Fuel Switching and Infant Health: Evidence from LPG Subsidy in Indonesia

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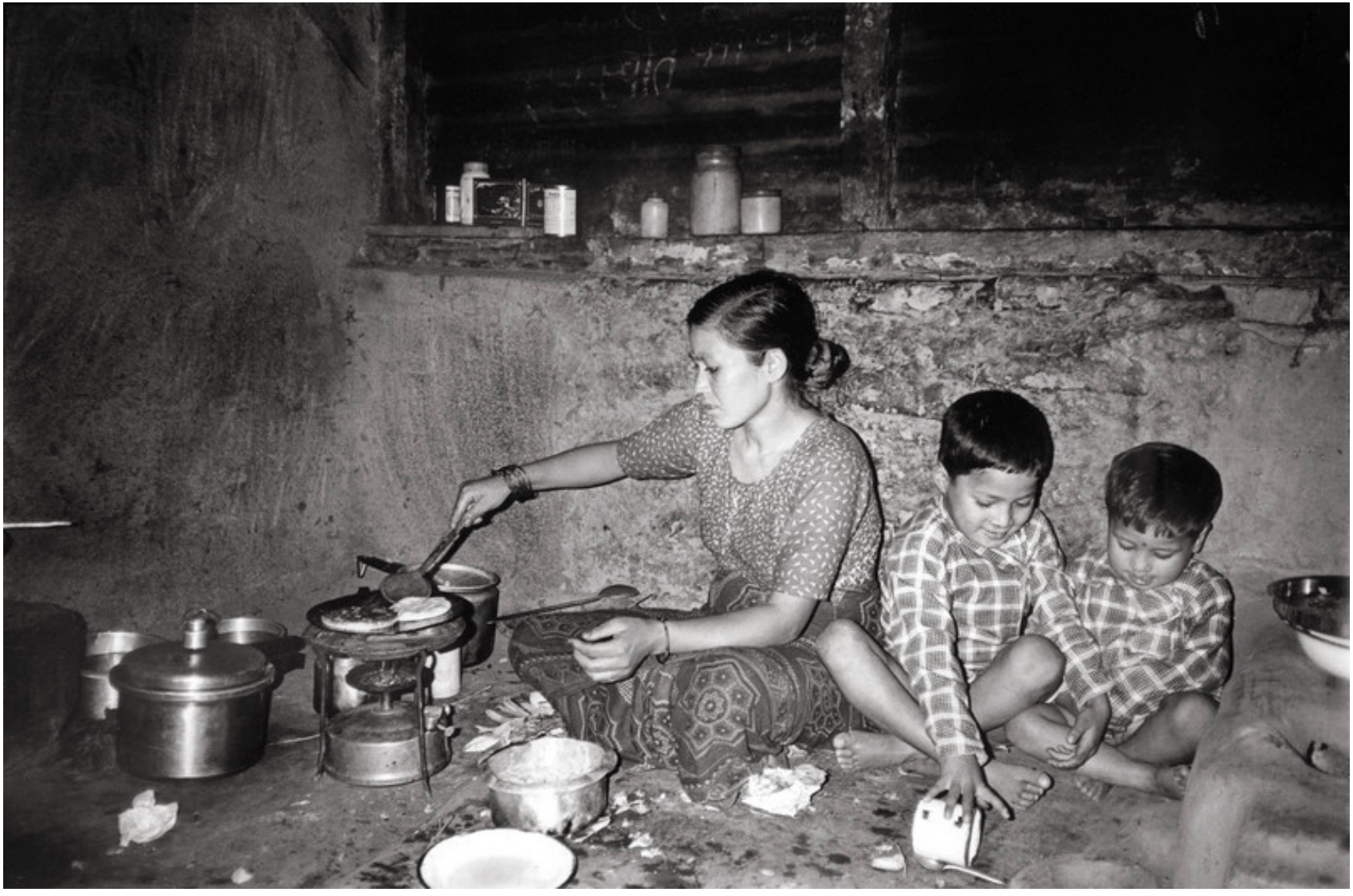
Cooking with Wood

Mother and Child while Cooking



Indoor Air Pollution and Infant Health

- Possible mechanisms for CO, particulates and health (Currie et al. 2009)
  - Acute respiratory infection
  - Affects mothers health which in turn fetus nutrition
  - Toxicants cross the placenta

