Railroads and Employment in Java

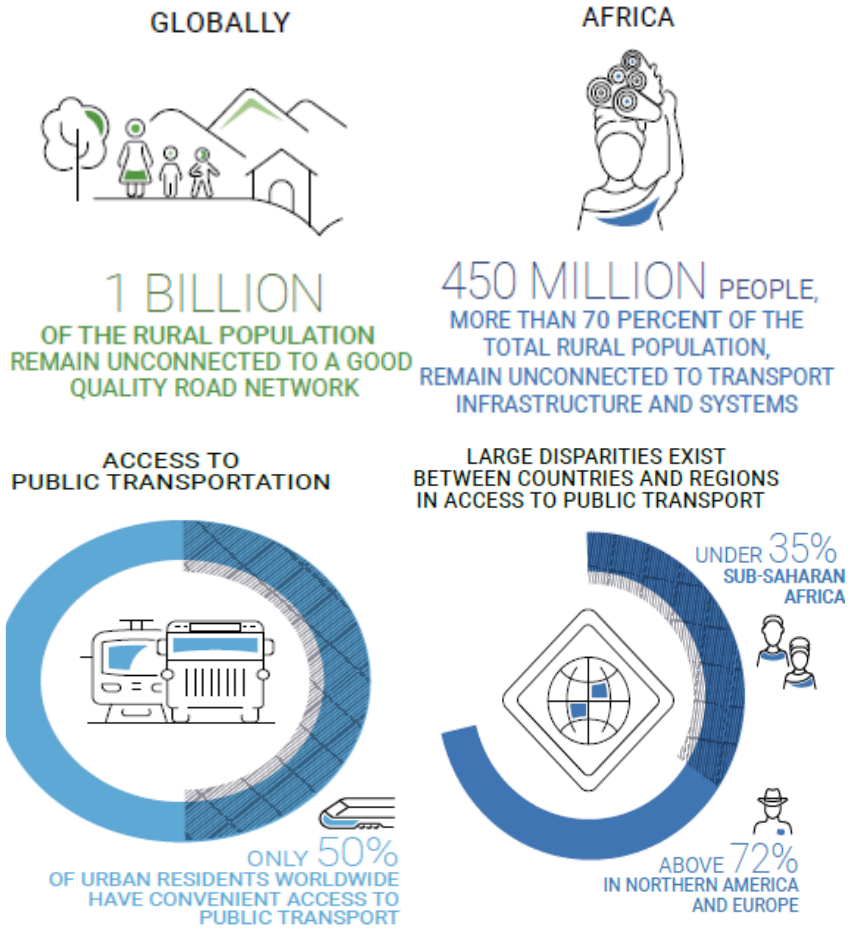
Inggrid
Independent Researcher
20 March 2025

Outline

1. Introduction
2. Background
3. Data
4. Empirical Strategy
5. Results
6. Conclusions

Introduction: Motivation

- Inequitable access to transportation services remains common in many countries.
- UN data
  - Over 1 billion people in rural areas have limited access to an all-weather road, particularly in developing countries.
  - Only half of the urban population worldwide have access to good public transport services.
- A lack of transportation restricts access to basic services and markets, fosters marginalization, and exacerbates social inequalities (United Nations, 2021).

