Cadasters and Economic Growth: A Long-Run Cross-Country Panel

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Our research questions

- We study a particular property right institution: The emergence of state-administered *narrative and mapped cadastral records of land ownership*.
- How and when did state-administered cartographic (vs narrative or non-existing) cadastral records of land ownership develop across the world during the last millennia?
- What was the relationship between the introduction of cadastral records and economic growth across countries and over time?
- Through which mechanisms do cadasters affect economic growth?

Contribution/take-away

- Development of data on the rise (and sometimes decline) of formal property rights to land based on cadastral records for 159 countries over the period 1000-2015 CE
- An empirical analysis of the relationship between cadaster-based property rights to land and economic growth, following tightly the empirical strategy of a different study (Acemoglu et al, "Does Democracy Cause Growth?" *Journal of Political Economy*, 2019)

Data

Three major sources of information:

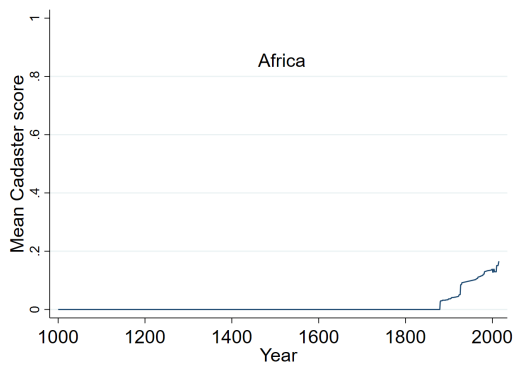
1. The *Cadastral Template Project* - a collection of standardised descriptions of the historical and contemporary states of cadaster in 60 countries around the globe, developed by the International Federation of Land Surveyors
2. Documents from the *Permanent Committee on Cadastre in the European Union* (PCC), and *Comité Permanente sobre el Catastro en Iberoamerica* (CPCE)
3. Specialised academic literature, examining cadastres historically and/or presently

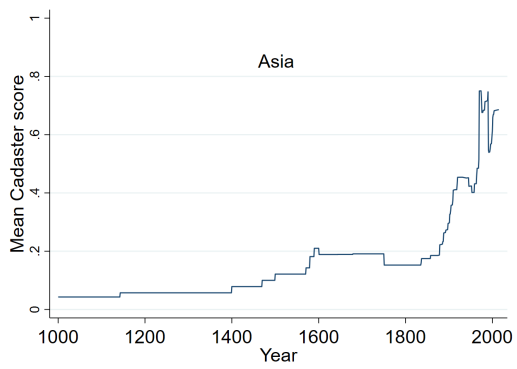
Summarized in Data Appendix to this paper

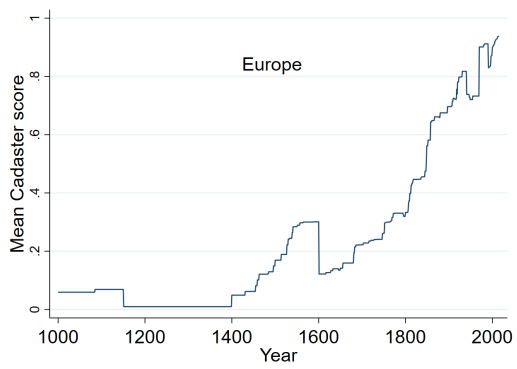
Coding

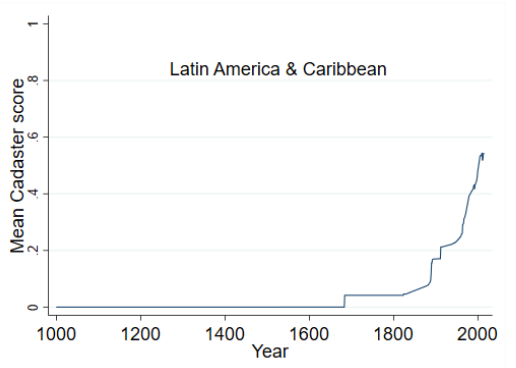
- Years with no cadasters were coded as "0", years with narrative cadaster as "0.75", and years with cartographic cadasters as "1".
- We apply a weight to capture the degree of implementation of cadastral recording by states, measured as percentage of the current territory of the country in question that was covered by the cadaster at different dates.
- In the case of ambiguity, we apply a 50 percent weight.
- For recent cadaster, we separate weights for urban and rural implementation: In those cases where the information on the properly surveyed and registered land is available in hectares, we standardise the coverage measure as a share of agricultural land.