Kerosene Subsidy

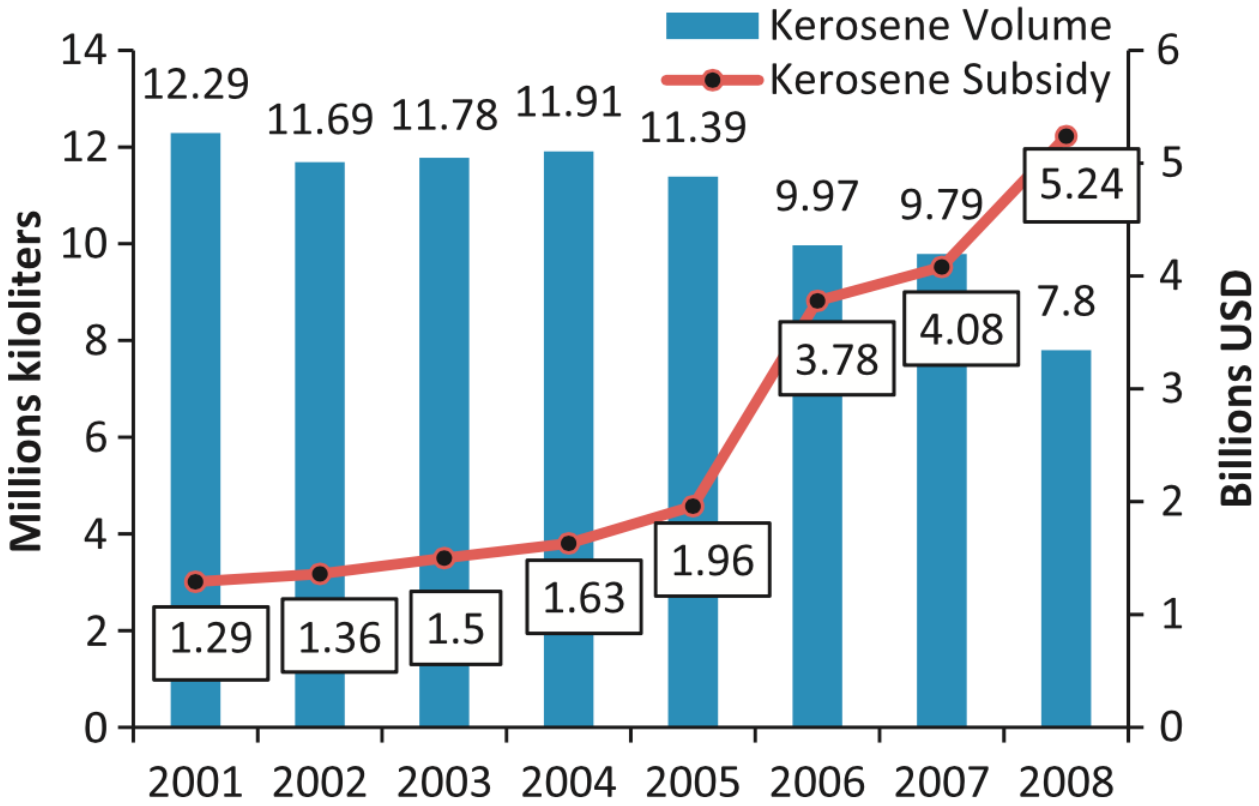


Fig. 2. Subsidized kerosene volume and its subsidy, years 2001–2008.
Source: Pertamina analysis.

Source: Budya & Arofat 2012

LPG Conversion Program

- Target: 50 million LPG distributed
- Mechanism: offer subsidized price
  - Price of LPG **US$ 0.45/kg**
  - Price of kerosene **US$0.28/lt**
  - 1 lt kerosene $\approx$ 0.57 kg LPG
  - no subsidy for old LPG
- Subsidy on kerosene would be removed

