

Water and Birth Outcomes: Lessons from a Policy Intervention in a Climate Vulnerable Area

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Motivation

- About 4 billion people experience severe water scarcity during at least one month of the year (UN-Water, 2019)
- Water stress is a major challenge for poor rural populations
 - where traditional water policies (e.g., sanitation) are likely to be unfeasible
- Availability and quality of drinking water is important during pregnancy (Currie et al 2013; Almond et al 2018)
- This paper studies *how in utero* exposure to a large-size water harvesting program affects birth outcomes

The Paper in a Nutshell

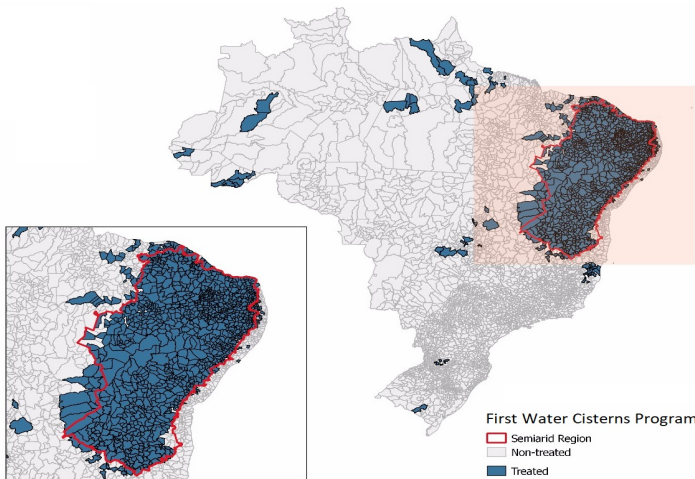
- We exploit the precise timing of increased exposure *in utero* to rainwater tanks based on the roll-out of a large-scale program
- Cistern Program: 1 million rainwater tanks in Brazil's poorest and driest region
- Data from different administrative registries
- Main Results
 - Sizable effect on birth weight
 - Effects stronger for more educated mothers

Literature and Contribution

We contribute to different strands of the literature

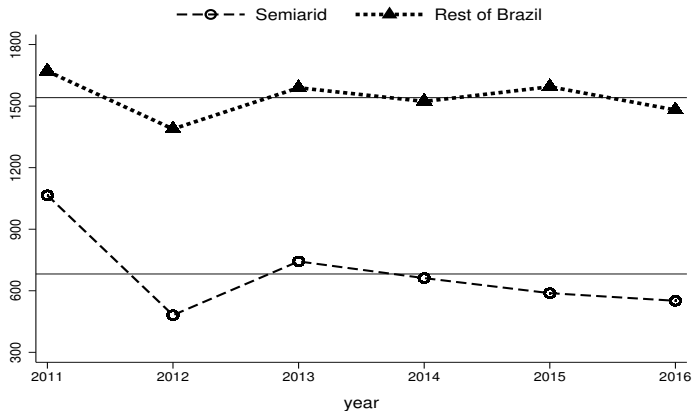
- Effects of a large-scale adaptation policy on health
- Literature on the impacts of in-kind welfare programs
- Adds to the place-based policies literature

First Water Cisterns Program



Semiarid Region

Figure: Yearly precipitation in Brazilian Semiarid Northeast and in the rest of Brazil, 2011-2016, in mm



First Water Cisterns Program



Source: Ministry of Social Development.