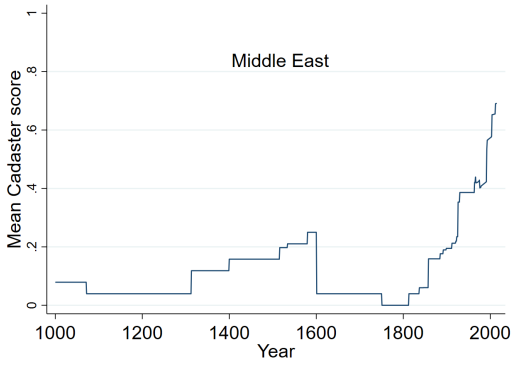
Cadaster index by region

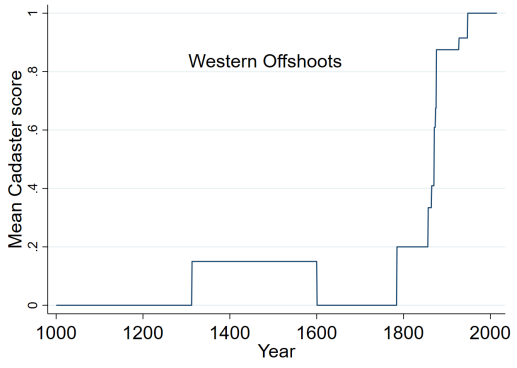








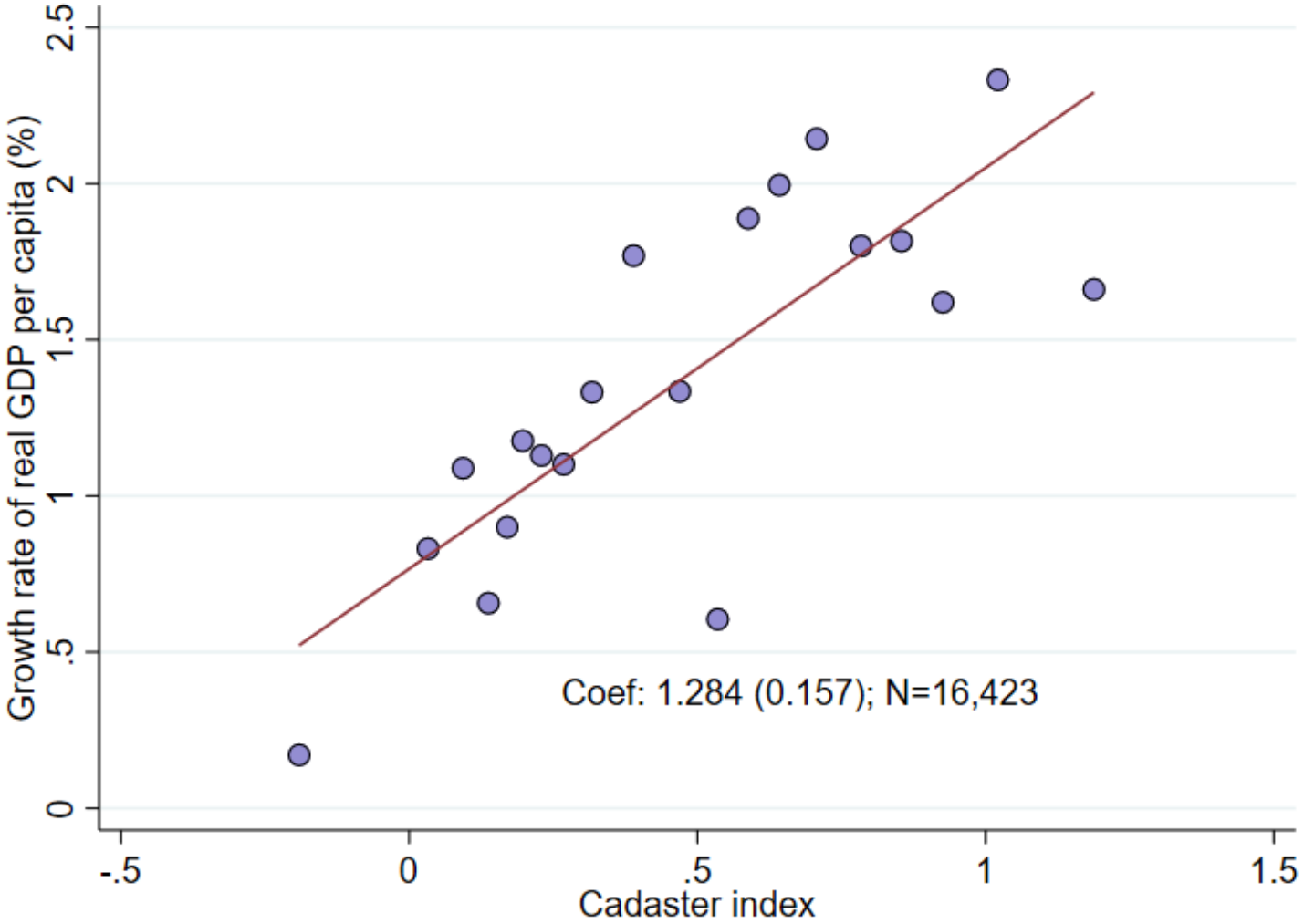




GDP data

- Real GDP per capita *RGDPNApc* (in 2011 USD) from Bolt et al (2018)(Maddison Project), based on growth rates from national accounts, suitable for growth comparisons over time (our chosen main variable)
- 150 countries, for UK from 1252 CE, France from 1280, Sweden from 1300, used for instance by Gollin et al (2021)
- Standard GDP data from *World Development Indicators* of the World Bank

Relationship between cadaster and economic growth pc all years



Baseline specification: Levels regression

- We use a "within"-estimator in a dynamic panel model following Acemoglu et al (2019, "Does Democracy Cause Growth?", JPE)
- We tie our hands and follow their main specification:

$$y_{it} = \beta C_{it} + \sum_{l=1}^{L} \gamma_{t-l} y_{it-l} + \alpha_i + \delta_t + \epsilon_{it} \qquad (1)$$

  - ...where y_{it} is log GDP per capita in country i in year $t \in \{1000, 2015\}$ with $L \geq 1$ lags controlling for pre-trends
