Resetting the Urban Network: 117-2012AD

Guy Michaels (LSE)

Ferdinand Rauch (Oxford)

Preliminary and incomplete

Introduction

- Are urban locations pinned down by locational fundamentals or is there path dependence?
  - Suppose we “reset” urban network and follow as towns re-emerge, comparing to similar network that was not reset
- We assemble new dataset on urban locations in France and Britain over two millennia
  - Rome occupied and urbanized both about 2000 years ago
  - 450AD: towns ceased to function in Britain, but not in France
  - What happened when urbanization restarted?

Simple Model

- A town is built in one of two locations
  - Locational advantage may exogenously change over time
  - If town exogenously dies it later re-establishes in best location
- Three different scenarios are possible:
  1. Fixed locational advantage (one location is always best)
     - High persistence of urban locations in both Britain and France
  2. Changing locational advantage with weak towns
     - Low persistence of urban locations in both Britain and France
  3. Changing locational advantage with strong towns
     - Persistence low in Britain & high in France, due to path dependence

Main Findings

- Persistence ≡ $\frac{\text{P(Site with Roman town is used by later town)}}{\text{P(Site without Roman town is used by later town)}}$

1. Persistence in France about 3 times higher than in Britain from Early Middle Ages until 1700
   - Consistent with 3rd Scenario (path dependence)
2. Why did British towns move from Roman sites?
   - In part because medieval British urban network reconfigured around coasts and navigable rivers
3. Why did French towns stay in Roman sites?
   - Possible role for 4th century Roman bishoprics

Contributions

- New dataset tracing urbanization in Britain and France from Roman Empire till the present day
- Methodology for measuring urban locations' persistence
- Implications of our findings:
  - Empirically characterize (sufficiently) extreme conditions for resetting an urban network
  - Temporary institutions affect urban locations over 1000+ years
  - Urban network may reconfigure around locational fundamentals that became valuable
    - But this isn't inevitable: towns may be stuck in obsolete locations

Structure of Presentation

- Related literature
- Simple model
- Historical overview
- Data
- Methodology
- Results and robustness
- Conclusions

Related Literature

- Theories of path-dependence: David (AER 1985), Arthur (1994)
- Models of spatial agglomeration: Krugman (JPE 1991)
- Empirical evidence in economic geography:
  - Mean reversion after wars and epidemics: Davis and Weinstein (AER 2002); Brakman, Garretsen, and Schramm (JEG 2004); Miguel and Roland (JDE 2011); Paskoff (2008); Beeson and Troesken (2006)
  - Path-dependence in modern economies: Redding, Sturm, and Wolf (ReStat 2011); Bleakley and Lin (QJE 2012); Kline & Moretti (2012)
- Debates over poor location of some urban centers: Glaeser (2005)
- Economics of European urbanization since middle ages: Acemoglu, Johnson, Robinson (2005) Bosker (2011)
- Roman Economy: Temin (JEP 2006), Bowman and Wilson (2011)

Simple model of urban location

- Infinite horizon discrete time model
- Measure 1 of identical, infinitely-lived people, each of whom maximizes $\sum\beta^t u(c_t)$, where $0<\beta<1$
- Two locations: $i\in\{1,2\}$
  - Fundamentals' contribution to location i's productivity is θ_i
    - Assume $\theta_i\in\{0, \theta_F\}$, $\theta_1\neq\theta_2$
    - In 1st period: $\theta_1=\theta_F>0$ and $\theta_2=0$
    - Each subsequent location productivity flips with probability p_F
    - Fundamentals themselves and/or their relative value may change
  - Town may form in either location
    - Working in town gives (additive) productivity adjustment θ_T
    - θ_T may be positive or negative, but we focus on case: $\theta_T+\theta_F\geq 0$

Sequence of events in each period

- Every period:
  - Each person costlessly chooses location, taking current town location as given
  - Each person inelastically supplies 1 unit of labor, receives output they produce, and consumes it
  - Nature then determines locational advantage for the next period: advantage flips with probability p_F
  - With probability $p_T \in (0,1)$ town is disrupted for one period and only fundamentals determine productivity
    - Following period town emerges in most productive location

Equilibrium: 3 possible scenarios

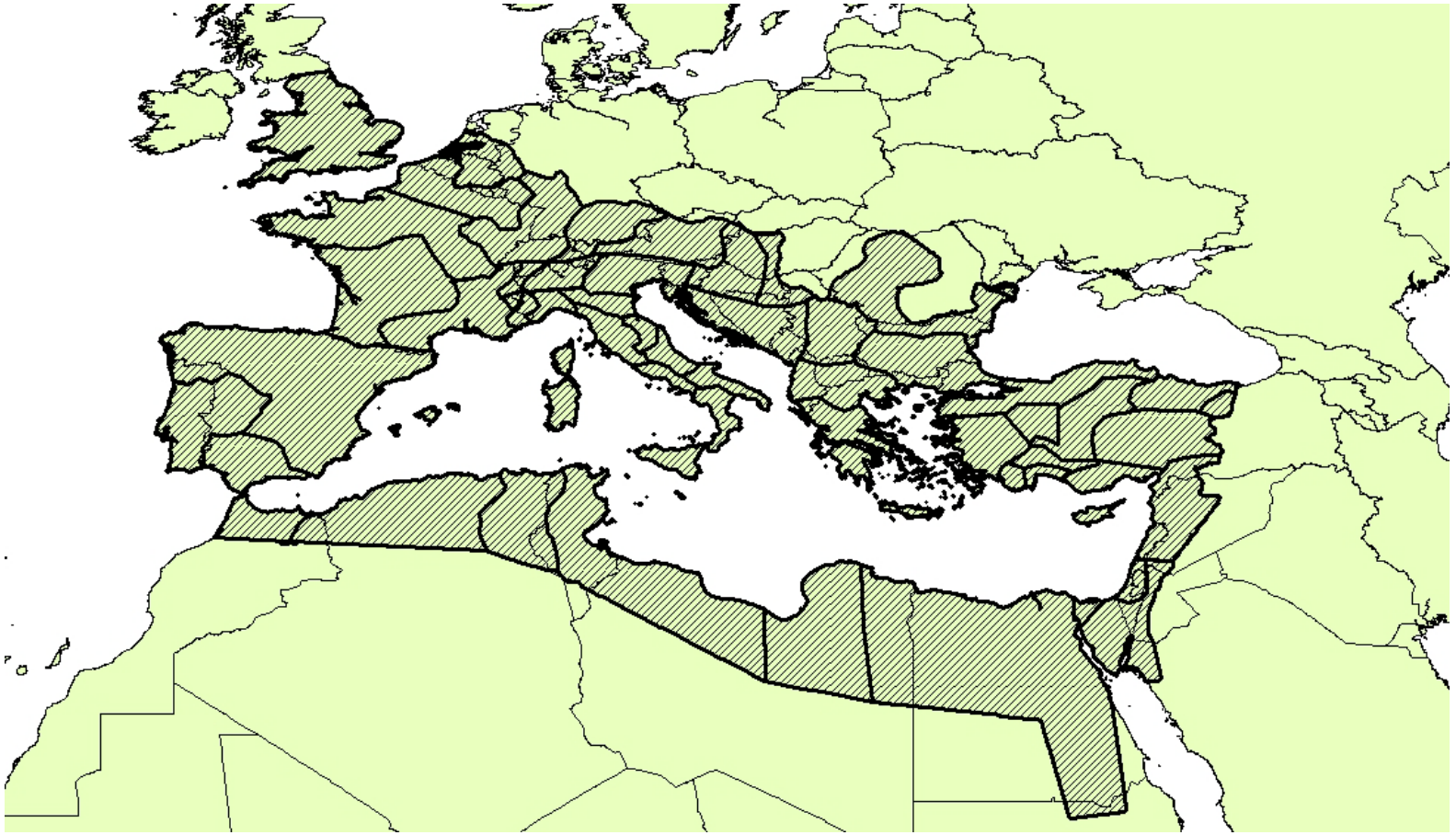
1. Fixed locational advantage ($p_F=0$): location 1 always more productive, and town always re-establishes in it
   - Expect high locational persistence in both France and Britain
2. Changing locational advantage with weak towns ($p_F>0$ and $\theta_F \geq \theta_T$): town always moves to better location
   - Expect low locational persistence in both France and Britain
3. Changing locational advantage with strong towns ($p_F>0$ and $\theta_F<\theta_T$): if locational fundamentals change town will remain in location despite it having become worse. Town will only move if it is exogenously disrupted
   - Expect high persistence in France and low persistence in Britain

Implication for town location in Scenario 3

- In Scenario 3 towns town location may be suboptimal:
  - Expected utility from being in town in better location strictly higher that from being in town in worse location
  - So a central planner would want to move town to better (more productive) location
  - Even if we add costs to moving town (not currently in model), town may still be "trapped" in worse location

- We now describe the setting in which we test between the three possible equilibrium scenarios

Roman Empire around Trajan's Death (117AD)