Data

- CadÚnico (2011-2018)
- First Water Cisterns Program (2003-2017)
- SINASC (2011-2017)

- Merge:
 - CadÚnico + First Water Cisterns Program
 - CadÚnico and First Water Cisterns Program + SINASC

Sample

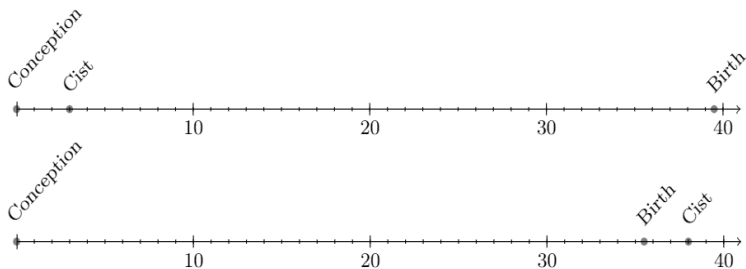
- Expected date of birth at conception (280 days) as an exogenous measure of gestational length
- Our sample P is given by:

$$P = \{i : c \leq \text{Cisterns} \leq b_{exp}\} = \{i : c \leq \text{Cisterns} \leq c + 280\}$$

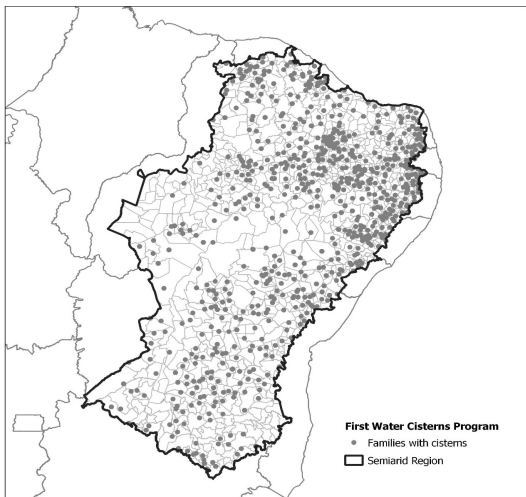
Sample

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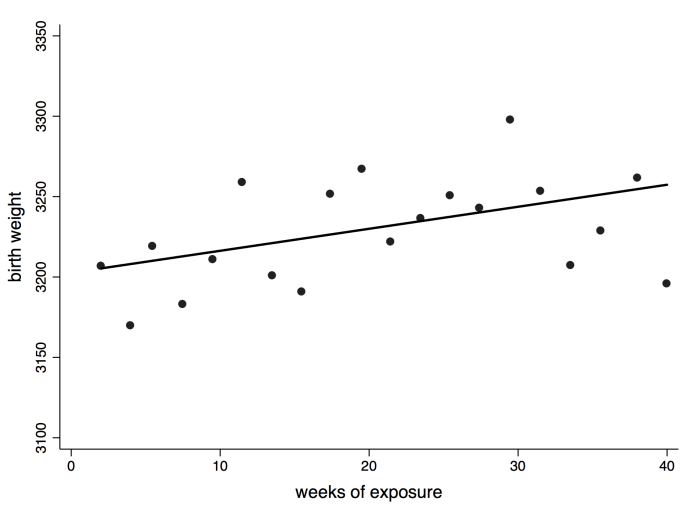
$$P = \{i : c \leq \text{Cisterns} \leq b_{exp}\} = \{i : c \leq \text{Cisterns} \leq c + 280\}$$



Location of the Individuals of our Sample



Correlation: weeks of exposure and birth weight



Empirical Strategy

- Main specification:

$$Y_{imts} = \mu_s + \gamma_{mt} + \beta \cdot \text{weeks_exposure}_{imts} + \mathbf{X}'_{imts} \Theta + \varepsilon_{imts} \quad (1)$$

- $\text{weeks_exposure}_{itm}$: measures the difference in weeks between the expected date of birth and the cistern's date of construction
- μ_s : Municipality fixed effect
- γ_{mt} : Month by Year of Conception fixed effect
- X_j : Controls
 - **Priority criteria variables**
 - **Delivery and mother's characteristics**
 - **Housing structure characteristics**

