Old But Gold: Historical Pathways and Path Dependence

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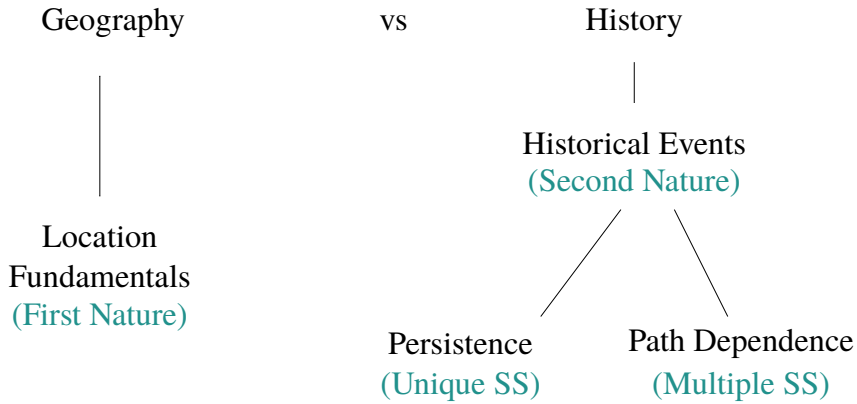
Motivation

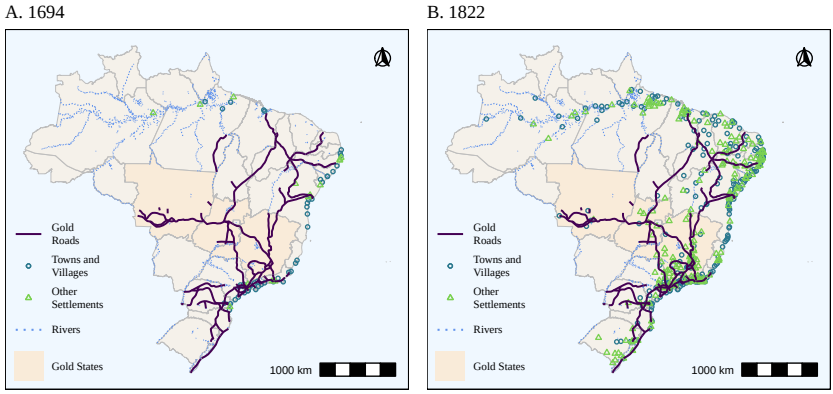
What drives the spatial distribution of economic activity and population?



This paper

- The question this paper addresses is whether (and how) history matters for the contemporaneous spatial distribution of population.
- Particularly, we study the long-run effects of ***historical roads*** on the distribution of population across space.
  - Our analysis centers on a pivotal event in the late 17^{th} century: the sudden discovery of gold around 1694, which led to the construction of ***gold roads*** connecting coastal settlements to the then unpopulated interior.
  - These roads eventually became obsolete with the advent of modern transportation in the twentieth century.

Gold Roads and Population Settlements



- Source of information: (1) Settlements: Azevedo (1956) and IBGE Cidades; (2) Gold roads: Georeferenced maps from Simonsen (1977)

Related Literature

1. Drivers of spatial distribution
   - Davis and Weinstein (2002, 2008); Lee and Lin (2017), Redding, Sturm and Wolf (2011); Bleakley and Lin (2012, 2015); Maloney and Valencia Caicedo (2016); Michaels and Rauch (2017); Hanlon (2017)
2. Impacts of historical infrastructure and settlement patterns on modern economic geography:
   - Jedwab and Moradi (2016); Jedwab, Kerby and Moradi (2017); Dalgaard, Kaarsen, Olsson and Selaya (2022); Barsanetti (2021); Portugal and Barsanetti (2023); Paik and Shahi (2022); Bosker, Buringh and van Zanden (2013); Cermeno and Enflo (2019)

- ***Main contribution***: richer temporal analysis and deeper investigation of both the mechanisms of the contemporaneous outcome and of the agglomeration spillover

Current Agglomerations

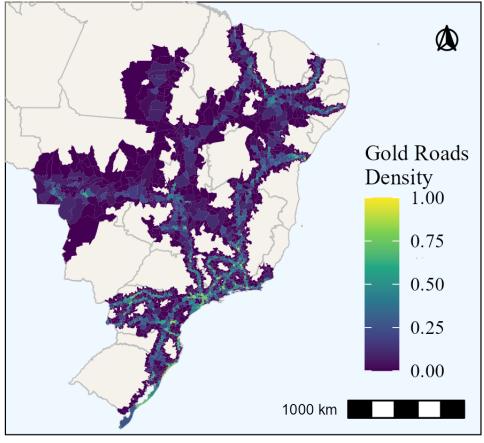
Gold roads and current agglomerations

- Our first analysis focuses on the long-run effects of historical roads created with the sudden discovery of gold around 1694 (***gold roads***).
- We estimate the following regression equation

$$y_i = \alpha_s + \beta \text{Road Density}_i + \mathbf{X}_i'\gamma + \varepsilon_i$$