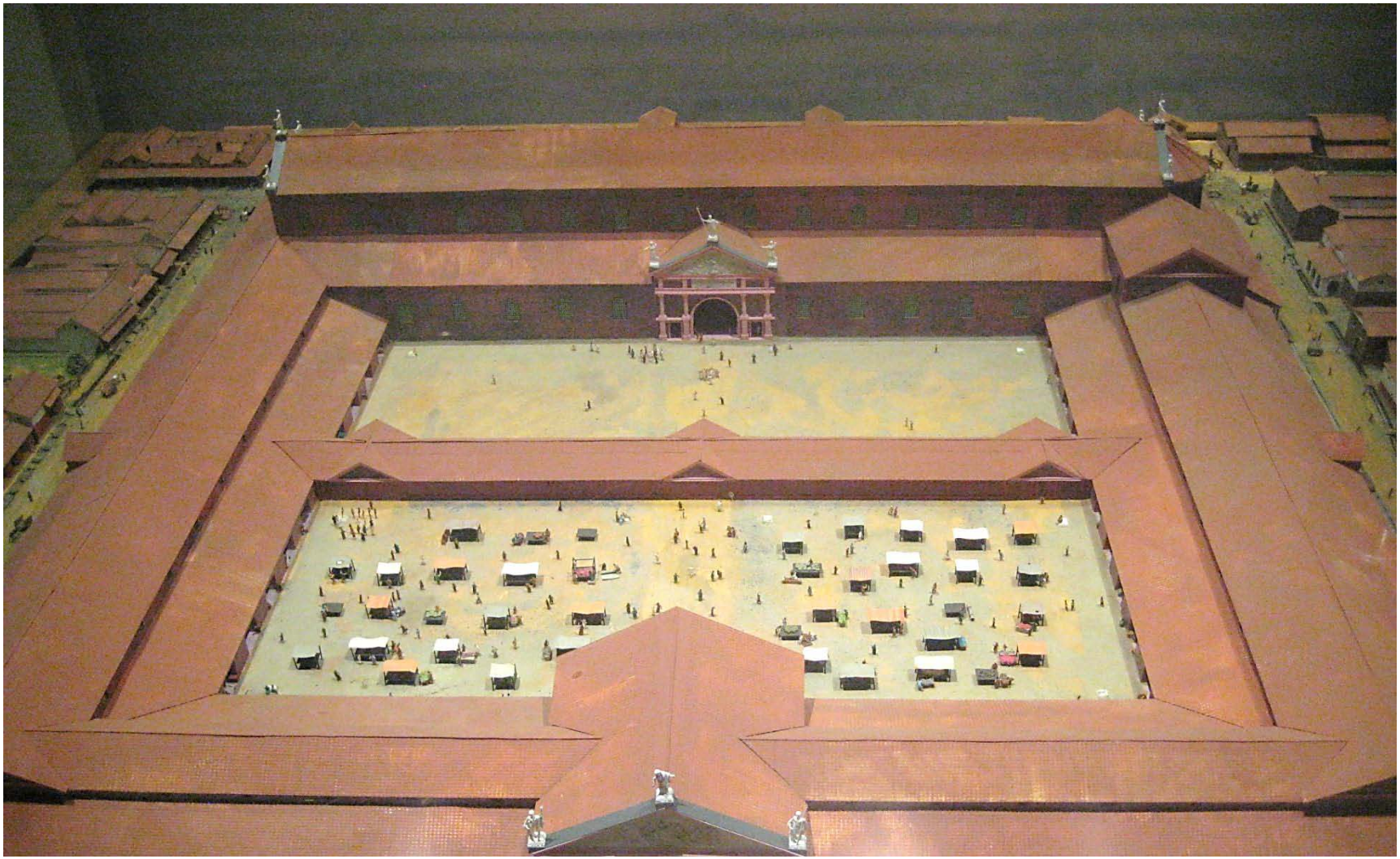


Note: We use "Britain" in reference to the part of the island south of Hadrian's Wall (which was constructed within about a decade of Trajan's death)

Historical overview:
Early Urbanization in Britannia and Gaul

- Rome conquered Gaul (France) mostly from 58-50BC and Britannia (Britain) around 43-84AD
- 1st-2nd centuries: administrative towns (*colonia, municipia, civitas*-capitals) develop and thrive with int'l trade. Roman army plays key roles
- 3rd century: warfare and usurpations. Towns in Gaul shrink. Britain is more stable, town walls built, rural economy becomes more productive and more monetized

Model of Londinium basilica, the largest north of the Alps



How populous were Roman towns in Britain compared to France?

- Wilson (2011) estimates lower bound for population in largest towns (with 5,000+ people) at empire's peak:
  - Britain: 114k
  - France: 222k of which 69k in North (Lugdenensis & Belgica)
- We use larger sample of Roman towns:
  - Britain: 74 towns. 38 had defenses≥5ha (mean(ln(area)=2.93))
  - France: 167 towns. 57 had defenses≥5ha (mean(ln(area)=2.97))
    - North France: 64 towns. 29 had defenses≥5ha (mean(ln(area)=2.79))
- Suggests Britain not so vastly different from France
  - Britain even more similar to Northern France in terms of geography, history and Roman era urbanization

Change and Decline in Roman Britain

- Early 4th century: larger British towns slowly depopulate, but `small' towns & villas develop
- Late 4th century: Roman Britain withstands incursions from north, usurpations and reprisals against elite. Major towns further contract
- Around 410AD: Germanic tribes cross Rhine into Gaul. Rome is sacked. Roman legions leave Britain
- By around 450 towns in Britain cease to function

The ending of Roman towns in Britain

- Ward-Perkins (2008, p. 350) “But most scholars would agree that, at least in the early fourth century, the province of Britain was flourishing, with a rich villa economy in the countryside, and a network of towns which included not only administrative capitals (civitates), but also secondary production and marketing centres whose prosperity depended primarily on economic activity. By the end of the fifth century... There were no towns, no villas and no coins.”
- Palliser (2008, p. 21-22, quoting Esmonde-Cleary 1989): “All of this, functioning with difficulty between c. 380 and 410, collapsed suddenly ‘in the generation or so after 411. In that time the towns, the villas, the industries and the other material evidence diagnostic of Roman Britain disappeared’.”
- Fleming (2010, p. 183): “within a generation or two of 400 all the towns of Roman Britain had ceased to function as towns”
- Mattingly (2006, p. 533): “It now seems clear that there was no real continuity of urban community between Roman Britain and Saxon England”
- Nicholas (1997, p. 23): “Although Roman urbanization… virtually ended in Britain… a stronger case for continuity can be made for some cities of interior Gaul, particularly those that housed bishoprics”

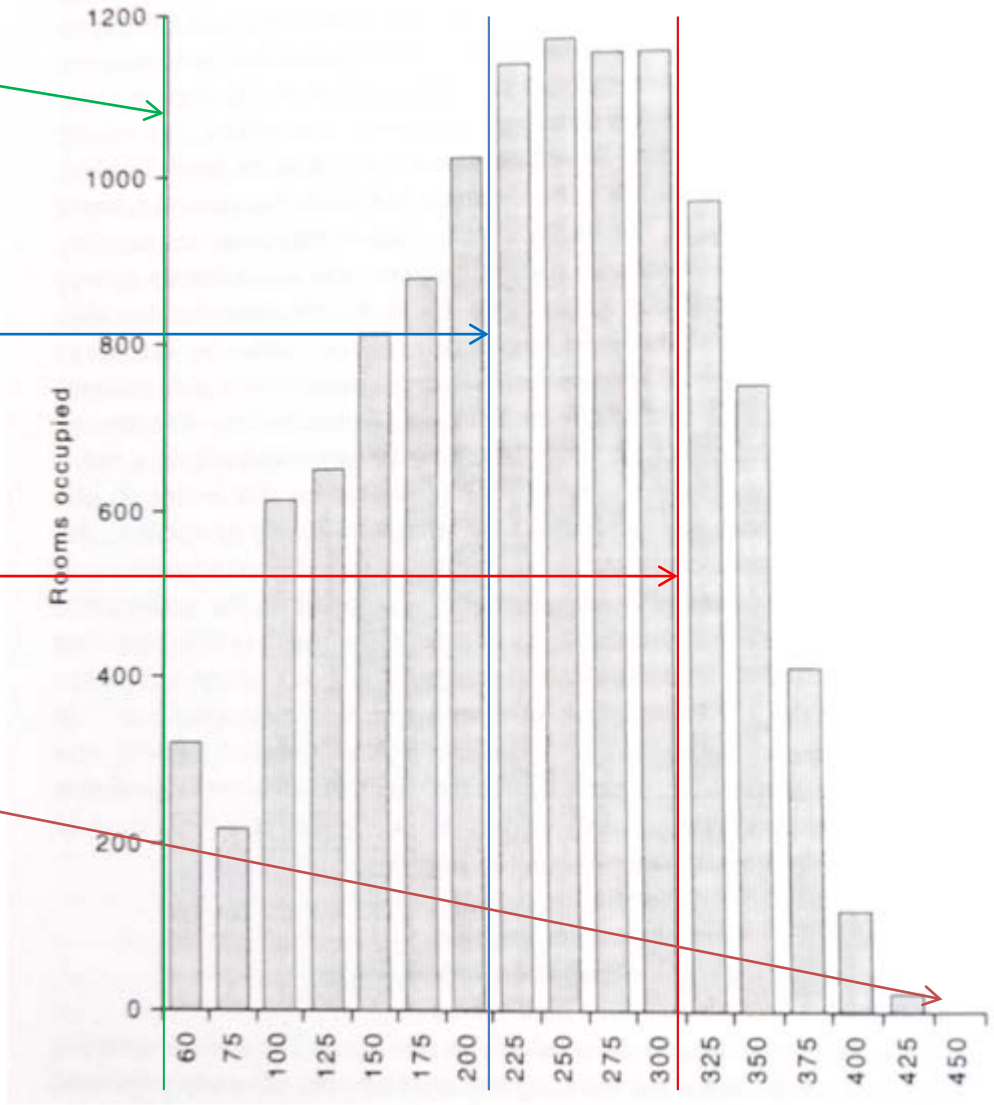
Faulkner (2000): rooms occupied in private buildings in 16 major Roman-British towns

Towns grow 50-225AD

Peak around 225-325AD

Decline after 325AD

Non-functional by 450AD



5th-6th centuries ("Dark Age Britain")

	Britain	**France**
Towns	All (or almost all) fail before Saxons arrive	Typically survive Franks' arrival
Political control	Highly fragmented	Merovingian Empire
Church establishment	Discontinued until 597	Persists
Coin use	Ceases	Continues
Trade in pottery	Ceases	Continues

- No clear consensus on the reasons for the difference:
  - We investigate role of bishops in sustaining French towns (Nicholas 1997), perhaps through demand for non-agriculture
  - Lower trade costs may have also helped sustain French towns

Description of post-Roman Britain

- Ward-Perkins (2008, p. 361) “Post-Roman Britain, of the fifth and sixth century, retained almost nothing of the sophistications of Roman economic life and, although this is a fact that is initially hard to credit, even sank to an economic level well below that reached in the pre-Roman Iron Age.”