Empirical Strategy

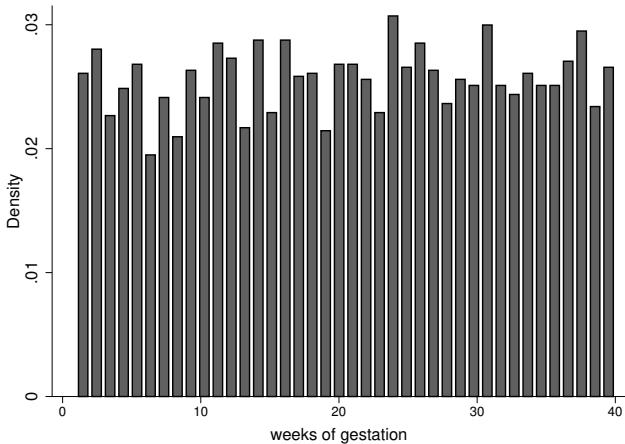
- Alternative specification:

$$Y_{imts} = \mu_s + \gamma_{mt} + \alpha \cdot \mathbf{trim1}_{imts} + \delta \cdot \mathbf{trim2}_{imts} + \mathbf{X}'_{imts} \Theta + \varepsilon_{imts} \quad (2)$$

- $trim1_{itm}$ (from the date of last menstruation plus 93 days)
- $trim2_{itm}$ (between 94 and 187 days after conception)

Histogram

Figure: Histogram of cisterns by week of gestation



Main Results

	(I)	(II)	(III)	(IV)
	Birth Weight		ln Birth Weight	
weeks_exposure	1.562** (0.756)	1.741** (0.754)	0.001** (0.000)	0.001** (0.000)
Month-year fixed effects	Yes	Yes	Yes	Yes
Municipality fixed effects	Yes	Yes	Yes	Yes
Controls	-	Yes	-	Yes
Observations	4,057	4,054	4,057	4,054

Main Results

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)	(IX)	(X)
	Birth Weight		ln Birth Weight		Fetal Growth Rate		Low Birth Weight		Weeks of Gestation	
weeks_exposure	1.562** (0.756)	1.741** (0.754)	0.001** (0.000)	0.001** (0.000)	0.035* (0.020)	0.042** (0.020)	-0.001* (0.000)	-0.001* (0.000)	0.003 (0.003)	0.002 (0.003)
Month-year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	-	Yes	-	Yes	No	Yes	-	Yes	-	Yes
Observations	4,057	4,054	4,057	4,054	4,057	4,054	4,057	4,054	4,059	4,056

Stata code

```

clear all
use Cistern estimation, clear

global fixed effects "i.ano ultmenst#i.mes ultmenst i.ibge"
global controls tot idoso d mulher chefe fam tot crianca 6anos fam ///
                tot crianca 7 17anos fam tot deficiente fam renda familia pc ///
                idade_mae_fam d_mulher_chefe_anafalbeta_fam d_hospital baby_fem

local replace replace
foreach v of varlist peso ln_peso peso_sem_gest d_peso_2500 temp_gest_sem {
reghdfe `v' weeks_exposure, a($fixed_effects) vce(cluster ibge)
outreg2 using table3.xls, keep(weeks_exposure) `replace' dec(3) nocons
local replace
reghdfe `v' weeks_exposure $controls, a($fixed_effects) vce(cluster ibge)
outreg2 using table3.xls, keep(weeks exposure) `replace' dec(3) nocons
}

```

Heterogeneous response

		Dependent variable: Birth Weight (g)							
		(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
		Mother's age		Illiterate mother		Marital status		Newborn sex	
		> 24 yrs	< 24 yrs	No	Yes	Married	Other	Female	Male
weeks_exposure		2.124*	1.391	2.255**	-5.503	2.072	1.143	0.523	1.799
		(1.108)	(2.072)	(0.996)	(4.588)	(1.523)	(1.305)	(1.476)	(1.308)
Month-year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations		2,895	1,308	3,445	599	1,683	2,443	2,024	2,179

Mechanisms

Quantity of Water, Quality of Water, Stress level, Maternal Nutrition, Time collecting water