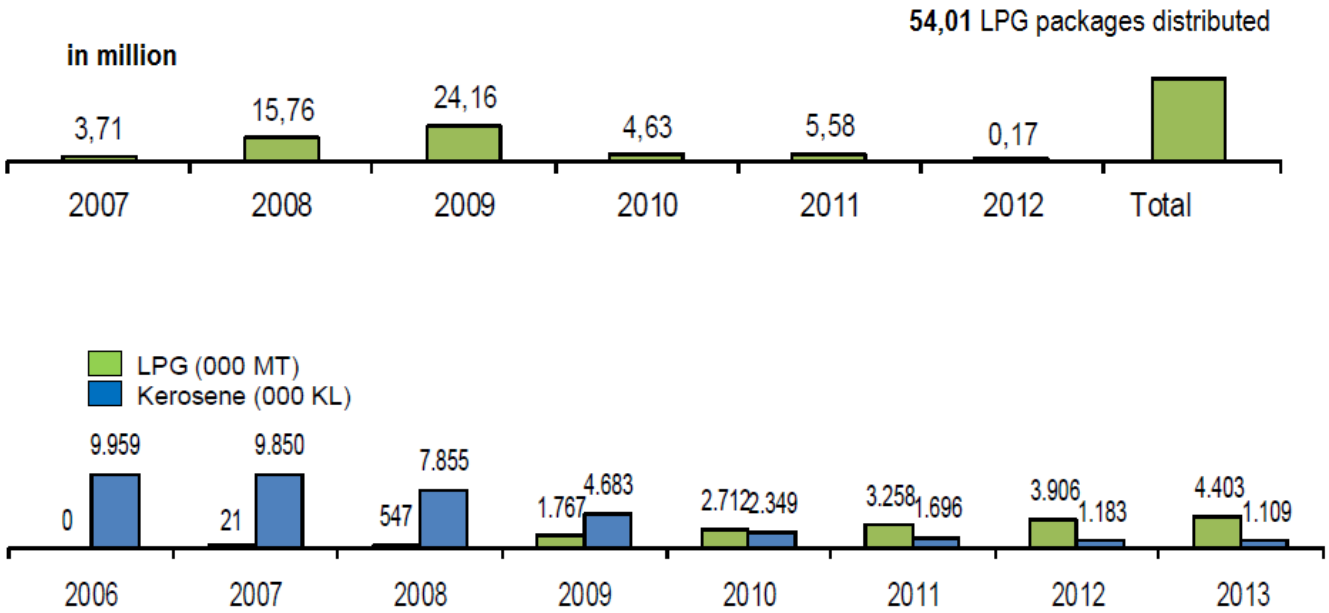
Liquid Petroleum Gas (LPG)

Started on July 2007
Purpose: reduce subsidies, improve efficiency, improve the environment.

Conversion Milestone

Based on 2005 and 2010 Indonesia Census data:

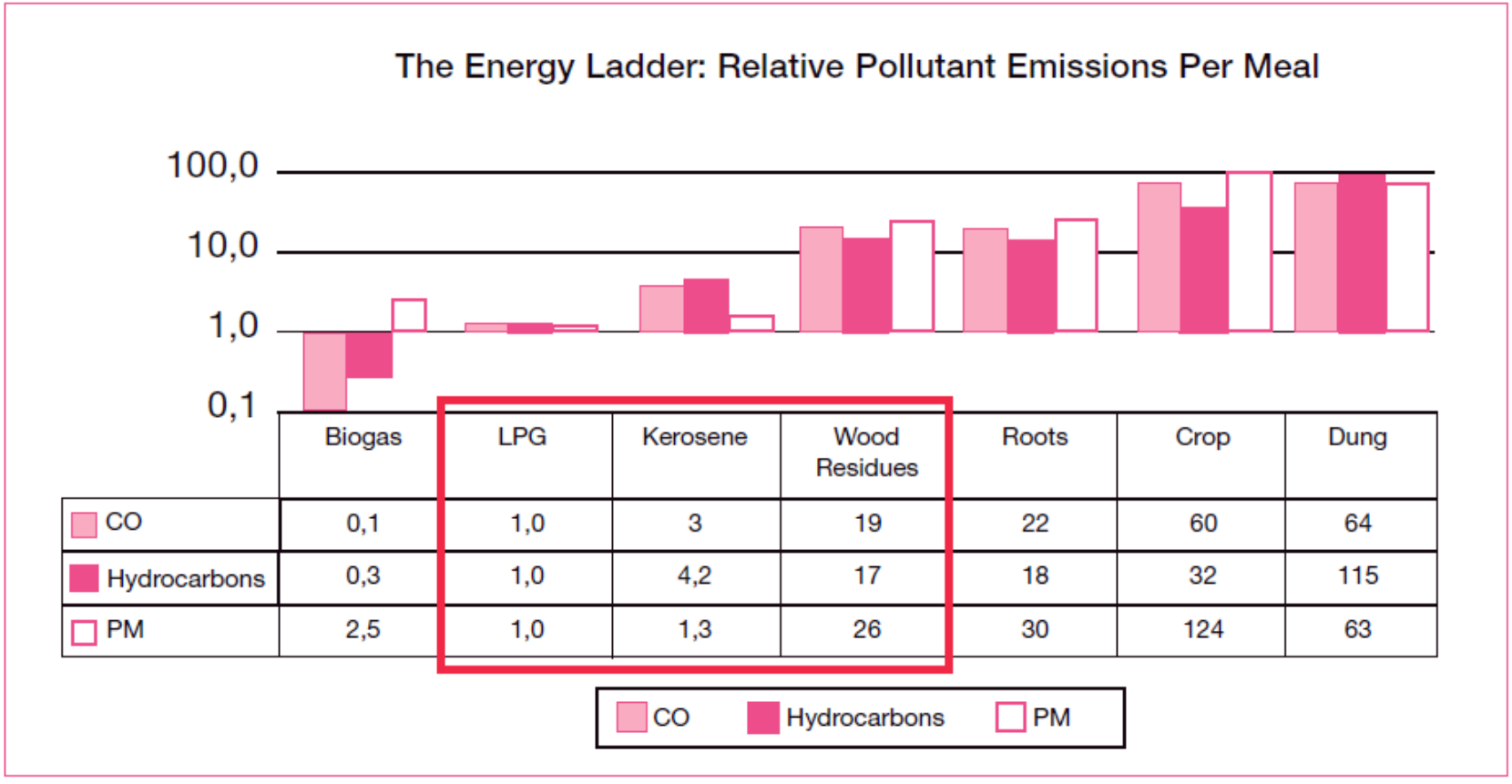
- household using kerosene was decreased from 42% to 12%
- using LPG was increased from 9% to 46%
- using wood was slightly decreased from 46% to 40%.