Slow urban recovery

- From 597 onwards Church returns to Britain with Gregorian Mission of St. Augustine
- In subsequent centuries towns slowly re-emerge in Britain and recover in France
- To examine relation between location of Roman and Medieval towns we need data…

Data Sources

- Geographic data: ESRI shapefiles, Global GIS DVD
- Navigable rivers: Historical GIS of Europe website
- Extent of Roman Empire, provinces, and roads: Digital Atlas of Roman and Medieval Civilization online
- Roman towns in Britain: Wacher (1995); Burnham and Wacher (1990); Millet (1990); Mattingley (2006)
- Roman towns in continental Europe: Bedon (2001, 1998); Woolf (1998); Goodman (2004), Harries (1978)
- Medieval bishopric (and archbishopric) locations: Reynolds (2008)
- Medieval mint data: Spufford (1988)
- Medieval town population estimates: Bairoch et al. (1988), Russell (1972), and Dyer (2008) estimates of Domesday book.
- City population estimates for 2012: World Gazetteer online
- NUTS3 identifiers: ESRI website

Dataset: grid and locational fundamentals

- Construct 1km^2 grid covering Roman Empire at its peak, around Trajan's death (117AD)
  - Entire empire: over 5,000,000 km^2
  - Northwestern Europe provinces: ~900,000 km^2
  - Britain and France provinces: ~700,000 km^2
- Data (below) fitted to nearest grid point
- Add geographic data on:
  - Proximity to coast or navigable rivers
  - Approximate elevation and ruggedness

Dataset: Roman Empire

- Roman towns:
  1. Comprehensive list for Britain & France
  2. Towns with walled area ≥ 5 hectares
  3. Administrative functions
  4. Fourth century bishoprics
- Roman towns and other location data matched using maps and gazetteers
- Proximity to (within 1km of) roman roads
- Indicators for Roman provinces c.117AD

Dataset: later outcomes

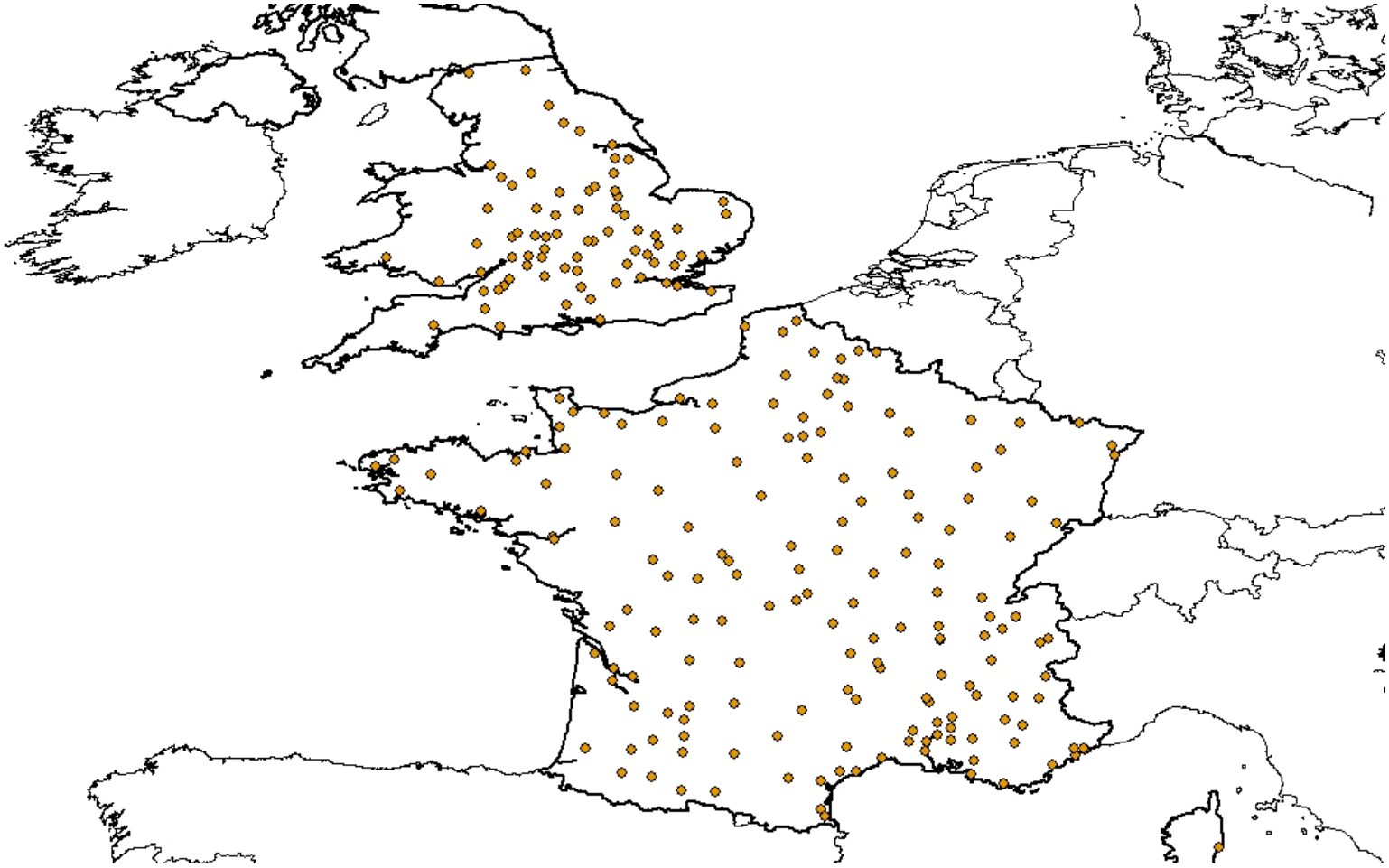
- Early medieval location data:
  - Bishoprics (and archbishoprics) from 700-900
  - Coin mints from c.768-1066
  - We use Bairoch (1988) and Dyer (2008) data for indicator for population of 1,000+ from 1086-1200
- Dummies for towns with populations above various thresholds for 1300-1800 and 2012 and largest towns in 2012 in NUTS3 regions

Summary Statistics for Britain and France in Roman Empire (697,198 observations)

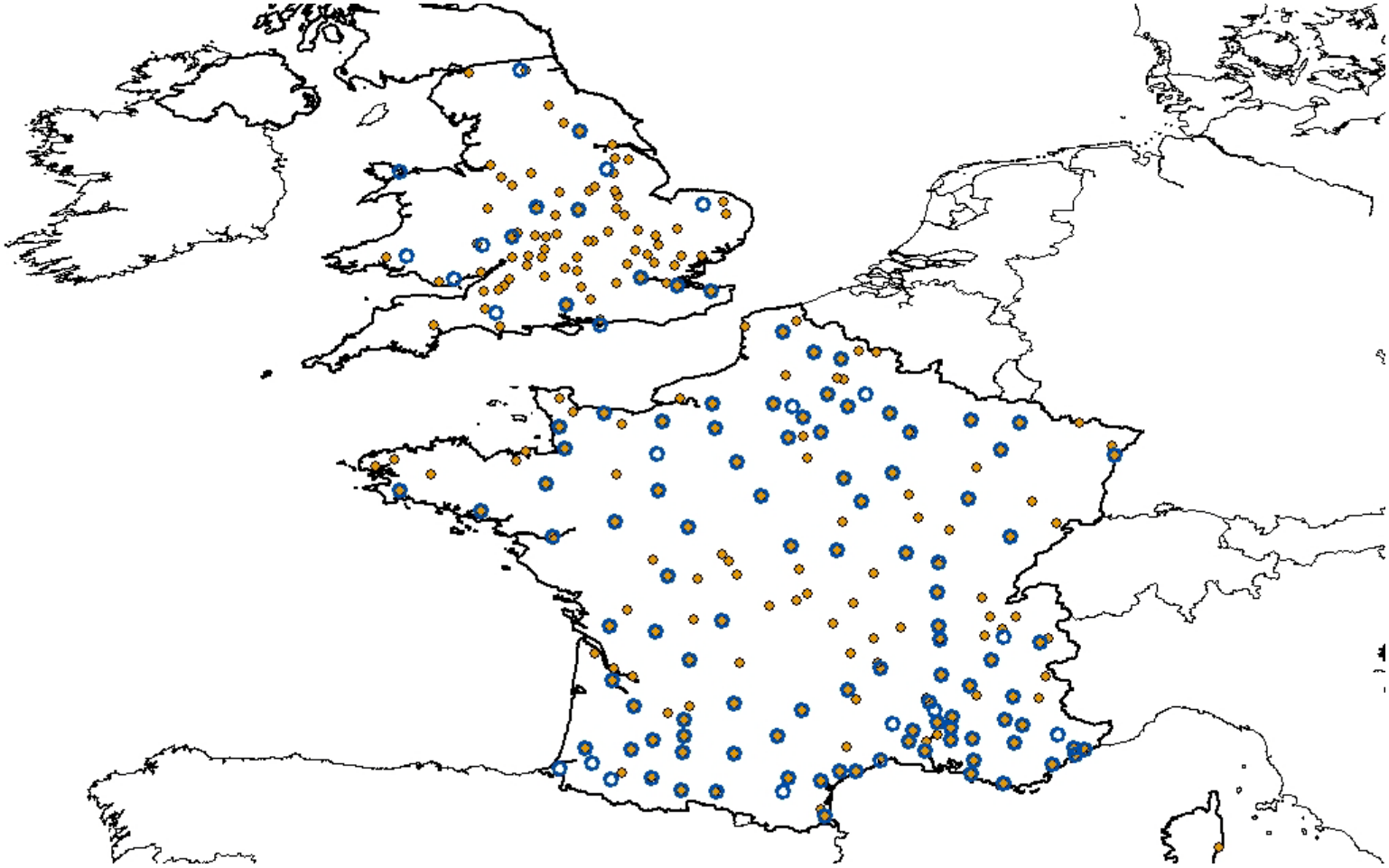
Variable	Mean	Std. Dev.
Britain_indicator	0.21	0.41
France_indicator	0.79	0.41
Britannia_indicator	0.21	0.41
Belgica_indicator	0.09	0.28
Lugdunensis_indicator	0.23	0.42
Elevation	296	377
Ruggedness	462	536
Coast_within_10km	0.10	0.30
Coastal_access1	0.17	0.38
Coastal_access2	0.27	0.44
Roman_road_within_1km	0.17	0.37
Roman town (baseline)	0.00035	0.01859
Roman town with 5ha+ walls	0.00014	0.01167
Roman administrative town	0.00019	0.01386
Bishopric between 700-900	0.00018	0.01323
Mint between 768-1066	0.00023	0.01519