Round trip to collect water	number of families	%
Before the rainwater tank		
Up to 15 minutes	74	5,6
Between 15 minutes and 1 hour	481	36,2
Between 1 and 2 hours	233	17,5
Above 2 hours	235	17,7
Do not know	299	22,5
Non-responded	6	0,5
After the rainwater tank		
Up to 15 minutes	884	66,6
Between 15 minutes and 1 hour	65	4,9
Between 1 and 2 hours	2	0,2
Above 2 hours	0	0
Do not know	354	26,7
Non-responded	23	1,7
Total	1,328	100

Notes. (EMBRAPA, 2009)

Adoption

Dependent variable:	Proper use of cistern			Family carries out water treatment		
Illiterate householder	-0.0714*** (0.0202)	-0.0605*** (0.0196)	-0.0509*** (0.0165)	-0.1065*** (0.0277)	-0.1427*** (0.0270)	-0.0597** (0.0249)
Observations	1,285	1,285	1,285	1,293	1,293	1,293
State FE	No	Yes	No	No	Yes	No
Municipality FE	No	No	Yes	No	No	Yes

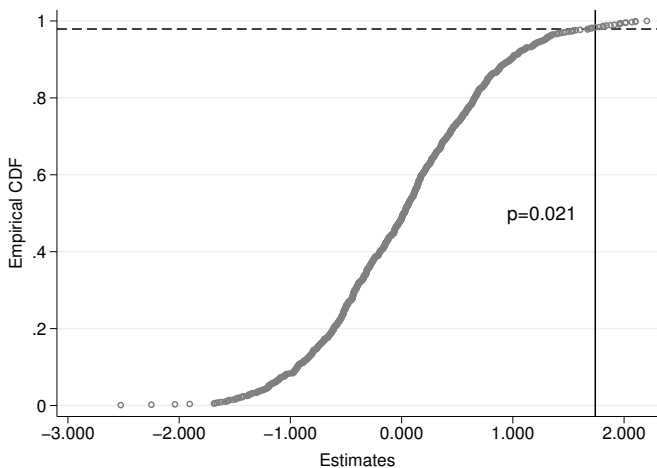
Additional exercises

- Other outcomes
 - APGAR 1, 5
 - Cesarean
 - Newborn female
 - Prenatal visits
- Dropping subsamples
- Additional Controls and Fixed Effects
- Analysis with older siblings
- Plabeco interventions

Older sibling

	(I)	(II)	(III)	(IV)
Dependent Variable:	Birth Weight Older Sibling		Birth Weight Treated Sibling	
weeks_exposure	0.575 (1.063)	0.695 (1.056)	1.907* (1.069)	1.824* (1.064)
Month-year fixed effects	Yes	Yes	Yes	Yes
Municipality fixed effects	Yes	Yes	Yes	Yes
Controls	-	Yes	-	Yes
Observations	2,521	2,521	2,521	2,521

Placebo interventions: Randomization of weeks of exposure



Alternative specification

	Dependent variables:				
	(I)	(II)	(III)	(IV)	(V)
	Birth Weight	ln Birth Weight	Fetal Growth	Low Birth Weight	Weeks of Gestation
trim1	45.846** (21.813)	0.016** (0.008)	1.028* (0.577)	-0.015 (0.011)	0.085 (0.083)
trim2	24.916 (21.957)	0.009 (0.008)	0.650 (0.557)	-0.006 (0.010)	0.009 (0.074)
Month-year fixed effect	Yes	Yes	Yes	Yes	Yes
Municipality fixed effect	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
Observations	4,054	4,054	4,054	4,054	4,056

Final remarks

- Each additional week of exposure to cisterns is associated with a positive effect on average birth weight of 1.5 – 1.7 gram
- The effect is stronger for literate mothers
- The main channel in our setting seems to be the water quality
- Policies for adaptation and reduction of vulnerability may bring about positive effects on an important predictor of future individual outcomes