  - C_{it} is out *cadaster* variable
  - α_i and δ_t are country and year fixed effects
  - ϵ_{it} is a serially uncorrelated error term
  - β is percentage increase in GDP per capita as a result of the reform in year t

Main results I: Replication of Acemoglu et al (2019)

Table: Effects of *Democracy* and *Cadaster* on GDP per capita, 1960-2010

	Dependent variable: Log GDP per capita								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Democracy	0.973***	0.787***	0.712***			0.814**	0.657***	0.201	0.272
	(0.294)	(0.226)	(0.240)			(0.321)	(0.238)	(0.414)	(0.313)
	[0.288]	[0.250]	[0.266]			[0.318]	[0.263]	[0.411]	[0.329]
Cadaster				3.011**	1.871*	3.455***	2.111*	3.097**	1.810
				(1.276)	(1.051)	(1.310)	(1.101)	(1.292)	(1.127)
				[1.064]	[0.815]	[1.130]	[0.851]	[1.081]	[0.855]
Democracy x Cadaster								1.434**	0.895*
								(0.687)	(0.497)
								[0.736]	[0.544]
y_{it} lags	1	4	4	1	4	1	4	1	4
Long-run	35.59**	21.24***	19.96**	107.87**	51.44*				
effect	(14.00)	(7.21)	(7.80)	(45.05)	(28.23)				
NT	6,790	6,336	5,365	5,825	5,393	5,748	5,355	5,735	5,342
Countries	175	175	145	145	145	145	145	145	145

