Can White Elephants Kill?

The Unintended Consequences of Infrastructure Development

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St.Andrews and IFS

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Investing in infrastructure

- Driver of productivity and economic development [Aschauer, 1989; Isham and Kaufmann, 1999].
  - Total spending in infrastructure projects in LMICs $\approx$ **1.2 trillion USD** $\rightarrow$ 5% of the global GDP [Fay et al., 2019].

- Ample evidence on the effectiveness of **completed and in-use** infrastructure to improve living standards:
  - Sewers, water-pipes, dams, and electricity and transportation networks [e.g. Watson, 2006; Duflo and Pande, 2007; Rud, 2012; Lipscomb et al., 2013; Donaldson, 2018; Alsan and Goldin, 2019; Bhalotra et al., 2021].

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Implementing infrastructure

- Construction works expose the local population to **hazards** and **disruptions**.

- Implementation plagued by inefficiencies that increase private and **social costs** in LMICs and HICs alike.
    - Delays and cost over-runs in up to 45% of OECD projects [Flyvbjerg, Holm, and Buhl, 2004].
    - 1/3 of infrastructure projects are halted and even abandoned mid-construction [Rasul and Rogger, 2018; Williams, 2017].

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- New focus: study the social costs imposed by infrastructure projects that are being **implemented** (i.e., projects started but not yet completed).
- Context: nation-wide implementation of sewerage projects in urban areas of Peru and its effect on early-life mortality.
- Data: novel administrative data matched to spatial data to construct a panel of more than 1,400 districts spanning 2005-2015.
- Strategy: exploiting geographic features and nationwide availability of funds as an instrument.

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- Projects increased mortality while being implemented, rather than not starting projects, due to hazards, infections and unsafe behavior.

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Data

- Budgetary reports for 6,000 projects in 1,400 districts:
  - Years of start and completion
  - **Number of implemented projects** per district–year
- Vital statistics and population forecasts:
  - Deaths by cause (ICD-10)
  - **Infant (IMR) and under-5 mortality rate (U5MR)** per 1,000 children per district–year

$$\frac{\text{deaths of infants (children)}_{dt}}{\text{infant (child) population}_{dt}} \times 1,000$$

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Specification

$$MR_{dt} = \beta S_{dt} + \gamma_d + \delta_t + \nu_{dt} \quad (2)$$

- MR_{dt} = mortality rate in district d and year t
- S_{dt} = number of implemented projects
- γ_d = district fixed effect
- δ_t = year fixed effect
- ν_{dt} = error term, standard error clustered at district level

- Sample: district–years before project completion.
- Counterfactual scenario: no project implemented.

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Empirical strategy

- Instrumental variable to deal with endogenous placement and timing of project implementation.

- Counterfactual implementation of projects, commonly used in the infrastructure literature [Duflo and Pande, 2007; Lipscomb et al., 2013; Burgess et al., 2015] based on:

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  2. Over time changes in **national funds** for sewerage projects.

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Instrumental variable

- Time-varying predicted projects:

$$P_{dt} = min(M, P_{dt-1} + I(fundrank_d \leq maxfund_t)) \quad (3)$$

  - $fundrank_d \rightarrow$ funding rank of district d based on its geographic suitability
  - $maxfund_t \rightarrow$ maximum fundable projects given the nationwide budget in year t Budget
  - $M \rightarrow$ maximum prediction per district d (based on median)

- *Identification assumption*: no other demand-side factors, policies or infrastructure evolved over time following same spatial lines.

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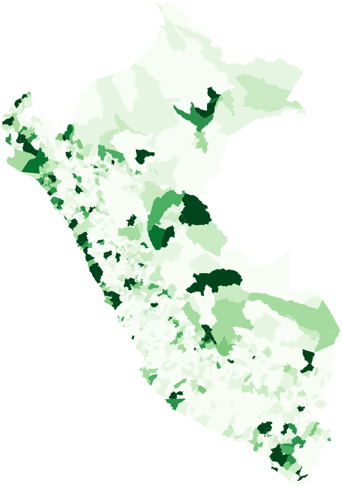
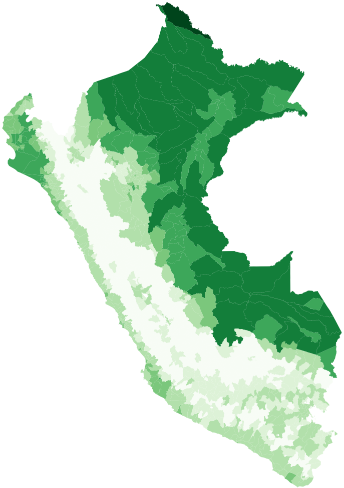
Sewerage implementation in Peru, snapshot of 2010



Actual



Predicted

Validity of the exclusion restriction

1. Lagged development indicators have no effect on the number of predicted projects.
2. While sewerage-intense districts experienced steeper mortality trends, low- and high-geographically suitable districts exhibit **parallel trends**.