Variable	Mean	Std. Dev.
Town with 1k+ pop, 1086-1200	0.00019	0.01371
Town with 5k+ pop, 1300 (Russell)	0.00008	0.00872
Town with 5k+ population in 1300	0.00007	0.00830
Town with 5k+ population in 1500	0.00012	0.01084
Town with 10k+ population in 1500	0.00007	0.00838
Town with 5k+ population in 1600	0.00024	0.01552
Town with 10k+ population in 1600	0.00010	0.01023
Town with 5k+ population in 1700	0.00031	0.01748
Town with 10k+ population in 1700	0.00012	0.01104
Town with 5k+ population in 1800	0.00061	0.02462
Town with 10k+ population in 1800	0.00022	0.01491
Town with 10k+ population in 2012	0.00236	0.04853
Town with 20k+ population in 2012	0.00134	0.03652
Town with 50k+ population in 2012	0.00043	0.02064
Town with 100k+ population in 2012	0.00014	0.01198
Largest town in NUTS3 in 2012	0.00028	0.01664

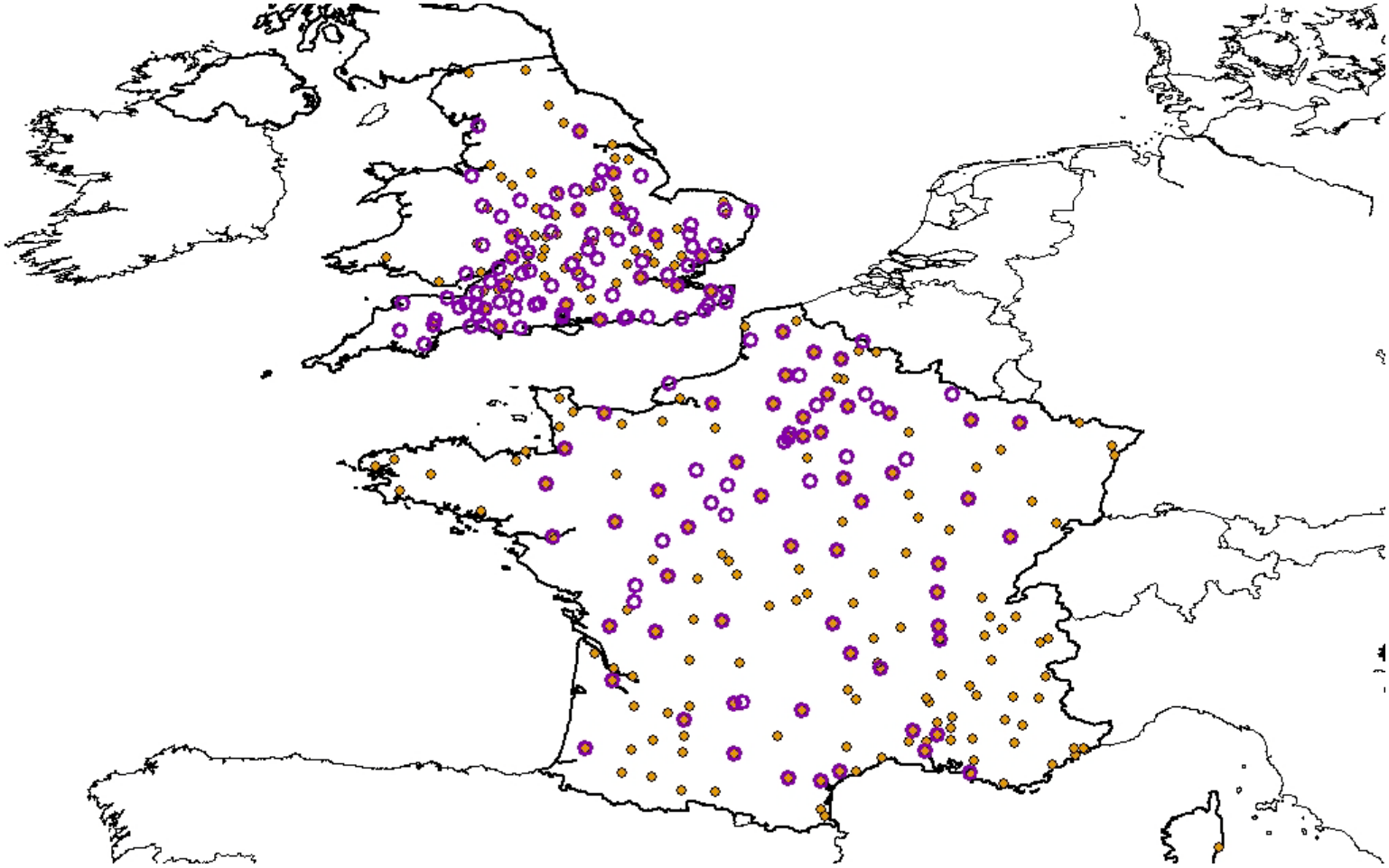
Roman baseline towns (•)



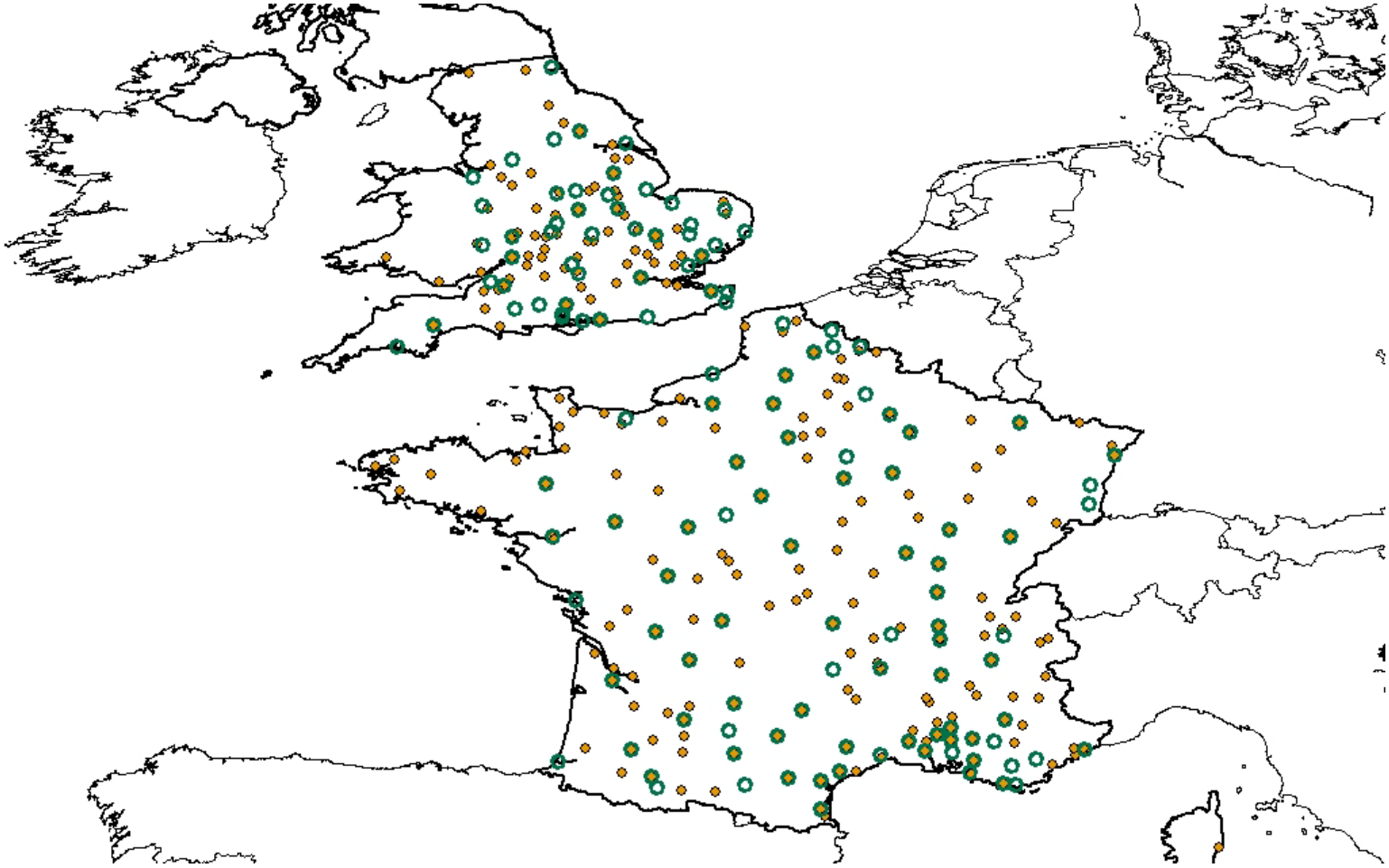
Roman baseline towns (●) and bishoprics 700-900 (○)