Remarks I

- Columns (1)-(2) replicate exactly Acemoglu et al (2019)
- Conley (HAC) standard errors correcting for spatial autocorrelation (2000 km cutoff) in []
- A typical cadastral reform of 0.3 would lead to an instantaneous increase in GDP pc with 0.63 percent in column (7)
- Long-run effect in column (5) of a 0-1 cadastral reform is 51.44 percent
- Columns (8)-(9) suggest that cadastral reforms have a stronger effect in democracies

Main Results II: Growth regressions

- Growth regression in Acemoglu et al (2019)

$$\Delta y_{it} = \beta C_{it} + \sum_{l=1}^{L} \gamma_{t-l} \Delta y_{it-l} + \alpha_i + \delta_t + \epsilon_{it} \qquad (2)$$

  - ...where $\Delta y_{it} = y_{it} - y_{it-1}$, i.e. an annual growth rate since y_{it} is in log form
  - C_{it} is our *cadaster* variable
  - α_i and δ_t are country and year fixed effects
  - ϵ_{it} is a serially uncorrelated error term
  - β percentage point increase in growth rate of GDP per capita as a result of the reform in year t

Main results II: Replication of Acemoglu et al, 2019

Table: Effects of *Democracy* and *Cadaster* on the growth rate of real GDP per capita, 1960-2010

	Dependent variable: Growth rate of real GDP per capita								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Democracy	1.028***	1.269***	1.156***			0.914***	1.115***	0.768**	1.029***
	(0.250)	(0.243)	((0.254))			(0.264)	(0.254)	(0.326)	(0.310)
	[0.241]	[0.256]	[0.273]			[0.261]	[0.268]	[0.332]	[0.322]
Cadaster				1.716*	1.720*	1.965**	1.855*	1.863*	1.774
				(0.936)	(1.028)	(0.977)	(1.065)	(0.991)	(1.084)
				[0.896]	[0.906]	[0.960]	[0.943]	[0.929]	[0.946]
Cadaster x Democracy								0.330	0.189
								(0.563)	(0.562)
								[0.590]	[0.560]
Δy_{it} lags	1	4	4	1	4	1	4	1	4
NT	6,642	6,178	5,219	5,681	5,249	5,620	5,219	5,607	5,206
Countries	175	175	145	145	145	145	145	145	145