Dependent variable:	Instrument for implemented sewerage projects			
Unit:	Projects			
	(1)	(2)	(3)	(4)
Population density ($t-5$)	0.000			
	(0.000)			
	[0.937]			
Revenues ($t-5$)		0.029		
		(0.037)		
		[0.434]		
Human resources ($t-5$)			−0.000	
			(0.000)	
			[0.245]	
Internet access ($t-5$)				0.038
				(0.030)
				[0.210]
District-year	8,448	6,889	8,345	8,414
Districts	1,408	1,408	1,408	1,408

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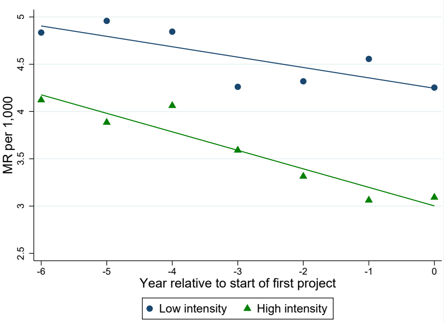

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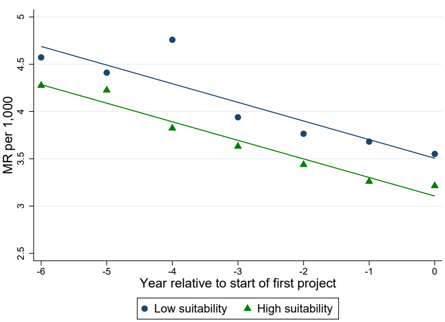


Predicted

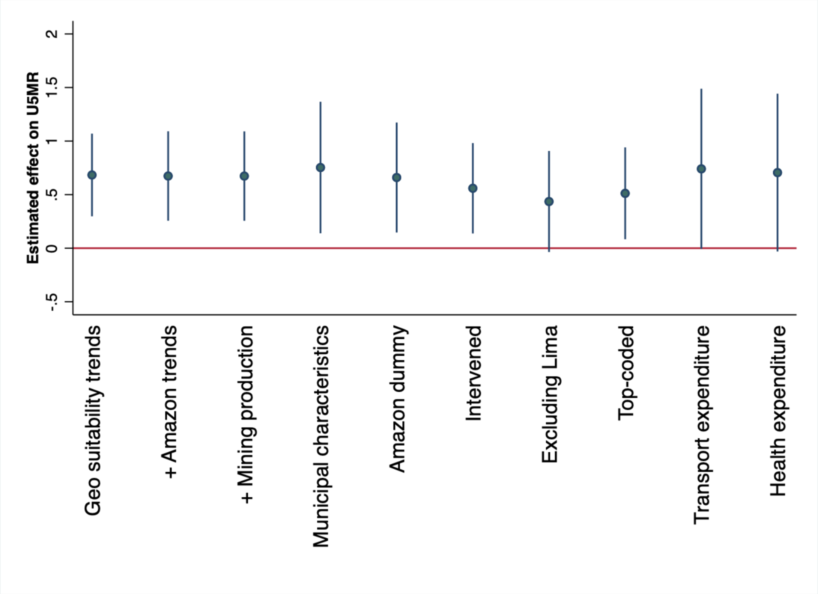
Main result: implementing infrastructure kills

Dependent variable:	IMR	U5MR	IMR	U5MR
Unit:	Deaths per 1,000 infants or children			
	(1)	(2)	(3)	(4)
	OLS		2SLS	
Implemented projects	0.000	0.057	0.003	0.660
	(0.000)	(0.016)	(0.001)	(0.312)
	[0.000]	[0.000]	[0.058]	[0.034]
Anderson–Rubin p-value			0.034	0.014
Mean (initial)	0.018	4.818	0.018	4.818
F-stat (SW)			14.716	14.716
District-year	8,555	8,555	8,555	8,555
Districts	1,379	1,379	1,379	1,379

Notes. Clustered standard errors at the district level in parenthesis and p-values in brackets. District and year fixed effects included.