Roman baseline towns (●) and mints 768-1066 (○)



Roman baseline towns (●) and towns with 1k+ pop 1086-1200 (○)



Top-20 Cities in Britain and France

Ranked by Bairoch **1700** population	5km of Roman town	Ranked by Bairoch **1700** population	5km of Roman town	Ranked by **2012** population	5km of Roman town	Ranked by **2012** population	5km of Roman town
London	1	Paris	1	London	1	Paris	1
Bristol	0	Lyon	1	Birmingham	0	Marseille	1
Norwich	0	Marseille	1	Liverpool	0	Lyon	1
Newcastle	0	Rouen	1	Leeds	0	Toulouse	1
Birmingham	0	Lille	0	Sheffield	0	Nice	1
Liverpool	0	Bordeaux	1	Manchester	0	Nantes	1
Manchester	0	Nantes	1	Bristol	0	Strasbourg	1
Exeter	1	Versailles	0	Cardiff	0	Lille	0
Leeds	0	Toulouse	1	Leicester	1	Montpellier	0
Plymouth	0	Strasbourg	1	Bradford	0	Bordeaux	1
Chester	0	Orleans	1	Hull	0	Rennes	1
Sheffield	0	Amiens	1	Coventry	0	Reims	1
Coventry	0	Montpellier	0	Plymouth	0	Angers	1
Nottingham	0	Caen	0	Derby	1	Le Havre	0
York	1	Dijon	1	Stoke-on-Trent	0	Toulon	1
Portsmouth	0	Brest	1	Nottingham	0	Saint-Etienne	0
Bath	1	Rennes	1	Wolverhampton	0	Grenoble	1
Sunderland	0	Metz	1	Southampton	0	Aix-en-Provence	1
Worcester	1	Nîmes	1	Portsmouth	0	Nîmes	1
Great Yarmouth	0	Avignon	1	Dudley	0	Limoges	1

Britain 1700: 5/20 France 1700: 16/20 Britain 2012: 3/20 France 2012: 16/20

Top-20 Cities in Britain and Northern France

Ranked by Bairoch **1700** population	5km of Roman town	Ranked by Bairoch **1700** population	5km of Roman town	Ranked by **2012** population	5km of Roman town	Ranked by **2012** population	5km of Roman town
London	1	Paris	1	London	1	Paris	1
Bristol	0	Rouen	1	Birmingham	0	Nantes	1
Norwich	0	Nantes	1	Liverpool	0	Lille	0
Newcastle	0	Versailles	0	Leeds	0	Rennes	1
Birmingham	0	Orleans	1	Sheffield	0	Reims	1
Liverpool	0	Caen	0	Manchester	0	Angers	1
Manchester	0	Amiens	1	Bristol	0	Le Havre	0
Exeter	1	Dijon	1	Cardiff	0	Amiens	1
Leeds	0	Brest	1	Leicester	1	Tours	1
Plymouth	0	Rennes	1	Bradford	0	Dijon	1
Chester	0	Metz	1	Hull	0	Le Mans	1
Sheffield	0	Reims	1	Coventry	0	Brest	1
Coventry	0	Angers	1	Plymouth	0	Orleans	1
Nottingham	0	Nancy	0	Derby	1	Metz	1
York	1	Douai	0	Stoke-on-Trent	0	Rouen	1
Portsmouth	0	Troyes	1	Nottingham	0	Boulogne-Billancourt	0
Bath	1	Valenciennes	0	Wolverhampton	0	Argenteuil	0
Sunderland	0	Arras	1	Southampton	0	Saint-Denis	0
Worcester	1	Abbeville	0	Portsmouth	0	Nancy	0
Great Yarmouth	0	Le Mans	1	Dudley	0	Caen	0

Britain 1700: 5/20

Northern France 1700: 14/20

Britain 2012: 3/20

Northern France 2012: 13/20

Estimation Step 1

Use cross-section of grid points to estimate:

$$Y_{it} = \beta_1 + \beta_2 \text{Roman}_i + \beta_3 \text{Britain}_i + \beta_4 \text{Roman}_i \times \text{Britain}_i + \varepsilon_{it}$$

- Y_{it}: dummy for being close (within 5km) to later (medieval or modern) town
- Roman_i: dummy for Roman town
- Britain_i: dummy for Britain
- ε_{it} is error term (we cluster spatially)

Estimation Part 1

$$Y_{it} = \beta_1 + \beta_2 \text{Roman}_i + \beta_3 \text{Britain}_i + \beta_4 \text{Roman}_i \text{ x Britain}_i + \varepsilon_{it}$$

- Test $H_0: (\beta_1 + \beta_2) / \beta_1 = (\beta_1 + \beta_2 + \beta_3 + \beta_4) / (\beta_1 + \beta_3)$ vs. $H_1: \sim H_0$
  - In words: is following ratio equal for Britain and France?

$$\frac{\text{P(Site with Roman town is used by later town)}}{\text{P(Site without Roman town is used by later town)}}$$

Model's predictions:

- Scenario 1 ("Fixed locational advantage"): ratio is high (even infinite) in both countries
- Scenario 2 ("Changing locational advantage with weak towns"): ratio lower but similar in both countries
- Scenario 3: ("Changing locational advantage with strong towns"): ratio lower in Britain than in France

Baseline results (700-1600)

Year(s):	700-900	768-1066	1086-1200	~1300 Russell	1300 Bairoch	1500	1500	1600	1600
	Bishopric	Mint	pop≥1k	pop≥5k	pop≥5k	pop≥5k	pop≥10k	pop≥5k	pop≥10k
Roman_town	0.57	0.34	0.35	0.24	0.16	0.23	0.19	0.37	0.25
	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)
Britain	-0.006	0.031	0.012	0.000	0.000	0.001	-0.003	0.000	-0.005
	(0.002)	(0.008)	(0.003)	(0.002)	(0.002)	(0.002)	(0.001)	(0.003)	(0.002)
Roman_town x Britain	-0.47	-0.11	-0.15	-0.19	-0.13	-0.14	-0.17	-0.25	-0.20
	(0.05)	(0.06)	(0.06)	(0.04)	(0.03)	(0.05)	(0.04)	(0.06)	(0.05)
Intercept	0.015	0.010	0.011	0.006	0.005	0.009	0.006	0.018	0.009
	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Ratio Britain	13.1	6.5	9.8	9.8	8.1	9.9	8.8	7.5	13.5
Ratio France	39.6	33.1	32.0	42.1	31.8	27.4	34.5	21.5	29.3
Ratio Britain/France	0.33	0.20	0.30	0.23	0.25	0.36	0.25	0.35	0.46
p-value	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.022

Baseline results (1700-2012)

Year:	1700	1700	1800	1800	2012	2012	2012	2012	2012
Town pop	≥5k	≥10k	≥5k	≥10k	≥10k	≥20k	≥50k	≥100k	Max in Nuts3
Roman_town	0.44	0.25	0.57	0.36	0.54	0.50	0.30	0.17	0.32
	(0.04)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)
Britain	-0.001	0.001	0.016	0.013	0.183	0.130	0.065	0.024	0.033
	(0.004)	(0.002)	(0.007)	(0.005)	(0.026)	(0.023)	(0.012)	(0.004)	(0.005)
Roman_town x Britain	-0.30	-0.20	-0.37	-0.24	-0.26	-0.24	-0.11	-0.08	-0.18
	(0.06)	(0.04)	(0.05)	(0.05)	(0.07)	(0.08)	(0.06)	(0.05)	(0.06)
Intercept	0.023	0.009	0.040	0.013	0.074	0.040	0.013	0.005	0.013
	(0.002)	(0.001)	(0.003)	(0.001)	(0.009)	(0.006)	(0.002)	(0.001)	(0.001)
Ratio Britain	7.4	7.0	4.6	5.6	2.1	2.5	3.5	4.2	4.1
Ratio France	20.0	30.2	15.2	28.5	8.3	13.5	24.3	33.8	25.7
Ratio Britain/France	0.37	0.23	0.30	0.20	0.25	0.19	0.14	0.12	0.16
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Robustness checks

- Baseline results largely robust to following:
  - 10km radius around medieval/modern towns
  - Restricting sample to Britain and Northern France (Trajan provinces: Britannia, Belgica, Lugdunensis)
  - Roman towns with defended area ≥ 5ha
  - Roman towns with defended area ≥ 5ha, adding all parts of Northwest Europe in Roman Empire
  - Roman administrative towns (some caveats)
  - Adding geographic controls (and their interactions with Britain dummy) to baseline

Higher persistence in locations in France over 1500 years

- Higher persistence in France than Britain is consistent with Scenario 3 (path dependence)
- ~Threefold difference in persistence from around is fairly stable from 700-1700
- Larger difference in persistence from 1800 onwards (perhaps Industrial Revolution)
- Some persistence in Britain: is it driven by locational fundamentals?

Why the persistence in Britain?

1. In some places non-urban settlement survived
2. Some Roman roads still used (many crossed in London)
3. Some Roman walls used after interruption (e.g. London)
4. Masonry sometimes reused (e.g. Verulamium-St. Albans)

- Estimates for Britain: upper bound for locational fundamentals' ability to pin down urban location
- But what change in locational fundamentals' value made Britain's urban network reconfigure?