- Road Density$_i$ is the area within a five-kilometer buffer around the roads relative to the municipality's total area.
- $\mathbf{X}_i$ contains geographical covariates. (Proximity to rivers and the coast, median temperature, precipitation, terrain ruggedness, elevation, area, and a second-order latitude-longitude polynomial)

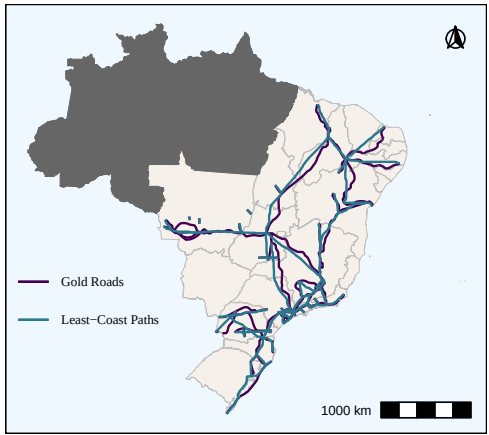
B. Gold Roads Density



Threats to Causal Interpretation of β

1. Historical roads capture advantageous geography
   - Set of geographic controls
2. Historical roads are built along previously developed areas:
   - Inconsequential Units Approach + Least-cost paths as instrumental variable (Barjamovic, Chaney, Coşar and Hortaçsu, 2019)
3. Central regions are more likely to receive treatment (pathways) and to develop:
   - Exogenous location of gold deposits + Re-centering (Borusyak and Hull, 2023)

A. Gold Roads



Gold roads and current agglomerations

	OLS			2SLS		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A - Dep. Var.: Population Density:						
Gold Road Density	1.650***	1.006***	0.8388***	3.305***	2.308***	2.222***
	(0.3686)	(0.2373)	(0.2023)	(0.6256)	(0.4943)	(0.5759)
Observations	5,197	5,197	2,088	5,197	5,197	2,088
Kleibergen-Paap F:				133.88	130.74	94.796
Fixed-Effects:	State	State	State	State	State	State
Geography Controls		✓	✓		✓	✓
Only Neighbors			✓			✓

Findings

- ***History matters:*** The evidence suggests that gold roads influence the distribution of population in 2010.
  - The effects are stronger for the IV strategy.
    - OLS estimates might be attenuated due to measurement error.
    - IV estimates capture LATE (ATE on compliers)

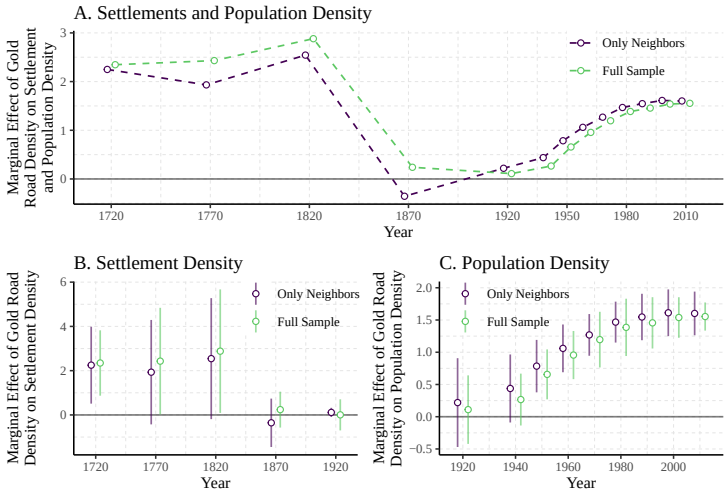
- Robustness: Similar results to nightlights, urban density and urbanization. Also to changes in sample (include Amazon basin, remove coast), MCA fixed effects, Conley SE, and inclusion of latitude-longitude thin plate spline (Kelly, Mokyr and Ó Gráda, 2023)

- Extensions: Same results for Mule roads (***external validity***) but no effect to fictitious roads that did not existed (***placebo***)

Dynamics

Dynamics

- The depicted trend reflects a spatial system with ***weak agglomeration forces***
- This limited impact of gold roads on sustained population growth can partly be attributed to the transitory nature of the gold boom and the poor quality of the roads themselves.