1st stage

Robustness checks



Mechanisms

- Increase in mortality caused by waterborne diseases and accidents.
  IMR U5MR
- Increase in use of unsafe water for drinking purposes and sanitation practices. WASH
- Alternative channels: no changes in fertility, migration and selective migration. Demography

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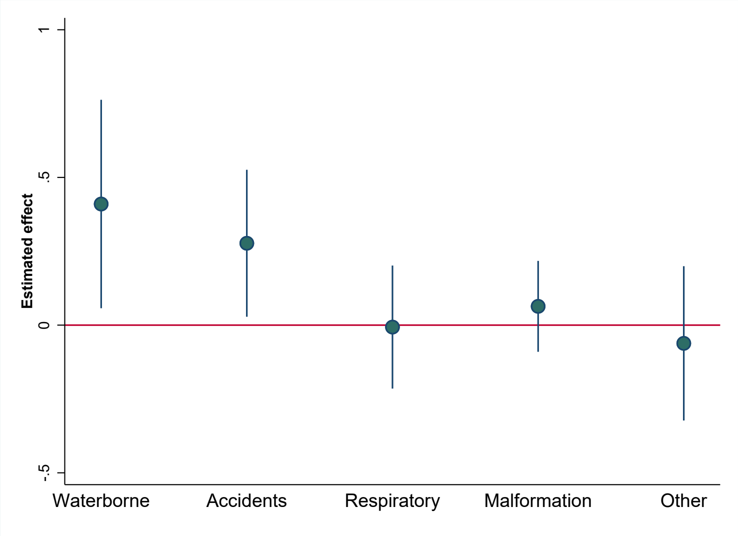
↑ U5MR by waterborne diseases and accidents



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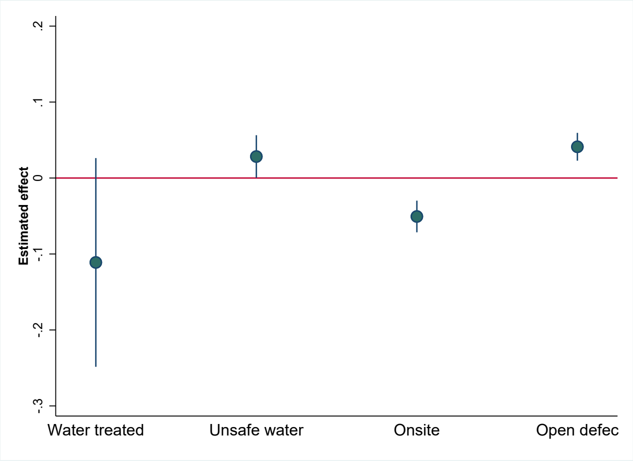
↑ unsafe water and sanitation behaviour



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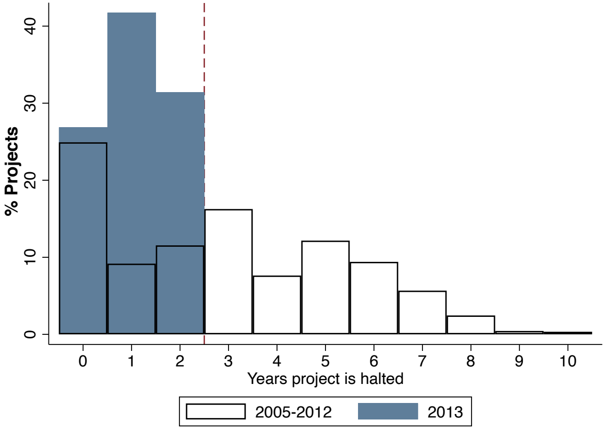
Many halted projects and for long



More than 70% of projects were halted, increasing average duration 3 to 5y

Pathway

Heterogenous effects by halting status

Dependent variable:	IMR	U5MR	IMR	U5MR
Unit:	Deaths per 1,000 infants or children			
	(1)	(2)	(3)	(4)
	2SLS		2SLS	
	No halting in district		All halted in district	
Implemented projects	0.003	0.633	0.006	1.707
	(0.002)	(0.455)	(0.004)	(0.930)
	[0.107]	[0.165]	[0.138]	[0.066]
Anderson–Rubin p-value	0.083	0.140	0.119	0.044
Mean (initial)	0.018	4.818	0.018	4.818
F-stat (SW)	16.070	16.070	16.504	16.504
District-year	5,236	5,236	4,346	4,346
Districts	1,009	1,009	968	968

Conclusions

- An additional implemented project ↑ early-life mortality, with respect to not starting projects
    - ↑ IMR by 0.003 deaths (17%)
    - ↑ U5MR by 0.66 deaths (14%)
- Effect on mortality of an additional halted project is 3x as large as the effect of an additional project that is just underway.
- Ignoring social costs during project implementation overestimates welfare calculations.