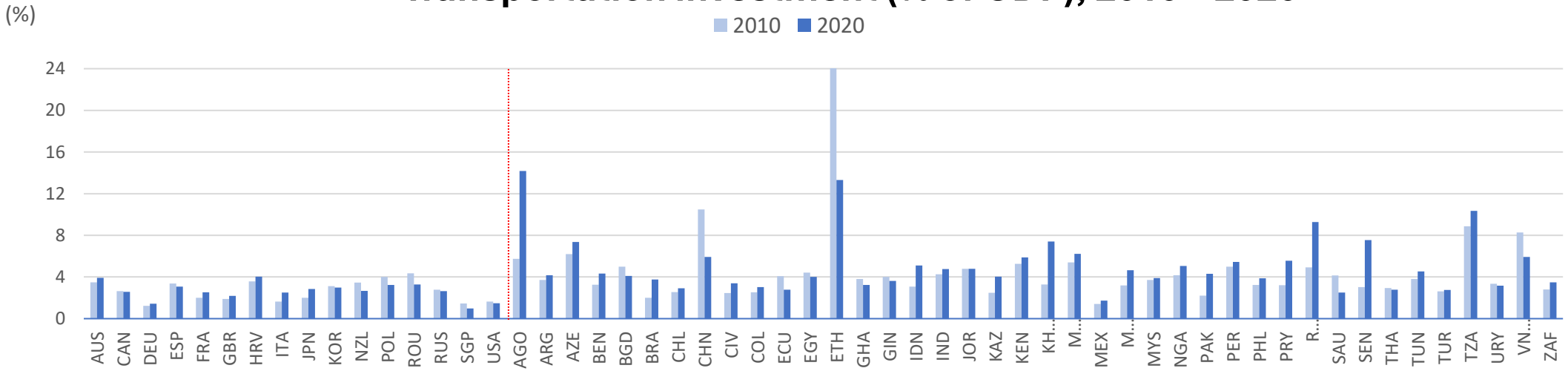


Source: United Nations (2021)

Introduction: Motivation

- A large fraction of countries' budgets is allocated to building and maintaining transportation infrastructure each year.
  - Transportation investments (% of GDP) in developing countries are higher than those in developed countries.
  - In 2023, around 10% of World Bank lending ($33.2 billion) went to transportation projects (Gonzalez-Navarro et al., 2023).

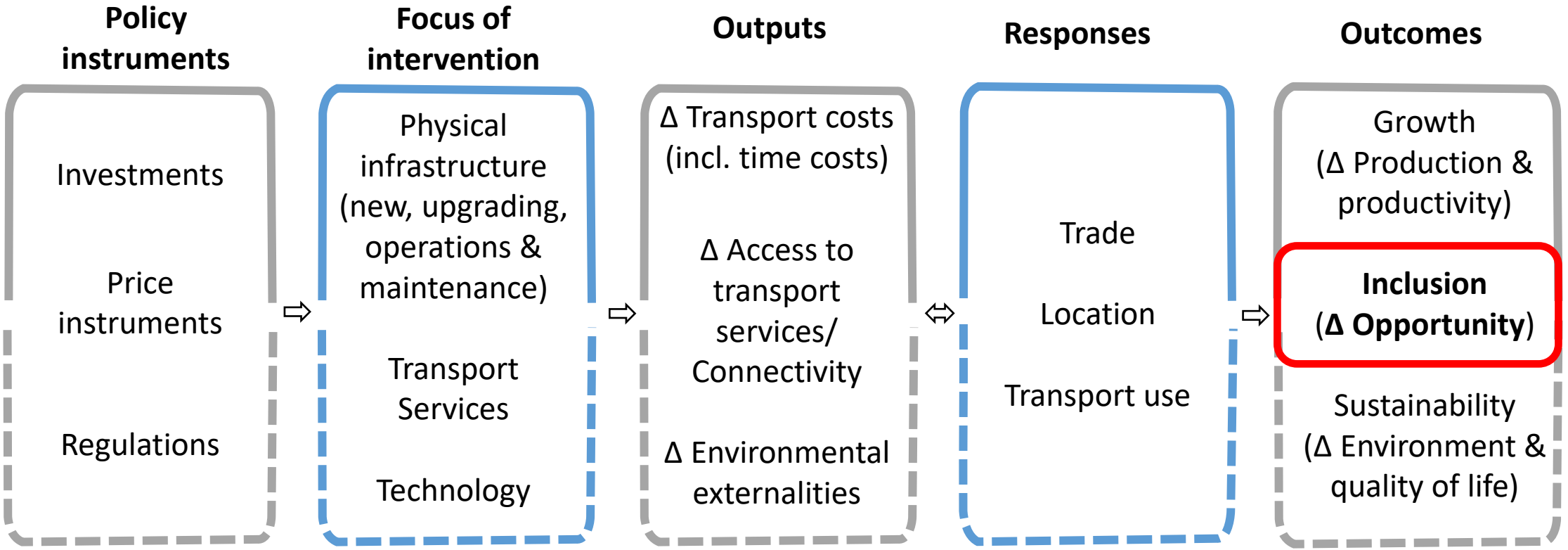
Transportation investment (% of GDP), 2010 – 2020