Road towns and the seeds of agglomeration

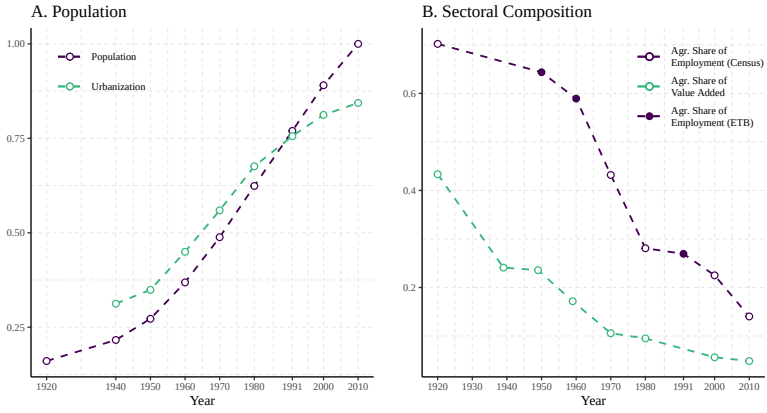
- The primary benefit of the ground transportation system lies not in the roads themselves but in the type of settlements established along these roads. (*e.g.,* Deffontaines, 1938)
- While estate-based settlements were dispersed and lacked a discernible urban center, the so-called ***road towns*** featured a main street lined with shops, cattle ranches, fairs, inns, and hotels.
- Naturally, these road towns attracted a different type of settler compared to agriculture-based towns, including craftsmen, workmen, merchants, and innkeepers, resulting in a distinctly different initial population mix (Deffontaines, 1938; Morse, 1974).

Road towns and the seeds of agglomeration

- Gold roads were associated with more industry and services in 1920
- These factors are strong mediators between gold roads and population density in 2010, explaining up to 46% of the total effect.

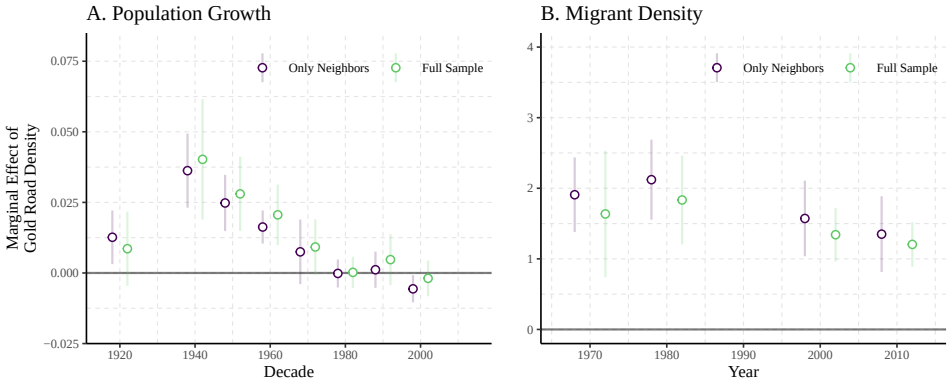
	Full Sample			Only Neighbors		
	Agriculture (1)	Manufacturing (2)	Services (3)	Agriculture (4)	Manufacturing (5)	Services (6)
Panel A - Dep. Var. in column						
Gold Road Density	-0.221***	0.110***	0.112***	-0.220***	0.097***	0.122***
	(0.057)	(0.029)	(0.034)	(0.027)	(0.020)	(0.018)
Observations	856	856	856	604	604	604
Kleibergen-Paap F	81.564	81.564	81.564	75.872	75.872	75.872
Panel B - Dep. Var.: Pop. Density 2010						
Gold Road Density	1.08***	1.36***	0.829**	1.30***	1.53***	0.910**
	(0.368)	(0.379)	(0.335)	(0.436)	(0.429)	(0.400)
Mediator (Column)	-2.15***	1.75**	6.48***	-1.37**	0.721	5.65***
	(0.562)	(0.880)	(0.721)	(0.674)	(0.952)	(0.926)
Sobel Test t-statistic	2.72	1.76	3.09	1.98	0.749	4.56
Share Mediated	0.306	0.123	0.467	0.188	0.044	0.432
Observations	856	856	856	604	604	604
Kleibergen-Paap F	80.651	80.825	80.881	67.000	67.890	63.948

The structural transformation of the Brazilian economy



- As the focus of production shifted toward non-agricultural activities, road towns became attractive spots for migrants.

Population growth and migration



- Thus, during the process of structural transformation, areas with more gold roads observed faster population growth and higher stock of migrants.