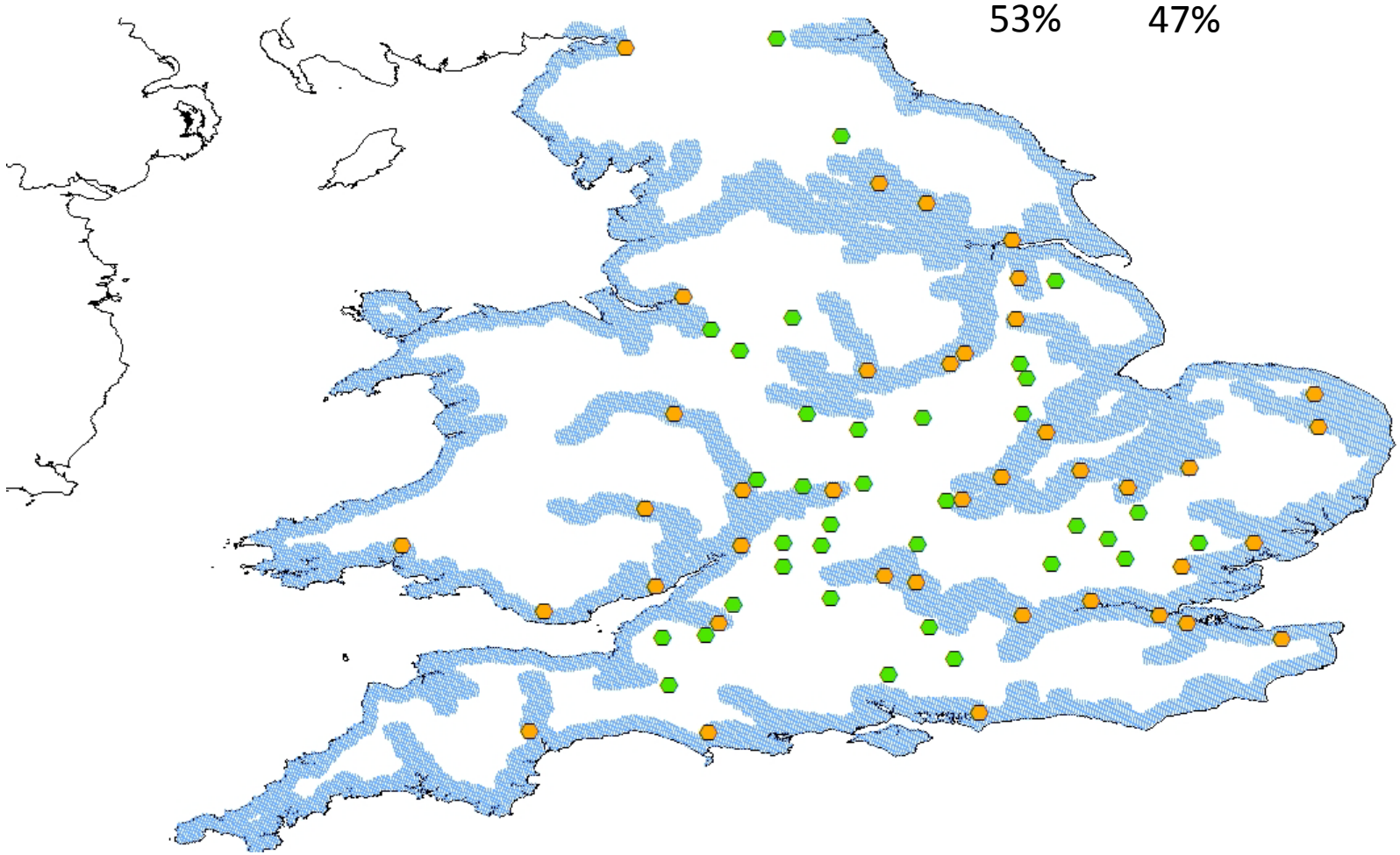
In Roman Empire era land transportation was important

- Roman Empire used Mediterranean, rivers and canals
- But roads were especially important for Roman army, which had key roles in procuring taxes and demanding goods
- Roman roads connected most Roman towns in both Britain and France

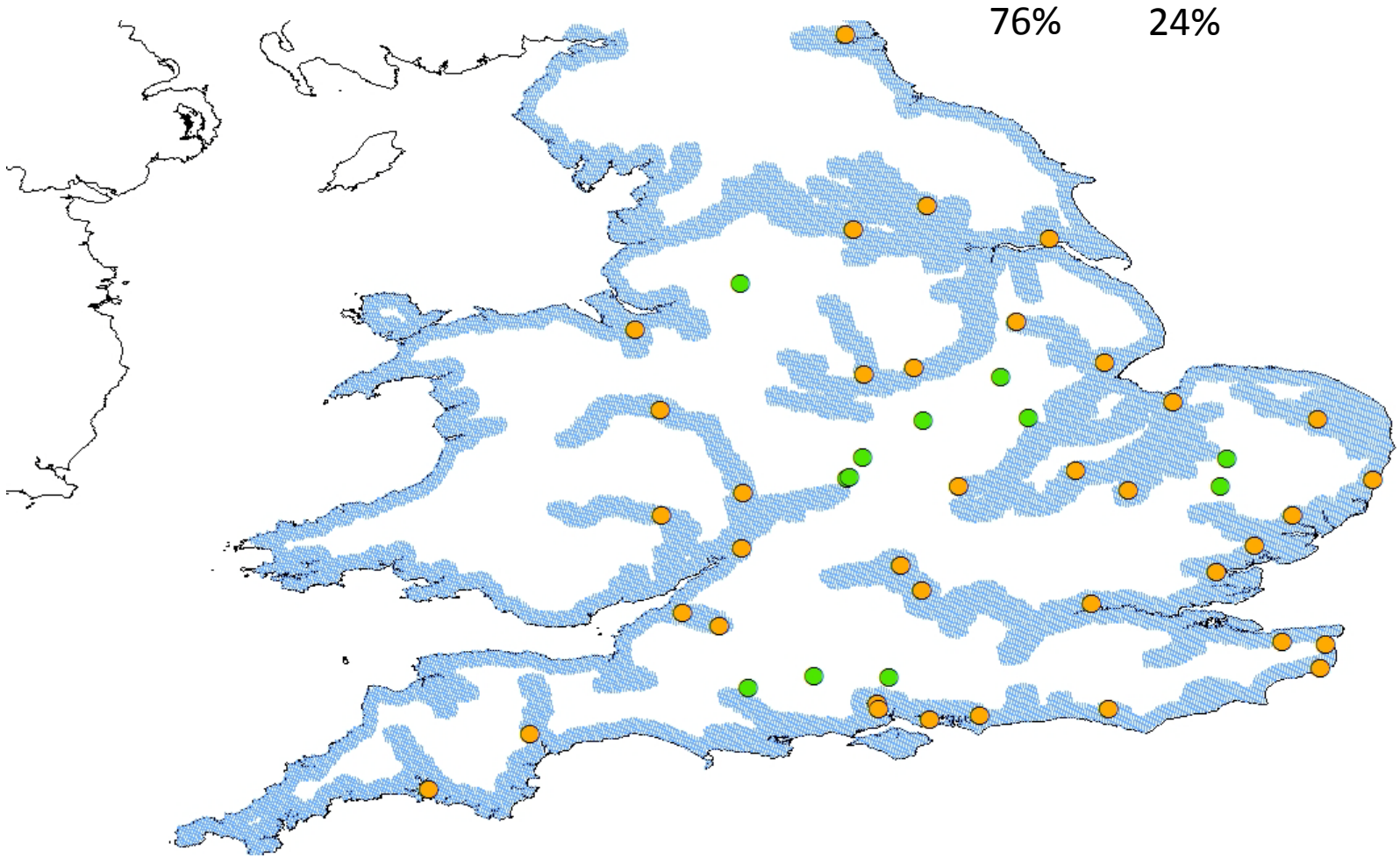
In Middle Ages water transportation became more important

- Early Middle Ages: coasts and rivers used for trade but also for Viking raids (Fleming 2010)
- Blair (2007): waterways in Medieval England especially important from 950-1250
  - Discussing coin-loss zones from 950-1180, he writes: “water routes look more consistently important over long distances than Roman roads…”
- River transport in England in Middle Ages was about 10 times cheaper than roads (Jones 2000, Britnell 2004)
- We examine whether growing importance of navigable access to coast explains part of Britain’s towns’ relocation