Source: Global Infrastructure Hub

Introduction: Transmission of Transportation Policy

- Impacts of transportation policies

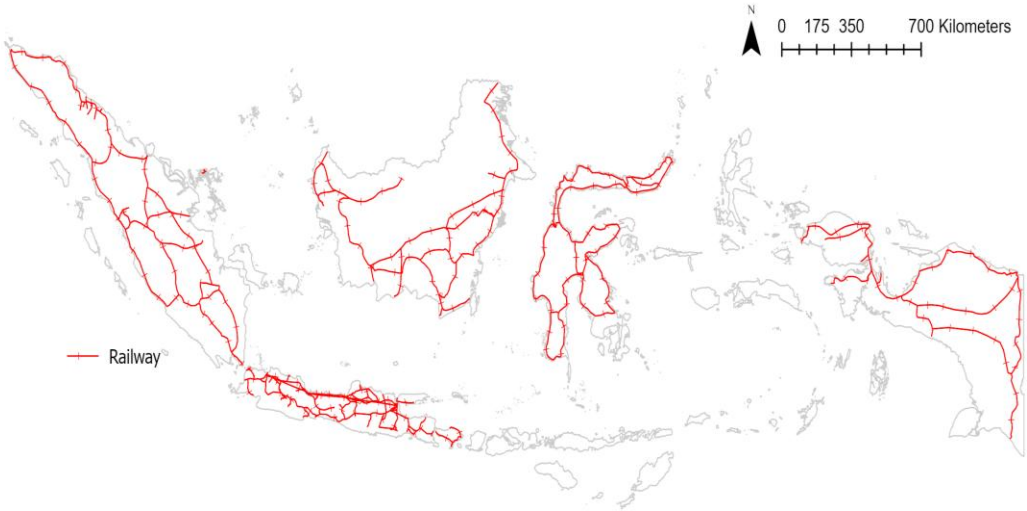


Source: Berg et al. (2017)

Introduction: Research Questions

- How has the decline of railroads affected labor market outcomes in Java?
- How do these effects differ across sub-groups?
- Relevance
  - New transportation technologies in the 19th century → "skill-biased technological change hypothesis" (Author et al., 1998) vs. the role of labor market institutions in boosting the benefits of technological change (Acemoglu & Johnson, 2023).
  - Current and future rail-building projects? 10,524 km of railways by 2030.