Source: Pertamina, 2014

Question: What was the effect of the policy on infant mortality?

Relative Pollutant Emission per Meal



	Biogas	LPG	Kerosene	Wood Residues	Roots	Crop	Dung
CO	0,1	1,0	3	19	22	60	64
Hydrocarbons	0,3	1,0	4,2	17	18	32	115
PM	2,5	1,0	1,3	26	30	124	63

Figure 9. Health-damaging pollutants per unit energy delivered: ratio of emissions to LPG (data from (Smith, Uma et al. 2000a)). Note the use of a log scale in the figure. The values are shown as grams per megajoule of energy delivered to the cooking pot (g/MJ-d).

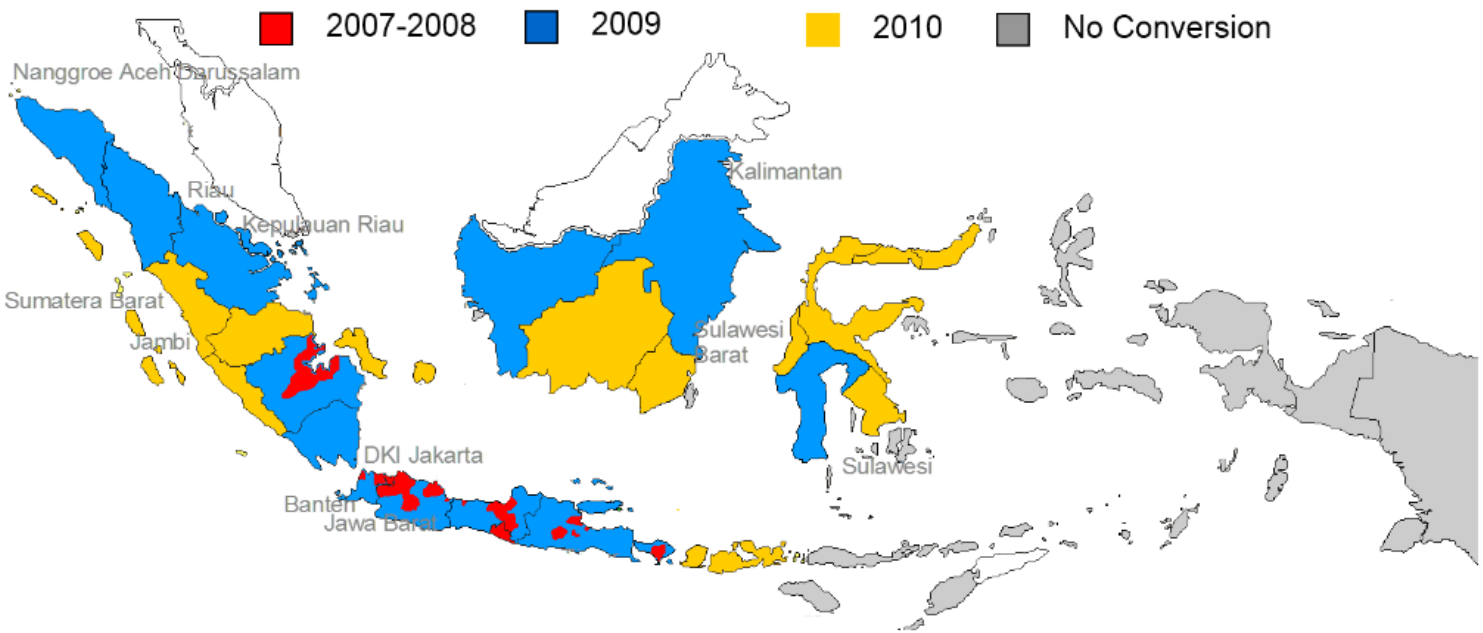
Source: Kirk Smith, Uma et al. 2000

Indoor Air Pollution and Health

- Indoor air pollution in developing countries
  - RCT: Duflo, Greenstone, Hanna (2012); Balakrishnan, Smith et al. (2015); Levine and Theresa (2010); McCracken and Smith (2007)