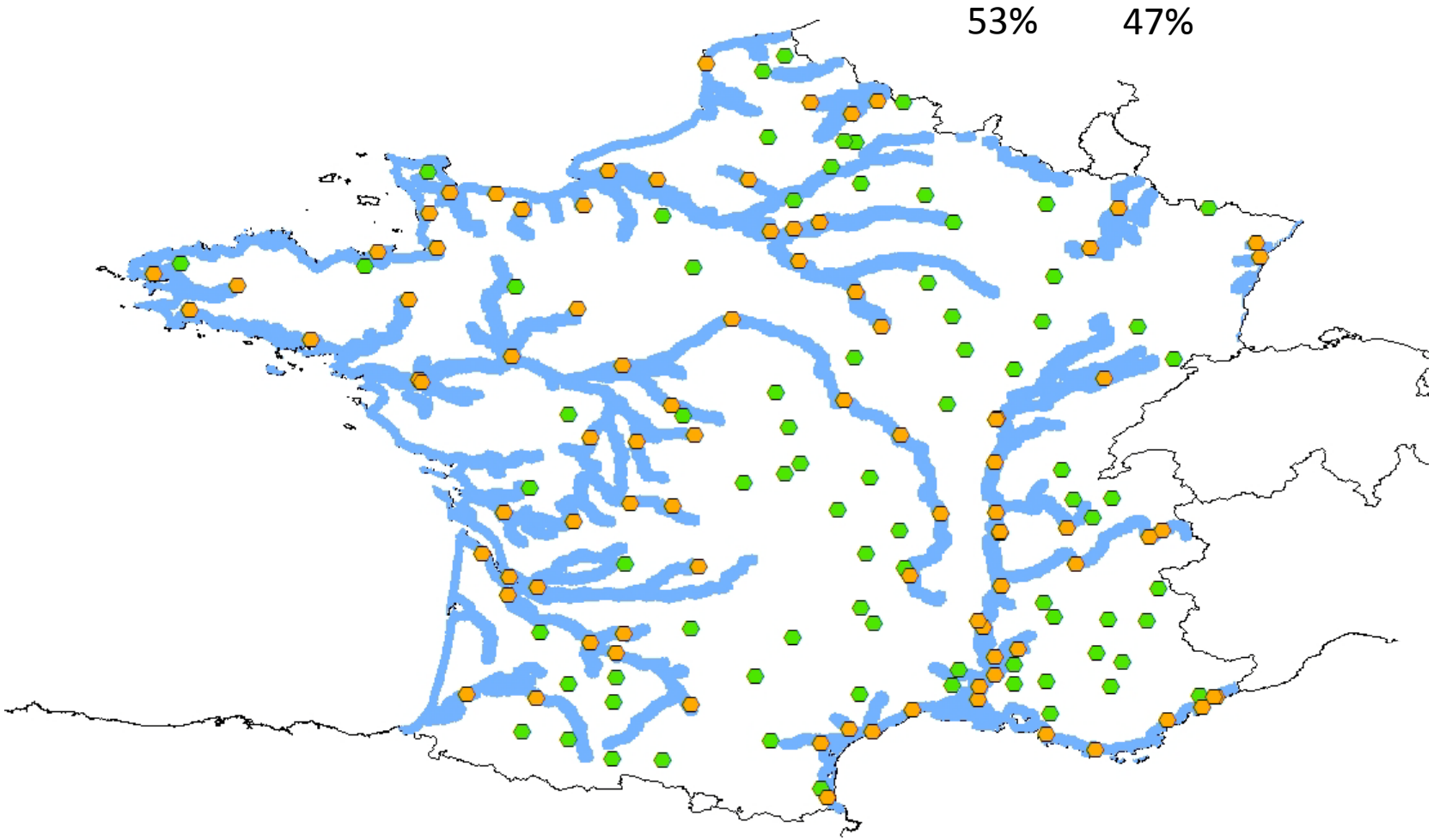
Britain: Roman baseline towns and Coastal access (yes, no)



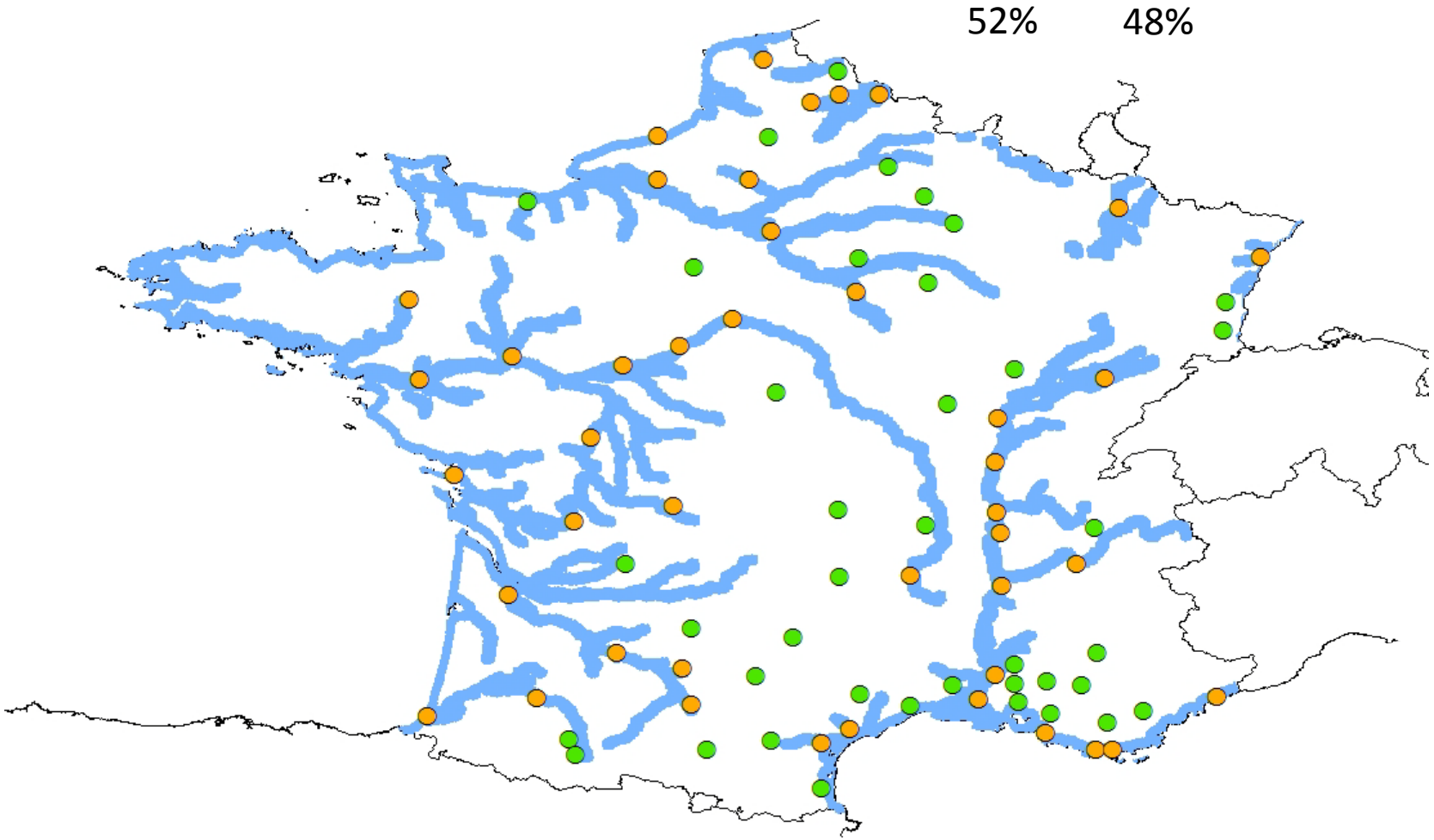
Britain: Towns with 1k+ pop 1086-1200 and Coastal access (yes, no)



France: Roman baseline towns and Coastal access (yes, no)



France: Towns with 1k+ pop 1086-1200 and Coastal access (yes, no)



Estimation Part 2

Use two cross-sections of grid points to estimate:

$$Y_{it} = \gamma_1 \text{Roman\_period}_t + \gamma_2 \text{Roman\_period}_t \text{ x Britain}_i + \gamma_3 \text{Roman\_period}_t \text{ x Coast}_i + \gamma_4 \text{Roman\_period}_t \text{ x Coast}_i \text{ x Britain}_i + \gamma_5 \text{Later\_period}_t + \gamma_6 \text{Later\_period}_t \text{ x Britain}_i + \gamma_7 \text{Later\_period}_t \text{ x Coast}_i + \gamma_8 \text{Later\_period}_t \text{ x Coast}_i \text{ x Britain}_i + \varepsilon_{it},$$

- Roman_period_t: dummy for Roman period
- Later_period_t: dummy for later (medieval) period
- Coast_i: dummy for coastal access, meaning on coast or on navigable river (multiple navigability measures)

Did coastal access matter more for location of Medieval (vs. Roman) towns in Britain?

$$Y_{it} = \gamma_1 Roman\_period_t + \gamma_2 Roman\_period_t \times Britain_i + \gamma_3 Roman\_period_t \times Coast_i + \gamma_4 Roman\_period_t \times Coast_i \times Britain_i + \gamma_5 Later\_period_t + \gamma_6 Later\_period_t \times Britain_i + \gamma_7 Later\_period_t \times Coast_i + \gamma_8 Later\_period_t \times Coast_i \times Britain_i + \varepsilon_{it},$$

Test 1: H_0: $(\gamma_5 + \gamma_6 + \gamma_7 + \gamma_8) / (\gamma_5 + \gamma_6) - (\gamma_1 + \gamma_2 + \gamma_3 + \gamma_4) / (\gamma_1 + \gamma_2) = 0$ vs. H_1: $(\gamma_5 + \gamma_6 + \gamma_7 + \gamma_8) / (\gamma_5 + \gamma_6) - (\gamma_1 + \gamma_2 + \gamma_3 + \gamma_4) / (\gamma_1 + \gamma_2) > 0$

Or in other words, was:

p(town|coastal_access=1)/p(town|coastal_access=0) higher in Britain in Medieval (vs. Roman) period?

Did coastal access matter more for location of Medieval (vs. Roman) towns in Britain?

$$Y_{it} = \gamma_1 \text{Roman\_period}_t + \gamma_2 \text{Roman\_period}_t \times \text{Britain}_i + \gamma_3 \text{Roman\_period}_t \times \text{Coast}_i + \gamma_4 \text{Roman\_period}_t \times \text{Coast}_i \times \text{Britain}_i + \gamma_5 \text{Later\_period}_t + \gamma_6 \text{Later\_period}_t \times \text{Britain}_i + \gamma_7 \text{Later\_period}_t \times \text{Coast}_i + \gamma_8 \text{Later\_period}_t \times \text{Coast}_i \times \text{Britain}_i + \varepsilon_{it},$$

Test 2: $H_0: (\gamma_5 + \gamma_7) / \gamma_5 - (\gamma_1 + \gamma_3) / \gamma_1 = 0$ vs. $H_1: (\gamma_5 + \gamma_7) / \gamma_5 - (\gamma_1 + \gamma_3) / \gamma_1 > 0$

Or in other words, was:

p(town|coastal_access=1)/p(town|coastal_access=0) higher in France in Medieval (vs. Roman) period?