Indonesia's Rail Network, 2030



Introduction: Contributions

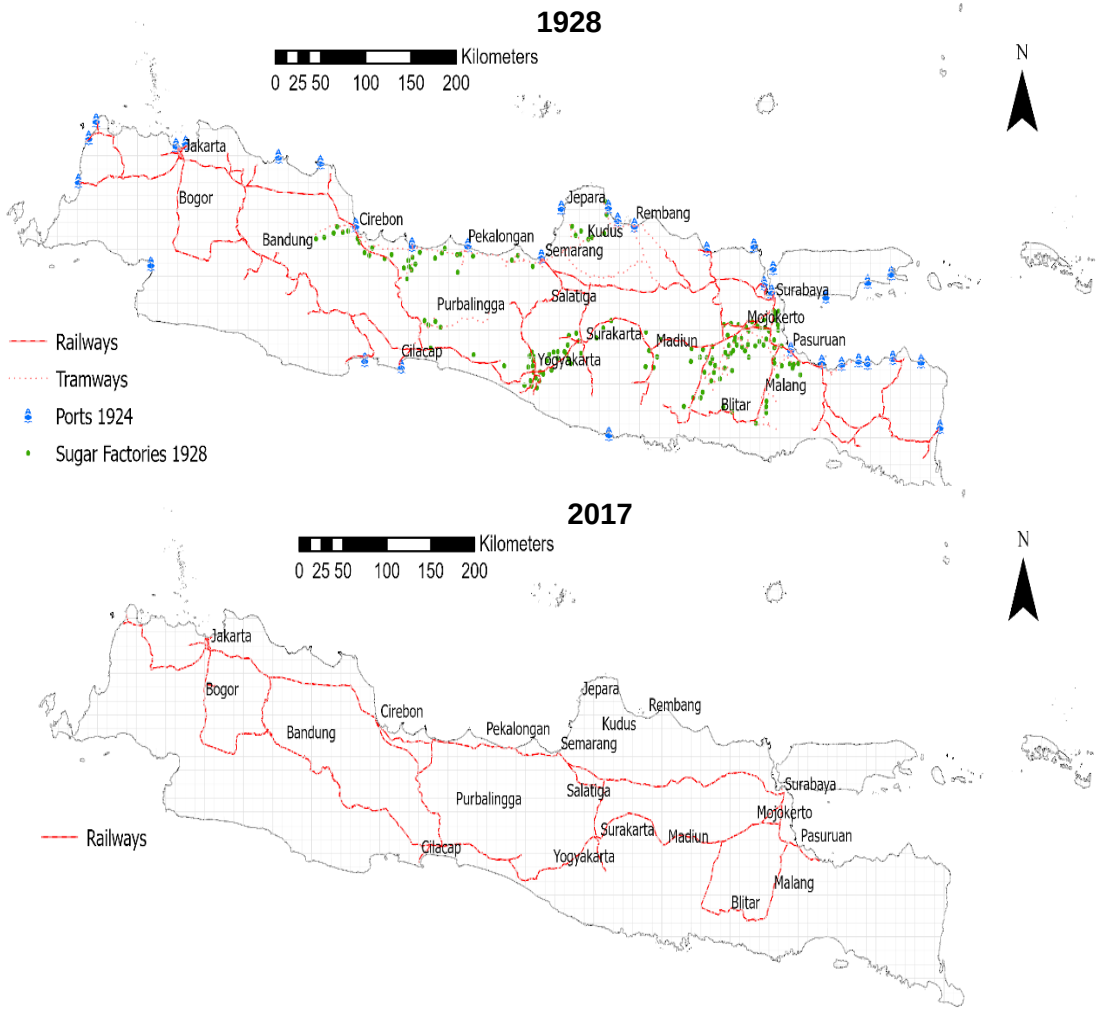
- The construction of a new dataset on colonial railroads in Java.
- This paper adds to the growing body of work examining the spatial disconnection between residential and work locations → the spatial mismatch hypothesis (e.g., Kain, 1992; Franklin, 2017; Perez et al., 2022; Card et al., 2024).
- This paper also contributes to the literature on the impact of transportation infrastructure on economic activity, employment, and urban growth (e.g., Donaldson & Hornbeck, 2016; Jedwab & Moradi, 2016; Jedwab et al., 2017; Baum-Snow et al., 2017; Donaldson, 2018; Alder, 2019).

Background: Railroads in Java

- The Dutch colonial government instituted the forced cultivation system (*Cultuurstelsel*) in Java during 1830–1870, compelling indigenous villagers to grow export crops on about one-fifth of their agricultural land.
- There was a surge of sugar production for export, requiring reliable transport services to carry it to the ports.
- The Dutch introduced railroads in Java between 1867–1939.