Agglomeration Spillovers

Agglomeration Spillovers

- Can these shocks imply a new spatial equilibrium, or is the steady state equilibrium unique?
- To answer this question, we estimate contemporaneous and historical agglomeration and interpret these values using the framework proposed by Allen and Donaldson (2020, 2022)

Agglomeration Spillovers

- Can these shocks imply a new spatial equilibrium, or is the steady state equilibrium unique?
- To answer this question, we estimate contemporaneous and historical agglomeration and interpret these values using the framework proposed by Allen and Donaldson (2020, 2022)
- We estimate ζ_1 and ζ_2 in the following supply and demand system

$$\log w_{it} = \zeta_1 \log L_{it} + \zeta_2 \log L_{it-1} + \zeta_3 \log Q_{it}^{1-\sigma} + \varepsilon_{it}, \quad (1)$$

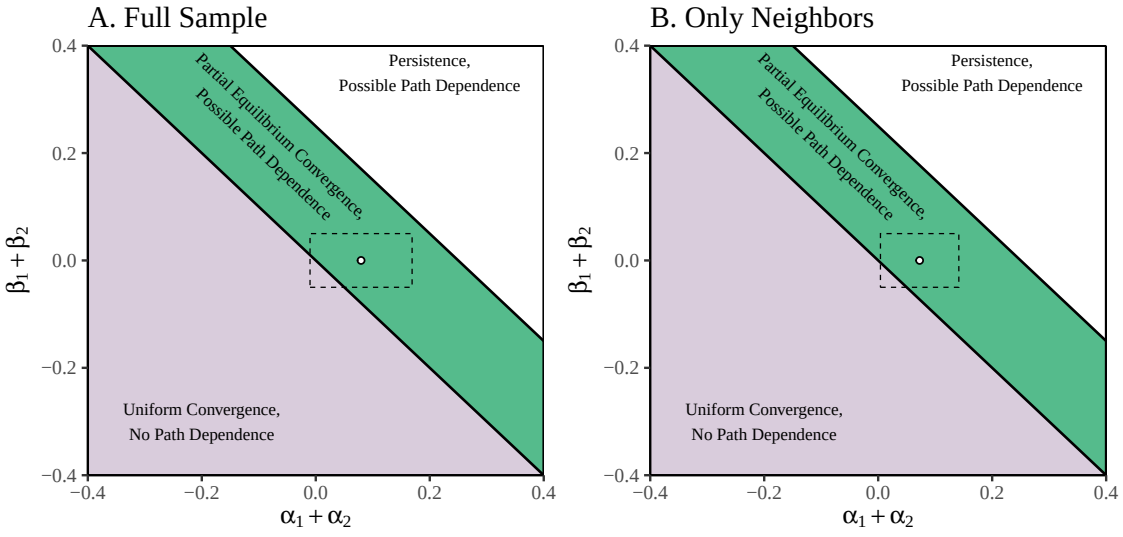
$$\log w_{it} = \nu_1 \log L_{it} + \nu_2 \log L_{it-1} + \nu_3 \log \Lambda_{it}^{\theta} + X_{it}' \nu_4 + \omega_{it}. \quad (2)$$

assuming that the LCP of gold roads is an instrument that affects L_{it} through the inward migration market access (Λ_{it}^{θ}), and not affecting ε_{it}

Agglomeration Spillovers

	Simple Model				Model with Trade	
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable: Hourly Wage						
Pop. Density	0.100***	0.124***	0.098***	0.103***	0.105***	0.105***
	(0.012)	(0.024)	(0.034)	(0.028)	(0.028)	(0.029)
Lagged Pop. Density		-0.049*	-0.018	-0.030	-0.042**	-0.044**
		(0.026)	(0.031)	(0.021)	(0.019)	(0.021)
Outward Market Access					0.098**	
					(0.044)	
Observations	11,039,347	11,039,347	11,039,347	8,957,715	8,957,715	8,957,715
Kleibergen-Paap F	44.630	23.335	20.136	23.687	21.229	23.687
Individual Controls	✓	✓	✓	✓	✓	✓
Geography Controls			✓	✓	✓	✓
Neighbors Only				✓	✓	✓
$\zeta_3 = 1/\sigma$						✓

Agglomeration Spillovers



Conclusions

- Historical pathways have a positive impact on the current distribution of population
- The effect is initially short-lived:
  - By 1920s, we no longer observe the impact of historical roads on population density
  - However, the initial agglomeration effects led to the creation of road towns, attracting a non-agricultural mix of workers
- These road towns served as a basin of attraction to newcomers as the structural transformation began in Brazil
- Agglomeration forces seem large enough for the economy to feature multiple equilibria, which suggests a possible lasting impact on the population distribution in Brazil.

Thank You!

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Backup Slides

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