Long-Run Growth: "Maddison" Data

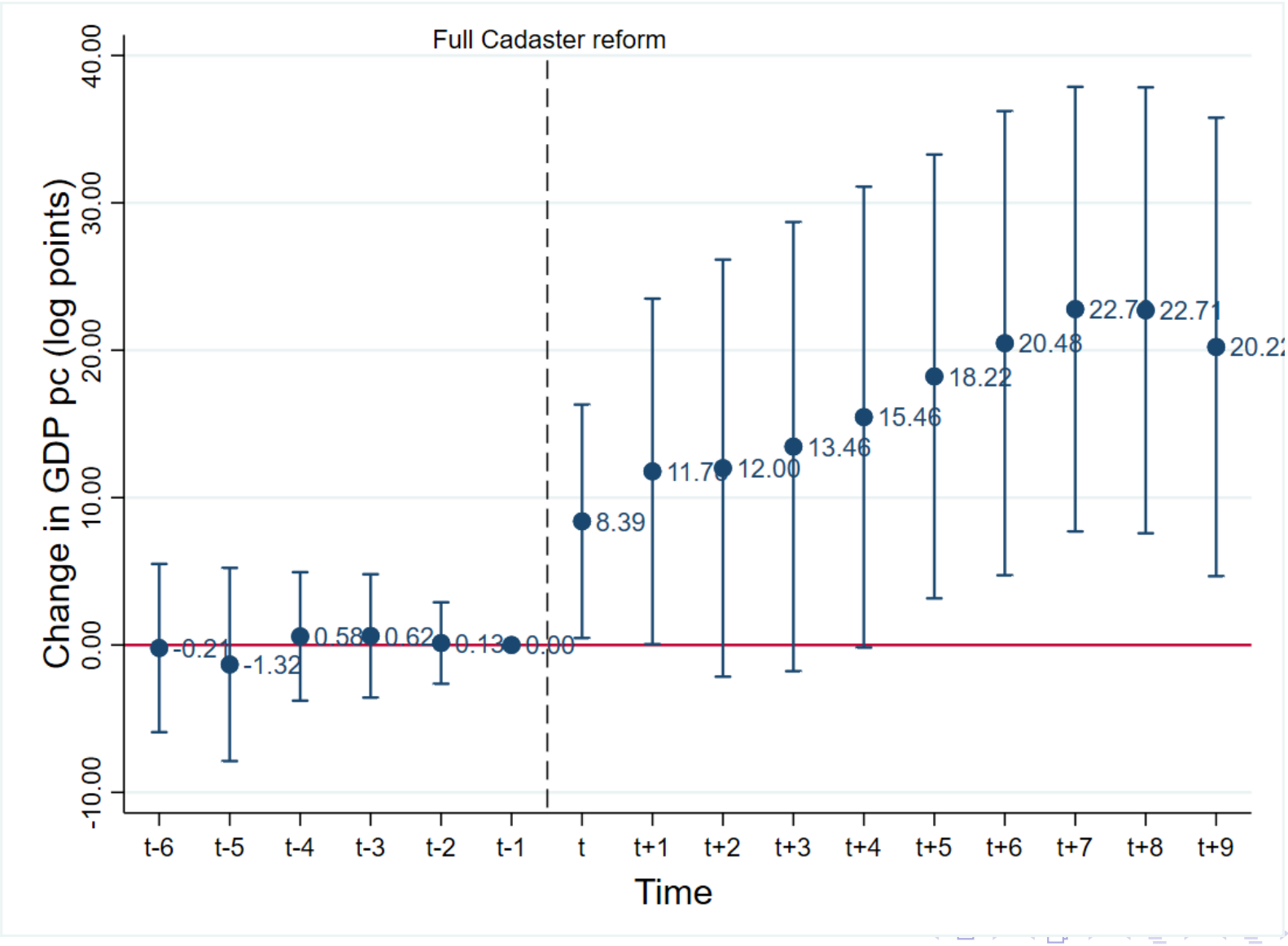
Table: Effect of *Cadaster* on GDP per capita through history, 1252-2015

	Dependent variable:					
	Log GDP per capita (Maddison)					
	1252-2015		**1900-2015**		**1950-2015**	
	(1)	(2)	(3)	(4)	(5)	(6)
Cadaster	0.600	0.555	1.941**	1.603**	2.747***	2.012**
	(0.538)	(0.497)	(0.842)	(0.698)	(1.023)	(0.789)
y_t lags	1	4	1	4	1	4
NT	16,423	15,911	11,219	10,833	8,999	8,689
Countries	150	150	150	150	150	150