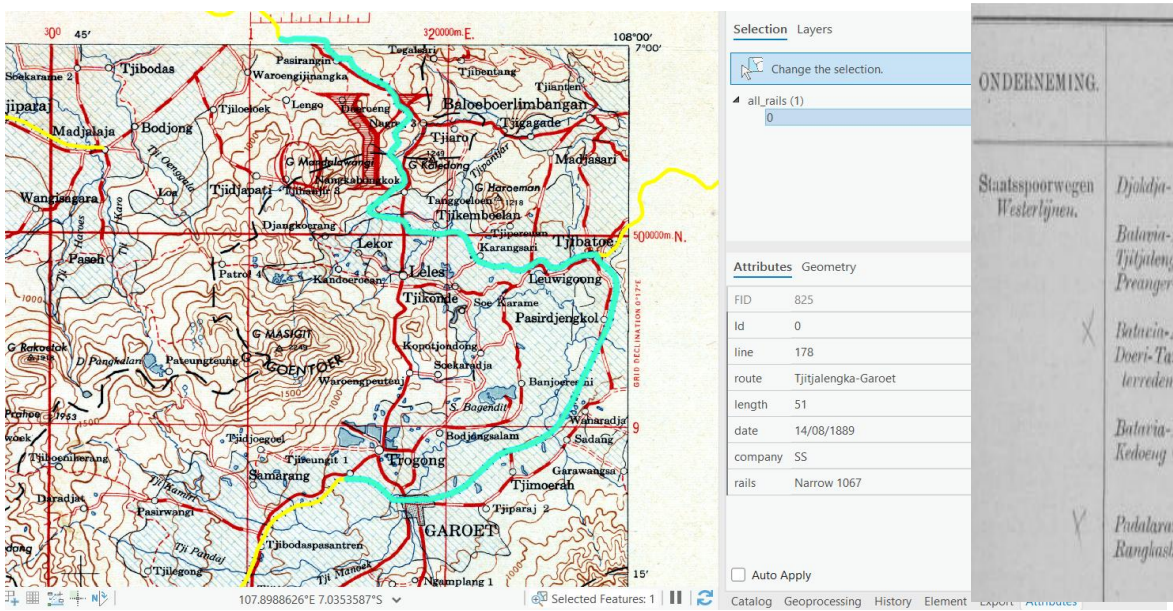
Background: Railroads in Java

- By 1928, Java Island had a well-integrated railroad network (5,191 km).
- The railroad system collapsed in the post-independence period due to war damage and poor track maintenance (Dick & Forbes, 1992; Leinbach, 1989; McCawley, 2015).
- By 2017, only 2,914 km of rail lines remained open for traffic.



Data

- GIS database of Java's railroads
  - Digitize 20 large-scale maps of Java, Madura, and Bali from the US Army Map Service (1944).
  - Use archival documents by Weijerman (1904) & Reitsma (1928, 1930) to identify the length and opening date of each railroad segment.



ONDERNEMING.	LIJN.	Spoor wijdte.	Duur der conces-sie in jaren.	Besluit—datum en jaartal—en Indisch Staatsblad.	BAANVAK.	Lengte in K.M.	Datum en Jaar der Opening.
Staatsspoorwegen Westerlijnen.	*Djokdja-Tjilatjap.*	1.067	—	Wet 20 Juli 1884. Sb. 111.	*Djokdja-Tjilatjap.*	176.	20 Juli 1887.
					Koetoardjo-Poerworedjo.	12.	
	Batavia-Priok.	1.067	—		*Batavia-Priok.*	9.	2 Nov. 1885.
	Tjitjalengka-Garoet.	1.067	—	Wet 24 Dec. 1886. Sb. 254.	*Tjitjalengka-Garoet.*	51.	14 Aug. 1889.
	Preanger-Tjilatjap.	1.067	—	Wet 31 Dec. 1888. Sb. 8 (1889).	*Tjibatoe-Tasikmalaja.*	56.	16 Sept. 1893.
					Tasikmalaja-Kesoegihan.	118.	1 Nov. 1894.
	Batavia-Anjer met zijtakken: Doeri-Tangerang en Tanah Abang-Weltevreden.	1.067	—	Wet 15 Juni 1896. Sb. 180.	*Batavia-Doeri-Tangerang.*	23.	2 Jan. 1899.
					Doeri-Rangkasbetoeng.	76.	1 Oct. "
					Rangkasbetoeng-Serang.	34.	1 Juli 1900.
					Serang-Anjerkidoel.	42.	20 Dec. "
	Batavia-Kedoeng Gedeh. Kedoeng Gedeh-Krawang.	1.067	—	Overgenomen van de Batavia Ooster Sp. Mij. ingevolge de Wet van 9 Juni 1898 Sb. 222.	*Batavia-Bekassie.*	27.	31 Mrt. 1887.
					Bekassie-Tjikarang.	17.	14 Aug. 1890.
					Tjikarang-Kedoeng Gedeh.	13.	21 Juni 1891.
					Kedoeng Gedeh-Krawang.	6.	20 Mrt. 1898.
	Padalarang-Krawang.	1.067	—	Wet 29 Dec. 1900. Sb. 8 (1901).	*Krawang-Poerwakarta.*	41.	27 Dec. 1902.
	Rangkasbetoeng-Labocan.	1.067	—	Wet 31 Dec. 1902. Sb. 17. (1903).			