  - non-experimental data: Edwards and Langpap (2012), Lam, Smith et al. (2012); Mark Pitt and Rosenzweig (2010); Kirk R. Smith and Sumi Mehta (2000)
- LPG Conversion Program in Indonesia (Andadari et al. 2014; Budya & Arofat 2012).

Data

Indonesian Demographic and Health Survey 2002, 2007, 2012. Full sample consist of 119,813 households, then restricted to to 91,017 households who have ever gave birth.



Source: Pertamina, 2014

Treated and Control Groups

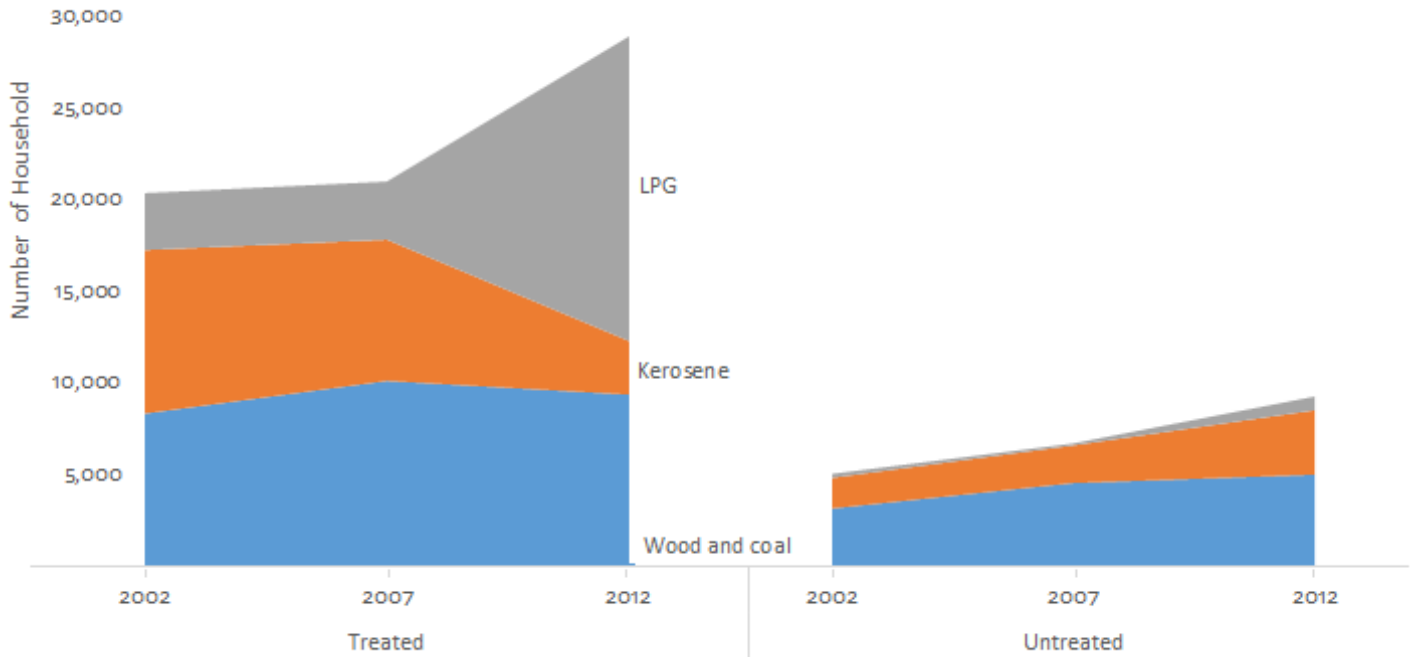
$$y_{irt} = \beta_0 + \beta_1 TreatedReg_r + \beta_2 Prog_t + \beta_3 TreatedReg_r * Prog_t + \beta_4 X_{irt} + \epsilon_{irt} (1)$$

where:

- y_{irt} = neonatal mortality (infant death 0 days); post-neonatal mortality=infant death within 1 year
- *Prog* is dummy program indicating the year of LPG started to be distributed.
- *TreatedReg* takes value 1 if the region is treated and 0 if otherwise.