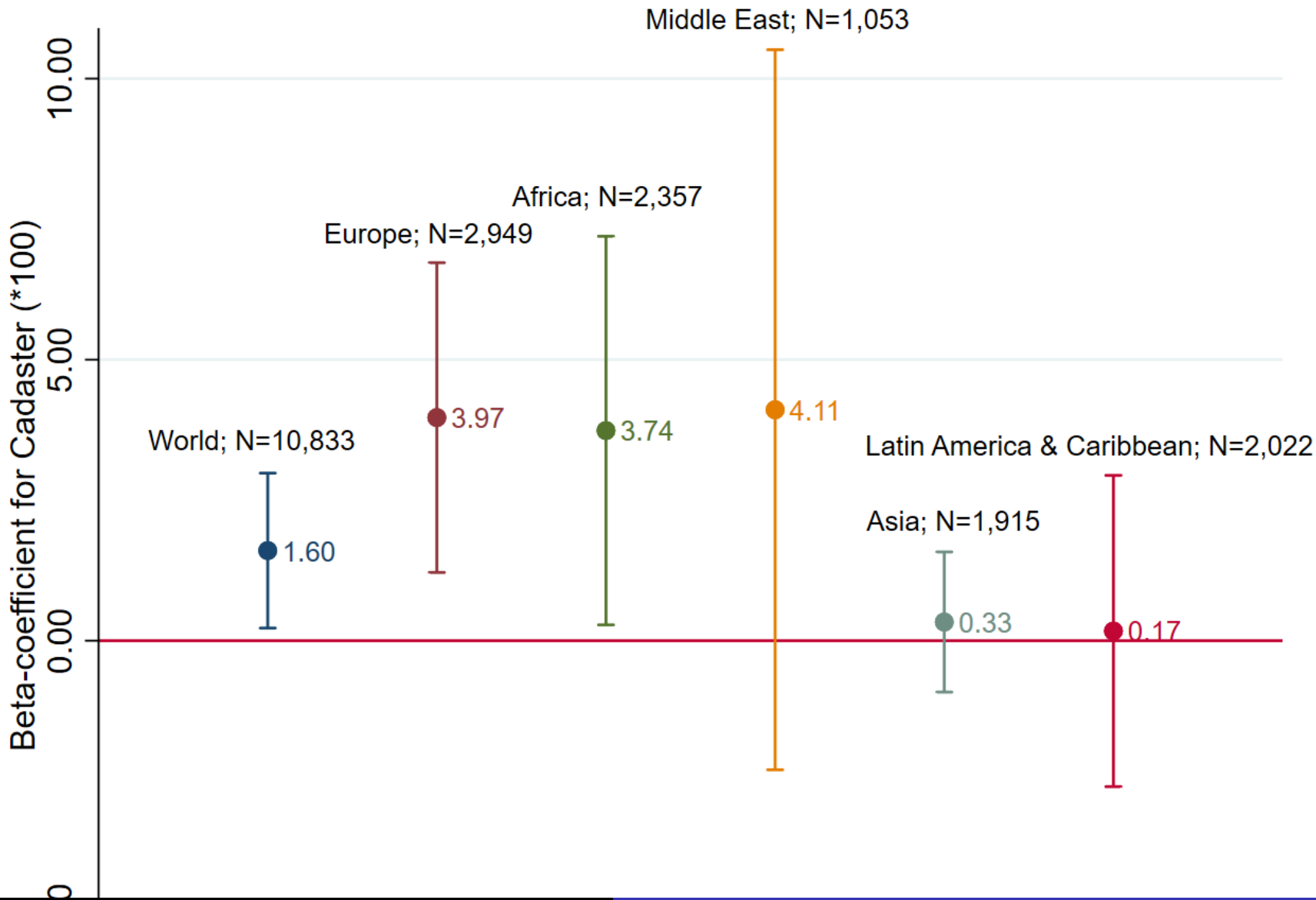
Remarks III

- 1900-2015 covers 44 countries, 1950-2015 120+ countries.
- Estimate in column (6) implies that a typical cadastral reform is associated with an increase in GDP per capita by 0.6 percent