Data

- Real vs. digitized railroad



Data

- Indonesian Family Life Survey (IFLS-5): labor market outcomes.
- Other datasets: geographical and historical controls.
  - Ruggedness (000, mm): Nunn & Puga (2012).
  - Slope (%), elevation (m): NASA's Shuttle Radar Topography Mission (SRTM).
  - distance to coast (km): de Zwart & Soekhradj (2023).
  - distance to main town, 1901 (km): de Zwart & Soekhradj (2023).
  - distance to main road, 1884 (km): de Zwart & Soekhradj (2023).
  - distance to sugar factory,1925 (km): Algemeen Syndicaat van Suikerfabrieken in Nederlandsch-Indië (1925).

Summary Statistics

Variable	Obs.	Mean	Std Dev	Min	Max
Outcomes					
Employed (=1)	16258	0.676	0.468	0.000	1.000
Full-time job (=1)	16258	0.413	0.492	0.000	1.000
Formal job (=1)	16258	0.333	0.471	0.000	1.000
Variable of interest					
Distance to railroad (log)	16258	0.934	1.453	-4.351	3.755
Individual level controls					
Age (years)	16258	39.287	16.238	15.000	65.000
Female (=1)	16258	0.526	0.499	0.000	1.000
Education					
Completed primary school (=1)	16258	0.312	0.463	0.000	1.000
Completed junior secondary school (=1)	16258	0.184	0.387	0.000	1.000
Completed senior secondary school (=1)	16258	0.317	0.465	0.000	1.000
Completed tertiary degree (=1)	16258	0.127	0.333	0.000	1.000
Household level controls					
Household head (=1)	16258	0.409	0.492	0.000	1.000
Number of household members	16258	6.167	3.247	1.000	25.000
Marital status					
Maried (=1)	16258	0.720	0.449	0.000	1.000
Divorced (=1)	16258	0.024	0.152	0.000	1.000
Widowed (=1)	16258	0.070	0.255	0.000	1.000
Geographical and historical control					
Ruggedness (000, mm)	16258	47.113	68.233	0.000	481.748
Slope (%)	16258	1.409	1.951	0.040	11.834
Elevation (m)	16258	177.304	274.916	0.000	1801.917
Distance to coast (log)	16258	1.223	0.494	-0.671	1.935
Distance to main town, 1901 (log)	16258	0.963	0.411	-1.449	2.121
Distance to main road, 1884 (log)	16258	0.512	0.662	-2.148	2.071
Distance to sugar factory,1925 (log)	16258	1.297	0.639	-0.460	2.296

Empirical Strategy

- Baseline specification

$$Pr(E_{ij} = 1) = \alpha + \beta r_j + X'_{ij}\varphi + \mu_j + \varepsilon_{ij} \quad (1)$$

$Pr(E_{ij} = 1)$ = outcomes of interest for individual i living in district j.

r = distance to the nearest railway in 1928.

X = a vector of individual-level and district-level covariates.

μ_j = district fixed-effects.

ε = the error term.