Was there more movement towards coastal access in Britain than in France?

Test 3:

H_0: $[(\gamma_5 + \gamma_6 + \gamma_7 + \gamma_8) / (\gamma_5 + \gamma_6)] / [(\gamma_1 + \gamma_2 + \gamma_3 + \gamma_4) / (\gamma_1 + \gamma_2)] - [(\gamma_5 + \gamma_7) / \gamma_5] / [(\gamma_1 + \gamma_3) / \gamma_1] = 0$, vs.

H_1: $[(\gamma_5 + \gamma_6 + \gamma_7 + \gamma_8) / (\gamma_5 + \gamma_6)] / [(\gamma_1 + \gamma_2 + \gamma_3 + \gamma_4) / (\gamma_1 + \gamma_2)] - [(\gamma_5 + \gamma_7) / \gamma_5] / [(\gamma_1 + \gamma_3) / \gamma_1] > 0$

In words: did coastal access become stronger predictor of town location in Medieval (vs. Roman) period in Britain (vs. France)?

Results for coastal access

Dependent variable: Roman town (baseline) or medieval town	1k+ people 1086-1200		5k+ people in 1700	
Coastal_access measure	High	Low	High	Low
C1 = Effect of Coastal_access on Roman towns in Britain	1.81	1.61	1.81	1.61
C2 = Effect of Coastal_access on Medieval towns in Britain	4.83	4.46	4.56	4.92
Test 1 H0:C2/C1 ≤0 vs. H1:C2/C1>0, p-value:	0.02	0.04	0.03	0.03
C3 = Effect of Coastal_access on Roman towns in France	3.95	3.73	3.95	3.73
C4 = Effect of Coastal_access on Medieval towns in France	3.76	3.6	4.18	3.64
Test 2 H0:C4/C3 ≤0 vs. H1:C4/C3>0, p-value:	0.59	0.57	0.38	0.56
Differential change, Britain minus France: (C2/C1)-(C4/C3)	1.71	1.8	1.46	2.08
Test 3 H0:(C2/C1)-(C4/C3)≤0 vs. H1:(C2/C1)-(C4/C3)>0, p-val.	0.02	0.03	0.06	0.03

Roman roads

- We estimate similar specifications for Roman roads instead of coastal access
- Test the hypothesis that as we move from Roman to Medieval period, access to Roman roads became less important in Britain than in France

Results for Roman roads

Dependent variable: Roman town (baseline) or medieval town	1k+ people 1086-1200	5k+ people in 1700
C1 = Effect of Coastal_access on Roman towns in Britain	17.71	17.71
C2 = Effect of Coastal_access on Medieval towns in Britain	4.53	3.75
Test 1 H0:C2/C1 ≤0 vs. H1:C2/C1>0, p-value:	0.00	0.00
C3 = Effect of Coastal_access on Roman towns in France	13.36	13.36
C4 = Effect of Coastal_access on Medieval towns in France	10.56	5.04
Test 2 H0:C4/C3 ≤0 vs. H1:C4/C3>0, p-value:	0.20	0.00
Differential change, Britain minus France: (C2/C1)-(C4/C3)	-0.54	-0.17
Test 3 H0:(C2/C1)-(C4/C3)≤0 vs. H1:(C2/C1)-(C4/C3)>0, p-val.	0.01	0.04

Robustness check

- Results on Coastal access and Roman roads are robust to restricting sample to Britain and Northern France (Britannia, Belgica and Lugdunensis)

Interpretation

- Coastal access partly replaced roads as primary transportation network in Britain in Middle Ages
- This may (partly) explain why British towns reconfigured
- In France Roman roads remained important
- Suggestive evidence for possible lock-in of sites of inferior value in France
- Still, why did some French towns remain on Roman sites?

Potential role of bishoprics in persistence of location of Roman towns in France

- Nicholas (1997, p. 23): “Although Roman urbanization… virtually ended in Britain… a stronger case for continuity can be made for some cities of interior Gaul, particularly those that housed bishoprics”

Estimation Part 3

$$Y_{it} = \delta_1 + \delta_2 \text{Roman}_i + \delta_3 \text{Britain}_i + \delta_4 \text{Roman}_i \text{ x Britain}_i + \delta_5 \text{French\_bishopric}_i + \varepsilon_{it}$$

- French_bishopric$_i$: dummy for 4th century Roman bishopric in France (where church survived)

Test $H_0:(\delta_1 + \delta_2) / \delta_1 = (\delta_1 + \delta_2 + \delta_3 + \delta_4) / (\delta_1 + \delta_3)$ vs. $H_1:\sim H_0$

- In words: is following ratio equal for Britain and France?

$$\frac{\text{P(Site with Roman town without bishop is used by later town)}}{\text{P(Site without Roman town is used by later town)}}$$

Results for non-4th c bishoprics (700-1600)

Year(s):	700-900	768-1066	1086-1200	~1300 Russell	1300 Bairoch	1500	1500	1600	1600
	Bishopric	Mint	pop≥1k	pop≥5k	pop≥5k	pop≥5k	pop≥10k	pop≥5k	pop≥10k
Roman_town	0.24	0.17	0.14	0.07	0.06	0.07	0.06	0.17	0.11
	(0.05)	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.05)	(0.03)
Britain	-0.006	0.031	0.012	0.000	0.000	0.001	-0.003	0.000	-0.005
	(0.002)	(0.008)	(0.003)	(0.002)	(0.002)	(0.002)	(0.001)	(0.003)	(0.002)
Roman_town x Britain	-0.14	0.06	0.07	-0.02	-0.02	0.02	-0.03	-0.05	-0.06
	(0.06)	(0.06)	(0.06)	(0.04)	(0.03)	(0.05)	(0.03)	(0.07)	(0.04)
4th c. Bishopric	0.62	0.32	0.40	0.32	0.20	0.30	0.25	0.38	0.27
	(0.07)	(0.08)	(0.07)	(0.05)	(0.05)	(0.06)	(0.05)	(0.08)	(0.06)
Intercept	0.015	0.010	0.011	0.006	0.005	0.009	0.006	0.018	0.009
	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Ratio Britain	13.1	6.5	9.8	9.8	8.1	9.9	8.8	7.5	13.5
Ratio France NB	17.2	16.9	13.3	13.0	12.0	8.9	11.1	10.5	13.0
Ratio Britain/France NB	0.76	0.39	0.73	0.75	0.67	1.11	0.79	0.72	1.04
p-value	0.36	0.02	0.39	0.61	0.50	0.83	0.72	0.41	0.94

Results for non-4th c bishoprics (700-1600)

Year:	1700	1700	1800	1800	2012	2012	2012	2012	2012
Town pop	≥5k	≥10k	≥5k	≥10k	≥10k	≥20k	≥50k	≥100k	Max in Nuts3
Roman_town	0.27	0.12	0.36	0.23	0.38	0.33	0.14	0.08	0.16
	(0.05)	(0.03)	(0.05)	(0.04)	(0.06)	(0.05)	(0.04)	(0.03)	(0.04)
Britain	-0.001	0.001	0.016	0.013	0.183	0.130	0.065	0.024	0.033
	(0.004)	(0.002)	(0.007)	(0.005)	(0.026)	(0.023)	(0.012)	(0.004)	(0.005)
Roman_town x Britain	-0.13	-0.06	-0.16	-0.11	-0.10	-0.06	0.05	0.01	-0.02
	(0.06)	(0.04)	(0.06)	(0.06)	(0.08)	(0.08)	(0.06)	(0.05)	(0.06)
4th c. Bishopric	0.32	0.26	0.39	0.25	0.31	0.34	0.31	0.16	0.30
	(0.08)	(0.06)	(0.07)	(0.07)	(0.08)	(0.07)	(0.07)	(0.05)	(0.07)
Intercept	0.023	0.009	0.040	0.013	0.074	0.040	0.013	0.005	0.013
	(0.002)	(0.001)	(0.003)	(0.001)	(0.009)	(0.006)	(0.002)	(0.001)	(0.001)
Ratio Britain	7.4	7.0	4.6	5.6	2.1	2.5	3.5	4.2	4.1
Ratio France NB	12.6	14.5	10.0	18.5	6.2	9.1	11.6	17.3	13.6
Ratio Britain/France NB	0.59	0.48	0.45	0.30	0.34	0.28	0.30	0.24	0.30
p-value	0.06	0.12	0.00	0.00	0.00	0.00	0.03	0.03	0.01

Results for bishoprics

- Once we control for 4th century bishoprics in France, Britain and France look much more similar in terms of locational persistence
- This suggests that bishoprics were important in pinning down urban locations in France

Conclusions

- New dataset tracing urbanization in Britain and France from Roman Empire till the present day
- Methodology for measuring urban locations' persistence
- Implications of our findings:
  - Empirically characterize (sufficiently) extreme conditions for resetting an urban network
  - Temporary institutions affect urban locations over 1000+ years
  - Urban network may reconfigure around locational fundamentals that became valuable
    - But this isn't inevitable: towns may be stuck in obsolete locations


Thank You

Additional materials

Number of Roman towns we use

		France	
	Britain	All provinces	Only Lugdunensis and Belgica
Baseline Roman towns	74	167	64
Roman towns with defenses ≥ 5 hectares	38	57	29
Roman administrative towns	24	110	46

Note: we also have data on 10 towns with defenses ≥ 5 hectares in other Roman provinces in Northwestern Europe (parts of Germany, Netherlands, Belgium, Luxembourg, and Switzerland), which we use in some robustness checks.

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