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- Benefit-cost ratio using estimated effects of completed projects [Alsan and Goldin, 2019; Galiani et al., 2005]
    - Social benefits of completed projects are 7x the estimated social cost of projects implemented without problems.
    - Social benefits just 7/10 of the social costs associated with delayed and halted projects.
    - No social benefits if projects are abandoned.
- Abandoning projects: also wasteful use of public resources
    - By 2015, halted and unfinished projects had 40% of contractual sum disbursed.
    - Total waste $\approx 1/3$ of public expenditure on tertiary education in 2015 in Peru [World Bank, 2020].

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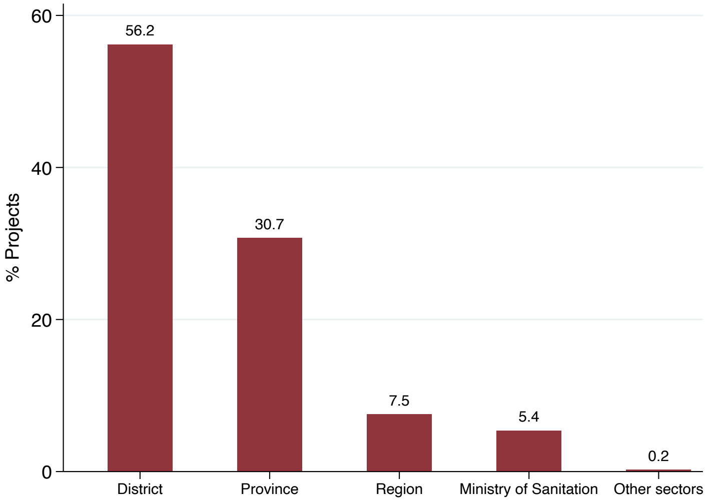
Thank you!

Implementing agent



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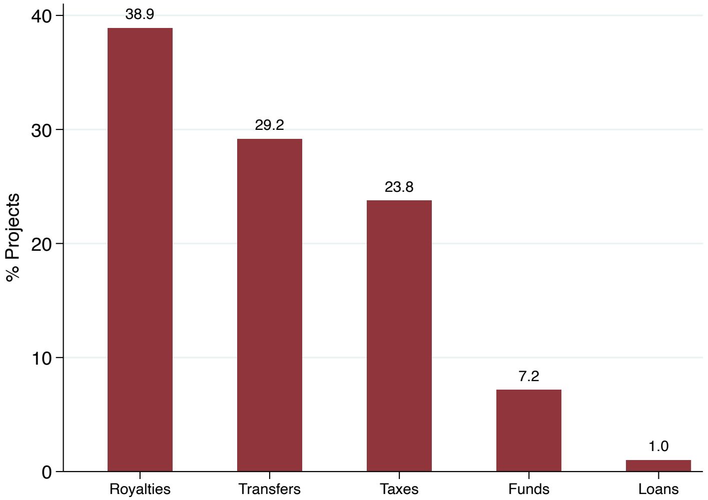
Funding source



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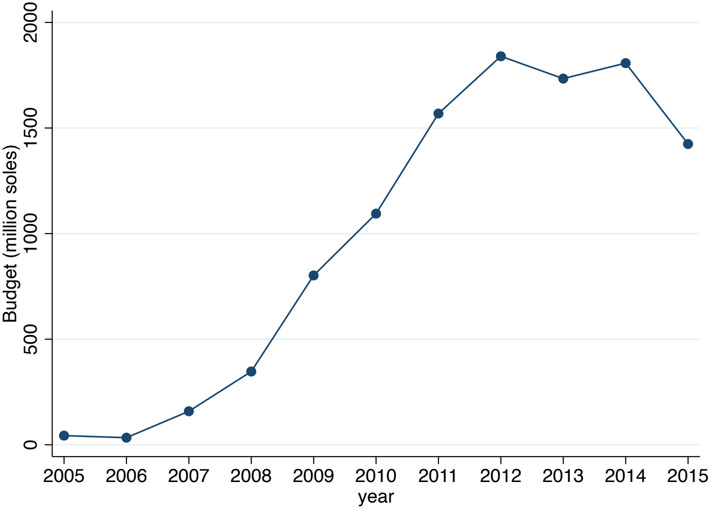
Nationwide funds for sewerage varies over time