Empirical Strategy

- Probing endogeneity of railroads
  - **Reverse causality**. Railroads may have been built in areas expected to have promising labor market outcomes during the Dutch occupation.
  - **Omitted variable bias**. Unobserved factors that drive railroad building and labor market outcomes.
  - **Measurement error**. Distance to the nearest railway in 1928 is a rough proxy.

Results

- Main results

Effect of railroads on employment

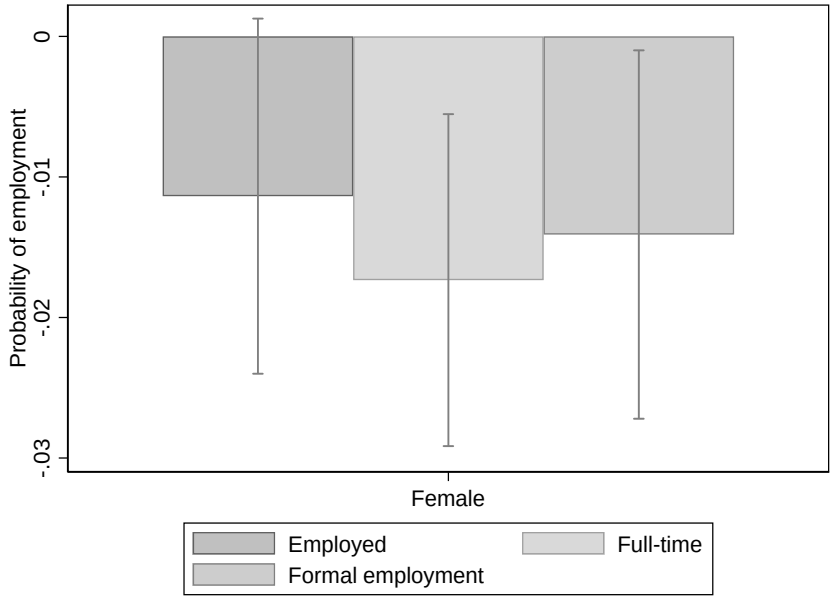
	Employed (=1)			Full time (=1)			Formal job (=1)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Log rail distance	-0.009**	-0.010***	-0.012***	-0.023***	-0.020***	-0.019***	-0.029***	-0.025***	-0.017***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.006)	(0.005)	(0.005)
N	16,248	16,248	16,248	16,258	16,258	16,258	16,253	16,253	16,253
Pseudo R^2	0.018	0.173	0.174	0.032	0.104	0.104	0.050	0.149	0.150
Individual Controls	NO	YES	YES	NO	YES	YES	NO	YES	YES
Household Controls	NO	YES	YES	NO	YES	YES	NO	YES	YES
District Controls	NO	NO	YES	NO	NO	YES	NO	NO	YES
District FE	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Standard errors are clustered at the district level. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