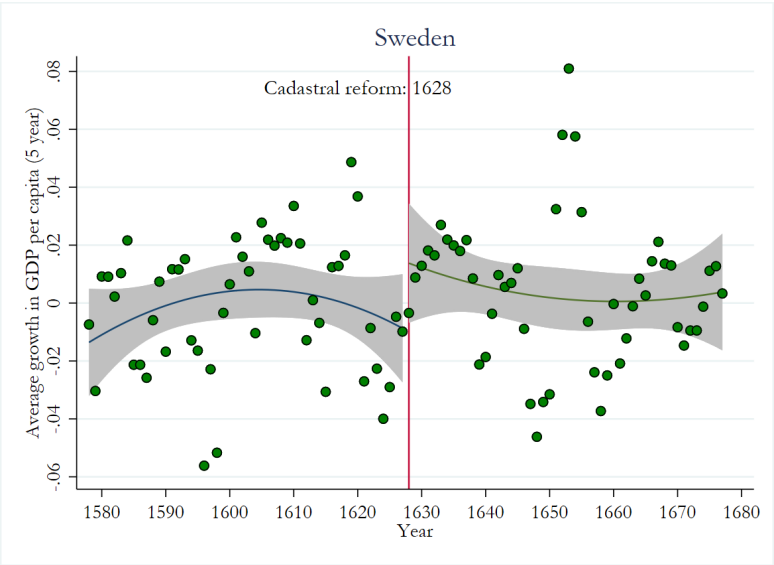
Treatment effects and selection on observables