X= dummies region, dummy urban, dummies municipality, dummies subdistrict, dummies for child's year of birth and dummies for 11 calendar months of the child's birth, year of birth x months, mother's age, year of survey, child's birth order, parent's contraceptive method, dummy termination of pregnancy in the past, marriage to first birth interval (months), dummy parents' literacy, household head's gender, household head's age and parents' education level.

Figure: Share of each cooking fuel choice



Source: Household sample DHS 2002-2012. Non-resident households and households who do not cook are exluded (1,992 observations).

Test Parallel Trend

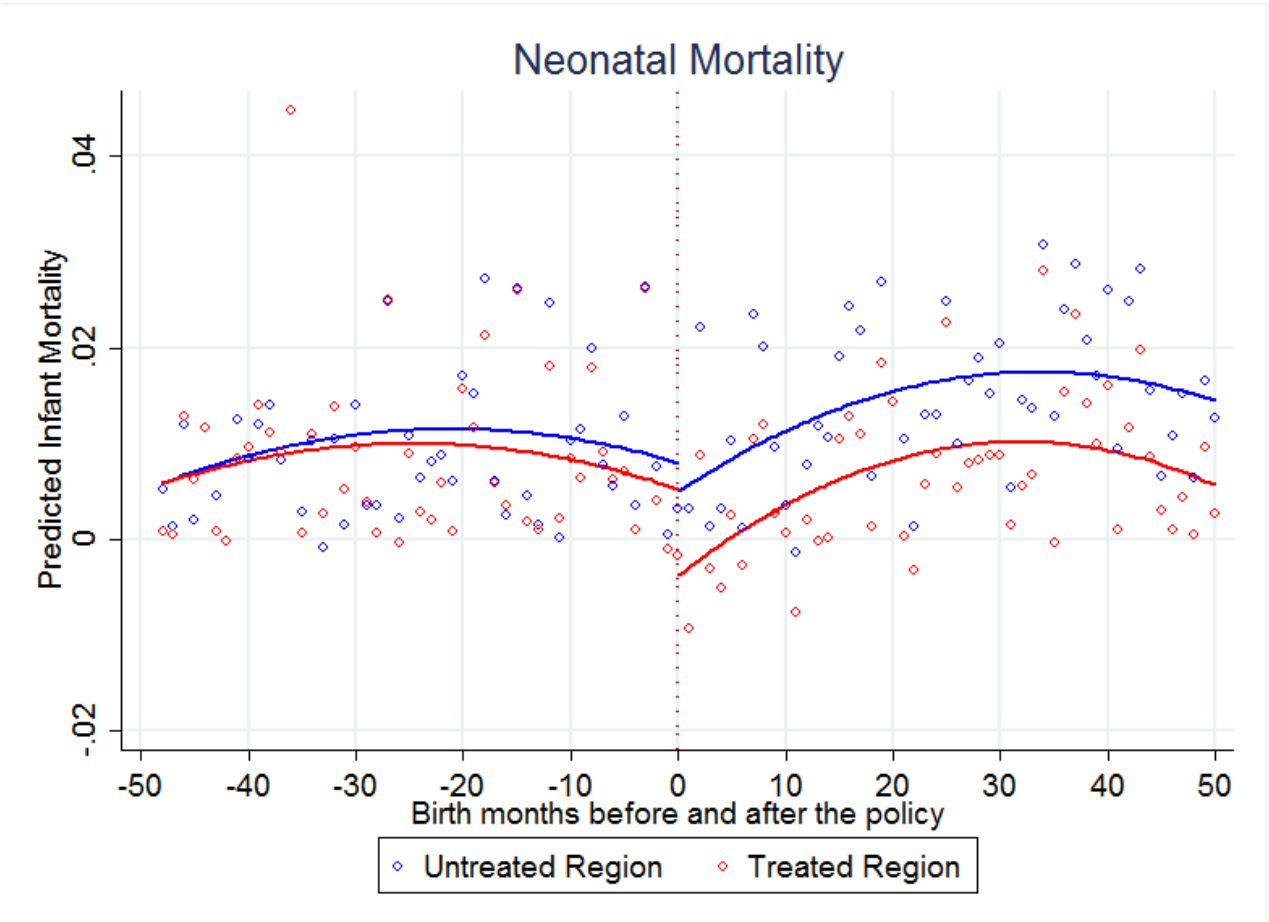
Table: Test of parallel time trends for infant deaths within one year old.

