var	0.264	0.162	0.239	0.09

Note: Units of observation are 250m x 250m blocks in the 2007–2014 period (with systematic first-time registration phased in over 2011–2014) and 'reform' denoting regulatory and institutional reforms, i.e., the Land Act and establishment of LAA that were effective from 2011. The stock of registered parcels is the lagged cumulative number of parcels registered in the name of a women alone or jointly and its interaction with the policy dummy. The number of observations throughout is 13,720 (1,715 blocks annually for 8 years). Mean and standard deviations for the dependent variables are for the pre-program period. Standard errors are in parentheses: \* p<0.10, \*\* p<0.05, \*\*\* p<0.010.

## Estimating equation (continuous indicators): spatial IV

$$Y_{it} = \alpha_j + \theta_1 R_{it-1}^P + \theta_2 R_{it-1}^P \times P + \theta_3 R_{it-1}^Y + \delta X_{it} + \lambda_t + \varepsilon_{it}$$

where:

- $R_{it-1}^P$  = Lagged stock of sporadic registered land (total or at least a female): instrumented by the average value of all other blocks in the ward
- $P$  = Post-2010 policy dummy
- $R_{it-1}^Y$  = Lagged stock of systematic registered land (total or at least a female)

# Titling and policy effects: long panel (2000-2019)

	No. of registered sales		No. of reg. mortgages	
	Total	Female owner	Total	Female owner
<b>Coefficients</b>				
Systematically reg. parcels, $\theta_3$	0.0066*** (0.0000)	0.0051*** (0.0000)	0.0016*** (0.0000)	0.0016*** (0.0000)
Sporadically reg. parcels, $\theta_1$	0.0479*** (0.0030)	0.0286*** (0.0070)	0.0296*** (0.0020)	0.0323*** (0.0040)
Spor. reg. parcels # post-2011, $\theta_2$	0.0071*** (0.0020)	0.0264*** (0.0060)	0.0029** (0.0010)	-0.0035 (0.0040)
<b>Elasticities</b>				
Syst. reg. parcels, $\theta_3$	0.1966*** (0.0124)	0.0862*** (0.0061)	0.0811*** (0.0151)	0.0436*** (0.0064)
Spor. reg. parcels post-reform, $\theta_1 + \theta_2$	1.9646*** (0.0940)	1.0108*** (0.0554)	2.0055*** (0.1174)	1.1134*** (0.0744)
Spor. reg. parcels with no reform, $\theta_1$	1.7101*** (0.1203)	0.5255*** (0.1275)	1.8262*** (0.1503)	1.2477*** (0.1712)
Spor. reg. parcels # post-2011, $\theta_2$	0.2545*** (0.0660)	0.4853*** (0.1051)	0.1793*** (0.0824)	-0.1343 (0.1413)
Mean dep. var.	0.041	0.015	0.034	0.007
SD dep. Var	0.225	0.129	0.198	0.084

Note: All regressions are at for 250m x 250m blocks for 2000–19. The dependent variable is the number of registered sales or mortgages, overall and with female co-owner at block level. Dependent variables (systematically and sporadically registered parcels) refer to the lagged cumulative number of parcels systematically or sporadically registered and the latter instrumented by its two-period lagged value as discussed in the text. The number of observations is 32,585 (1,715 blocks annually for 19 years) throughout. Mean and standard deviations for the dependent variables are for the pre-program period. Elasticities are calculated at mean values. Standard errors are in parentheses: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.010$ .

# Gender effects: long panel (2000-2019)

Number of parcels registered for the first time with a female co-owner in the relevant year

	Naïve Regression	With Policy Reforms	
		2006 only	2006 and 2011
Systematically reg. parcels, $\gamma_3$	0.8700*** (0.0049)	0.8702*** (0.0050)	0.8703*** (0.0049)
Sporadically reg. parcels, $\gamma_1$	0.4856*** (0.0555)	0.2671*** (0.0296)	0.2618*** (0.0285)
Sporadically reg. parcels # post-2006, $\gamma_4$		0.2331*** (0.0518)	
Sporadically reg. parcels # post-2006 & pre-2011, $\gamma_0$			0.1309** (0.0596)
Sporadically reg. parcels # post-2011, $\gamma_2$			0.2523*** (0.0608)
N	32,585	32,585	32,585
R-squared	0.971	0.9714	0.9715

Note: All regressions are for 32,585 (1,715 blocks annually for 19 years) 250m x 250m blocks for 2000–19. Standard errors are in parentheses. Standard errors are in parentheses: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.010$ .



# Test of spatial dependence: 2-km and 8-km bands

	Parcels reg. first time		Registered sales		Registered mortgages	
	Total	Female own	Total	Female own	Total	Female own
<b>2-km band</b>						
Titling dummy	7.1344*** (0.6720)	6.1943*** (0.5980)	-0.0316 (0.0530)	0.0315 (0.0330)	-0.0183 (0.0250)	-0.0072 (0.0190)
Stock of registered parcels (lagged)	-0.2623*** (0.0330)	-0.2262*** (0.0280)	0.0045 (0.0050)	-0.0073 (0.0060)	-0.0021 (0.0030)	0.0021 (0.0040)
Reform # stock of registered parcels	-0.0275 (0.0220)	-0.0124 (0.0180)	0.0067** (0.0030)	0.0161*** (0.0060)	0.0070** (0.0030)	0.0024 (0.0040)
<b>Spatial</b>						
Lag of the outcome	0.8588*** (0.0390)	0.8765*** (0.0350)	0.0213 (0.2080)	0.064 (0.1330)	0.0809 (0.0740)	0.0949 (0.0610)
Autoregressive errors	0.7112*** (0.0490)	0.7056*** (0.0530)	0.1142 (0.1870)	0.1846 (0.1130)	0.1018 (0.0710)	0.1801*** (0.0690)
<b>8-km band</b>						
Titling dummy	6.7708*** (0.6100)	5.8656*** (0.5280)	-0.0309 (0.0510)	0.0291 (0.0320)	-0.0209 (0.0250)	-0.0089 (0.0180)
Stock of registered parcels (lagged)	-0.2406*** (0.0300)	-0.2245*** (0.0260)	0.0044 (0.0050)	-0.0079 (0.0060)	-0.0021 (0.0030)	0.0022 (0.0040)
Reform # stock of registered parcels	-0.0324 (0.0210)	-0.0082 (0.0180)	0.0068** (0.0030)	0.0164*** (0.0050)	0.0069** (0.0030)	0.0022 (0.0040)
<b>Spatial</b>						
Lag of the outcome	3.2008*** (0.0280)	2.6438*** (0.0320)	0.0477 (0.3810)	0.2051 (0.1870)	0.1389 (0.1330)	0.2001 (0.1510)
Autoregressive errors	1.2124*** (0.0140)	0.9927*** (0.0020)	0.1845 (0.3290)	0.3128** (0.1460)	0.2428** (0.0990)	0.4141*** (0.1450)
N	13,720	13,720	13,720	13,720	13,720	13,720

ref:5-km band