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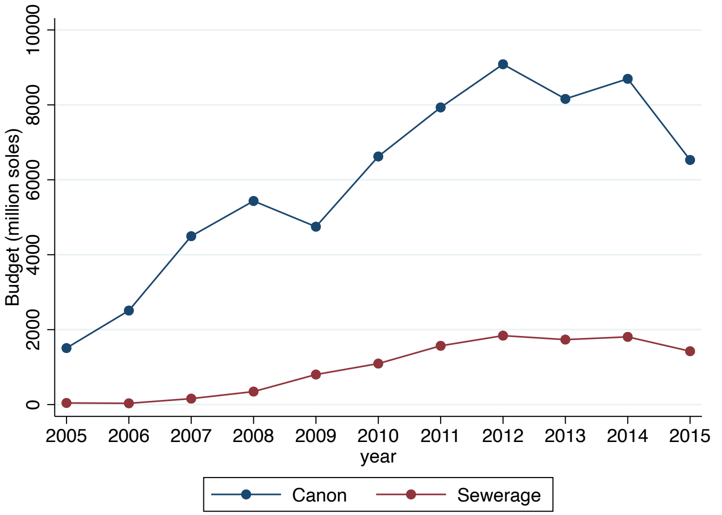
Driven by exogenous shock to royalties



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Placebo test, reduced form and first stage

	Placebo test		Reduced-form		1st stage
Dependent variable:	IMR	U5MR	IMR	U5MR	Implemented
Unit:	Deaths per 1,000 infants or children				Projects
	(1)	(2)	(3)	(4)	(5)
Predicted projects	0.000	0.071	0.000	0.100	0.151
	(0.000)	(0.064)	(0.000)	(0.041)	(0.039)
	[0.156]	[0.266]	[0.034]	[0.014]	[0.000]
Mean (initial)	0.018	4.818	0.018	4.818	0.086
District-year	5,630	5,630	8,555	8,555	8,555
Districts	1,283	1,283	1,379	1,379	1,379

Notes. Clustered standard errors at the district level in parenthesis and p-values in brackets. District and year fixed effects included.

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Alternative mechanism: demographic changes

Dependent variable	Fertility		Migration		Selective	
	Infants	Under-5	Population	Density	Education	Electricity
Unit:	Population in age sub-group		Total population	Population per km^2	Share of households	
	(1)	(2)	(3)	(4)	(5)	(6)
Implemented projects	0.173	0.864	3513.991	12.323	0.004	-0.003
	(12.510)	(62.551)	(1210.377)	(29.233)	(0.002)	(0.004)
	[0.989]	[0.989]	[0.004]	[0.673]	[0.091]	[0.386]
Anderson-Rubin p-value	0.989	0.989	0.000	0.674	0.063	0.380
Mean (initial)	495.913	2479.565	23472.257	645.086	0.219	0.557
F-stat(SW)	15.861	15.861	15.861	15.861	15.812	15.635
District-year	8555	8555	8555	8555	8551	8528
Districts	1379	1379	1379	1379	1379	1376

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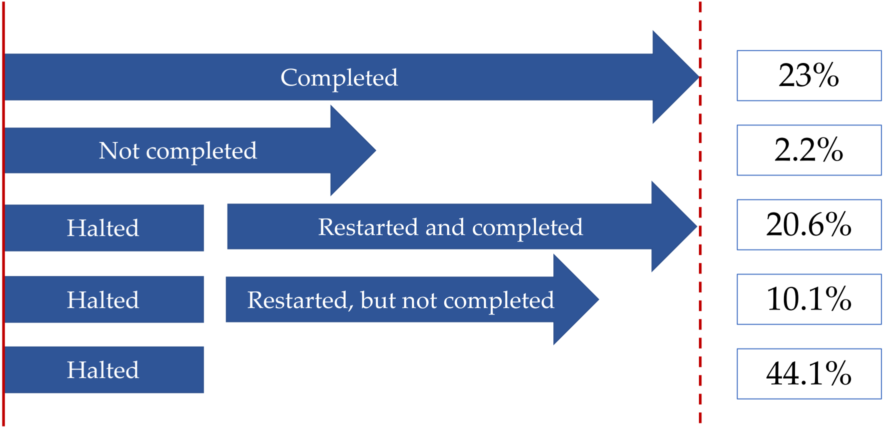
Project pathway



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