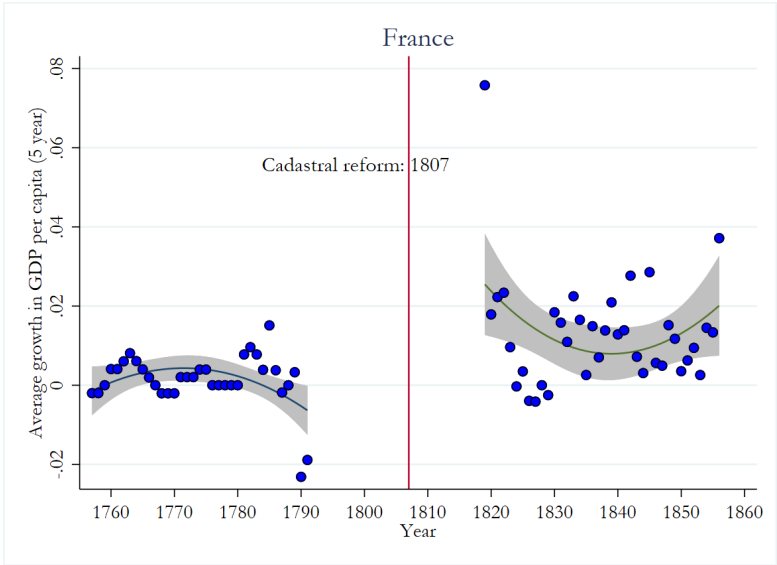


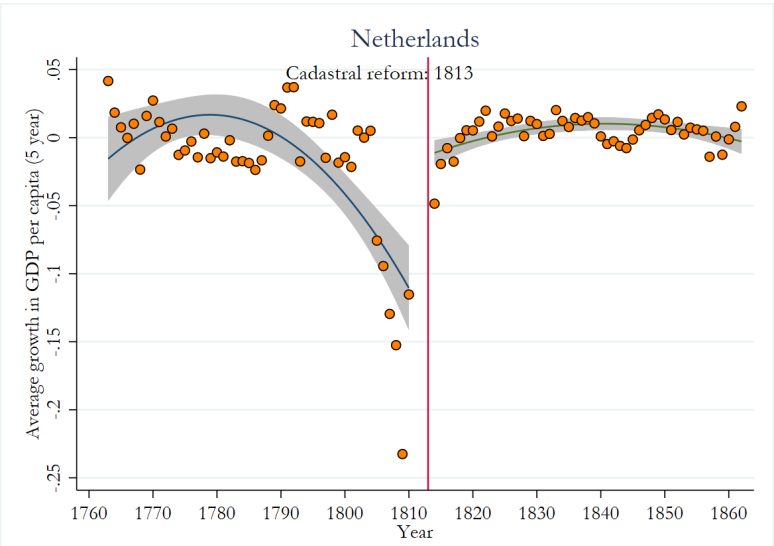
Spatial parameter heterogeneity

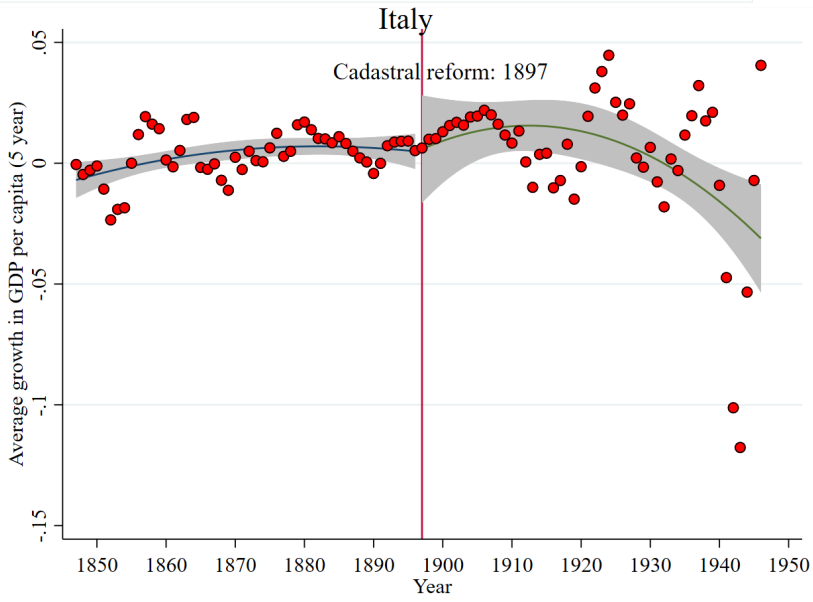


Event study of full cadastral reform in four countries









Mechanisms

Main equation to be estimated: The basic empirical equation that we estimate in the sections on mechanisms is:

$$M_{it} = \beta C_{it} + \sum_{l=1}^{L} \omega_{t-l} M_{it-l} + \sum_{l=1}^{L} \gamma_{t-l} y_{it-l} + \alpha_i + \delta_t + \epsilon_t \quad (3)$$

- M_{it} is the mechanism in question (transaction costs, tax levels, investment)

Effect of Cadaster on transaction costs

Dependent variable is World Bank's *Registering Property Indicators*

Table: Effect of *Cadaster* on Transaction Costs, 2005-2015

	Dependent variable:					
	Procedures (#)		**Time(days)**		**Cost (% value)**	
	(1)	(2)	(3)	(4)	(5)	(6)
Cadaster	-1.031**	-0.320	-274.067***	-98.246***	-5.840***	-0.034
	(0.402)	(0.284)	(67.233)	(23.301)	(1.190)	(0.308)
Mean	6.07	6.07	64.04	64.04	6.14	6.14
Country FE	✓	✓	✓	✓	✓	✓
Year FE		✓		✓		✓
y_t, lags	0	1	0	1	0	1
M_t, lags	0	1	0	1	0	1
N	1,459	1,256	1,459	1,256	1,459	1,256
Countries	149	142	149	142	149	142

Effect of Cadaster on tax revenue

Table: Effect of *Cadaster* on Tax Revenue, 1980-2015 and 1960-2015

	Dependent variable:							
	Property taxes	**Direct taxes**	**Indirect taxes**		**Tax ratio**		**Tax ratio (ANRR sample)**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cadaster(t)	0.026	0.043	0.773***	0.971**	1.126***	1.054***	0.907*	1.285**
	(0.046)	(0.179)	(0.260)	(0.398)	(0.370)	(0.377)	(0.502)	(0.609)
Mean	0.78	8.58	10.79	10.79	19.28	19.28	18.13	18.13
y_t, lags	1	1	1	4	1	4	1	4
M_t, lags	1	1	1	4	1	4	1	4
Period			1980-2015				1960-2015	
N	2,361	2,454	2,640	2,265	2,499	2,145	4,429	4,084
Countries	108	108	115	111	106	105	115	115

Discussion

- Positive association between cadastral reform and growth in income per capita
- A causal relationship? Omitted variable bias?
- Acemoglu et al (2019): GMM, HHK, and IV estimations
- In cross-country analyses, almost impossible to completely rule out omitted variables
- Bottom line: *New data and an empirical analysis based on preferred specification in other paper*