	Household sample			Child sample	
	(1)	(2)	(3)	(4)	(5)
Variables	using LPG	using kerosene	using wood	Neonatal mortality	Post-neonatal mortali-ty)
Treated region	0.1830***	0.4454***	-0.6584***	0.0066	-0.0085*
	(0.0199)	(0.0458)	(0.0390)	(0.0044)	(0.0040)
Time trend[a]	-0.0185*	-0.0490	0.0663	0.0000	0.0066
	(0.0069)	(0.0356)	(0.0350)	(0.0010)	(0.0034)
Treated region x time trend	0.0190	-0.0370	0.0196	0.0076	-0.0003
	(0.0119)	(0.0373)	(0.0379)	(0.0041)	(0.0037)
Control variables	No	No	No	Yes	Yes
Observations	163,131	163,131	163,131	13,594	13,594
R-squared	0.1117	0.2343	0.3816	0.0546	0.0482

Notes: [a] for household sample, it considers year of interview as the time trend (2002 as the baseline), and for child sample, it considers year of birth as the time trend. Standard errors in parentheses are clustered at the region level.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

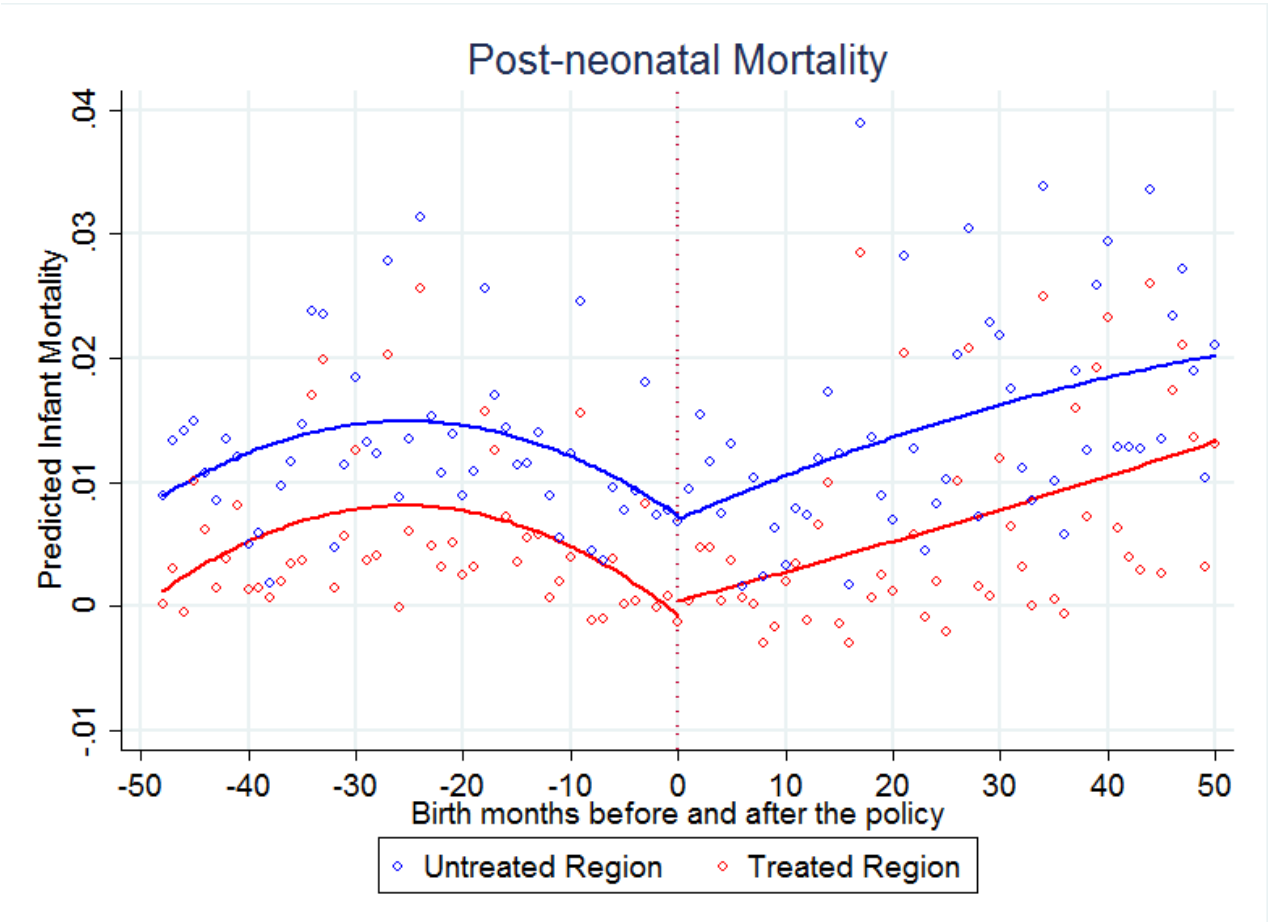
Treatment Effects

Figure: Predicted Probability of Neonatal Mortality



Treatment Effects

Figure: Predicted Probability of Post-neonatal Mortality



Treatment Effects

Table: Difference-in-difference Estimation Results

Outcome	Neonatal mortality				Post-neonatal mortality			
Covariates	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TreatedRegion x Prog	-0.0037	-0.0061*	-0.0061*	-0.0114***	0.0028	0.0002	0.0002	-0.0026
	(0.0027)	(0.0026)	(0.0024)	(0.0029)	(0.0033)	(0.0028)	(0.0031)	(0.0031)
Treated Region	0.0020	0.0030	0.0023	0.0210***	-0.0068***	-0.0054*	-0.0059*	-0.0072
	(0.0022)	(0.0021)	(0.0019)	(0.0037)	(0.0011)	(0.0021)	(0.0026)	(0.0043)
Year of birth	-0.0001	0.0010	0.0006	0.0005	0.0001	0.0021	0.0008	0.0226
	(0.0001)	(0.0006)	(0.0008)	(0.0034)	(0.0002)	(0.0014)	(0.0024)	(0.0138)
Survey data	Full sample	Full sample	2012&2007	2012	Full sample	Full sample	2012&2007	2012
Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Observations	248,167	38,765	26,903	13,594	248,167	38,765	26,903	13,594
R-squared	0.0150	0.0414	0.0472	0.0552	0.0219	0.0275	0.0348	0.0482

Standard errors (in parentheses) are clustered by region.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Heterogeneous Effect on Subgroups