Results

- Heterogenous effects by gender

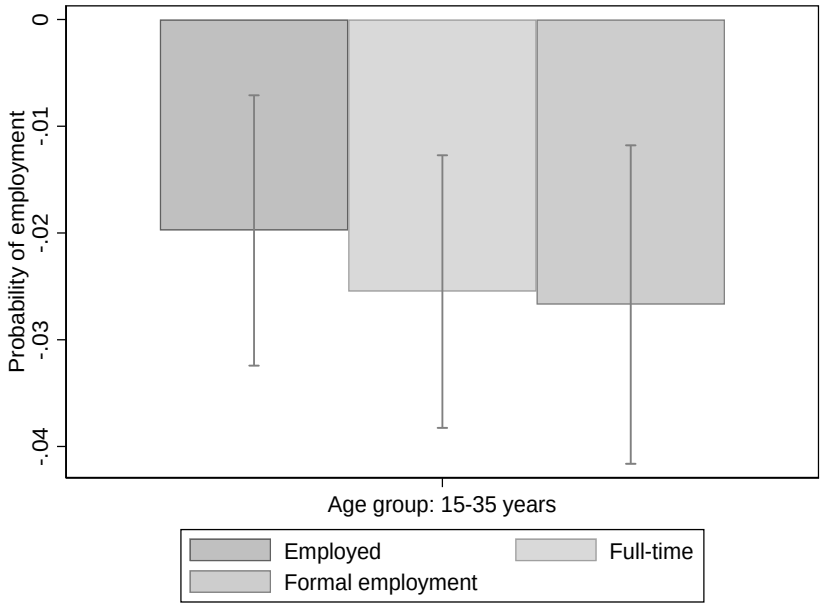


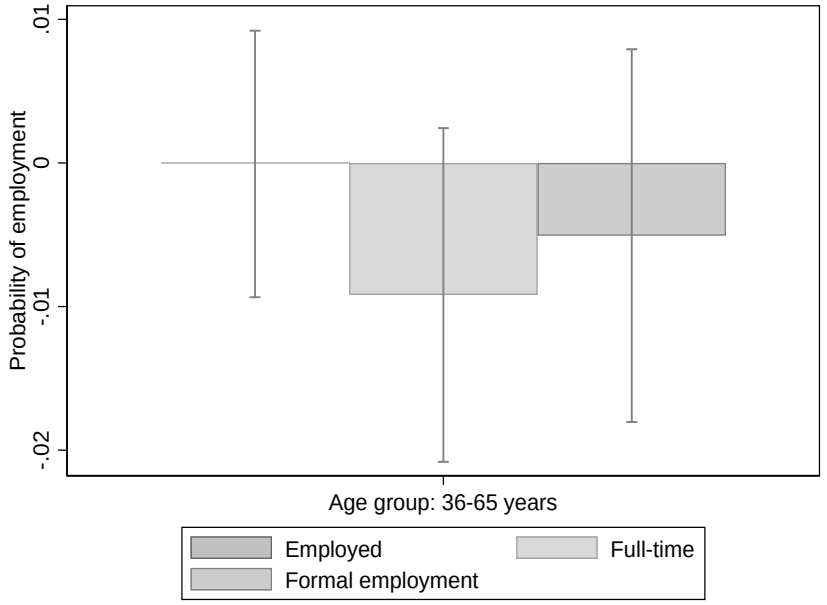


The effects are larger for males….

Results

- Heterogenous effects by age group





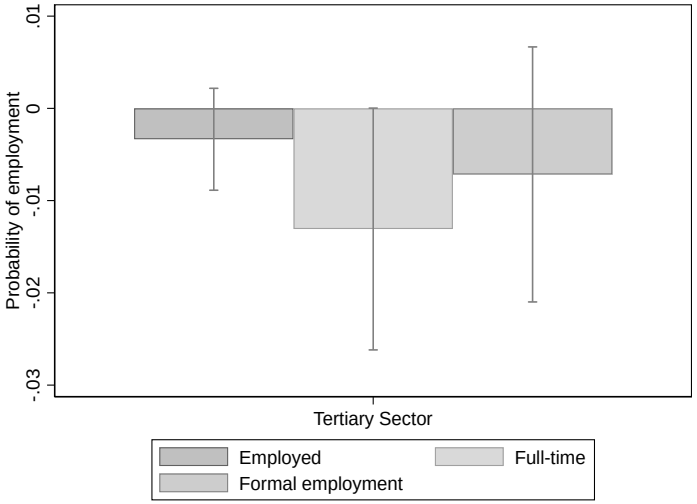
The effects are larger for younger employees….

Results

- Heterogenous effects by economic sectors







The largest effects in the primary sector....

Conclusions

- The paper provides prima facie evidence of the positive effects of rail proximity on employment.
- The empirical analysis also suggests that the effects are larger for males and younger age groups, as well as for those employed in the primary sector.
- Ongoing work:
  - Look at a broader range of labor market outcomes.
  - Address the endogeneity of railroads.
  - Tease out potential mechanisms through which railroads affect labor market outcomes.

Thank you







Source: Leiden University, Liputan 6 & Kompas