Table: Triple Difference Results

Covariates	Food cooked location		Wealth index		Child's gender	
	(1)	(2)	(3)	(4)	(5)	(6)
	Neonatal	Post-neonatal	Neonatal	Post-neonatal	Neonatal	Post-neonatal
Treated Region x Prog	-0.0118***	-0.0016	-0.0215*	-0.0047	-0.0104**	-0.0018
	(0.0032)	(0.0031)	(0.0099)	(0.0067)	(0.0037)	(0.0039)
TreatedRegion x Prog x	0.0040	-0.0013				
food cooked in a separate building[a]	(0.0076)	(0.0057)				
TreatedRegion x Prog x	0.0020	-0.0235**				
food cooked outdoors[a]	(0.0054)	(0.0074)				
TreatedRegion x Prog x wealth=poorest[b]			0.0195	0.0003		
			(0.0139)	(0.0088)		
TreatedRegion x Prog x wealth=poorer[b]			0.0091	-0.0047		
			(0.0096)	(0.0094)		
TreatedRegion x Prog x wealth=richer[b]			0.0104	0.0009		
			(0.0149)	(0.0073)		
TreatedRegion x Prog x wealth=richest[b]			0.0113	0.0149		
			(0.0077)	(0.0147)		
TreatedRegion x Prog x female					-0.0020	-0.0016
					(0.0044)	(0.0044)
Observations	13,545	13,545	13,594	13,594	13,594	13,594
R-squared	0.0558	0.0491	0.0573	0.0510	0.0555	0.0483

Notes: [a] considers food cooked inside the house as baseline, [b] consider middle wealth quantiles as baseline. Standard errors (in parentheses) are clustered by region. *** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level.

Alternative Hypothesis

- Fuel stacking
  - Subsidy on kerosene will be removed.
- Financial crisis 2007-2008
  - Region fixed effects and time trend.
- Migration
  - Limit the time range to be within 5 years.

Conclusion

- The policy led to a reduction in neonatal mortality rate in the range of 0.61 to 1.14 percentage points on average (about 1 infant per 1000 live births)
- No evidence of on cough, Acute Respiratory Infection symptoms, birth size and birth weight.
- Within subgroups: female child and child born in poorer households experienced the largest benefit, but not statistically significantly.
- Households that cook outdoors experience a significant reduction in post-neonatal mortality 2.35 percentage points compared to household that cook inside the house.