Informative Inefficiencies and Social Networks in the Decision to Adopt Improved Cookstoves: Experimental Evidence from Mali

J.Bonan* P.Battiston J.Bleck P.LeMay-Boucher
S.Pareglio B.Sarr M.Tavoni

*Catholic University of the Sacred Heart, LabExpo (Feltrinelli Foundation) and FEEM

FEEM, April 20 2015

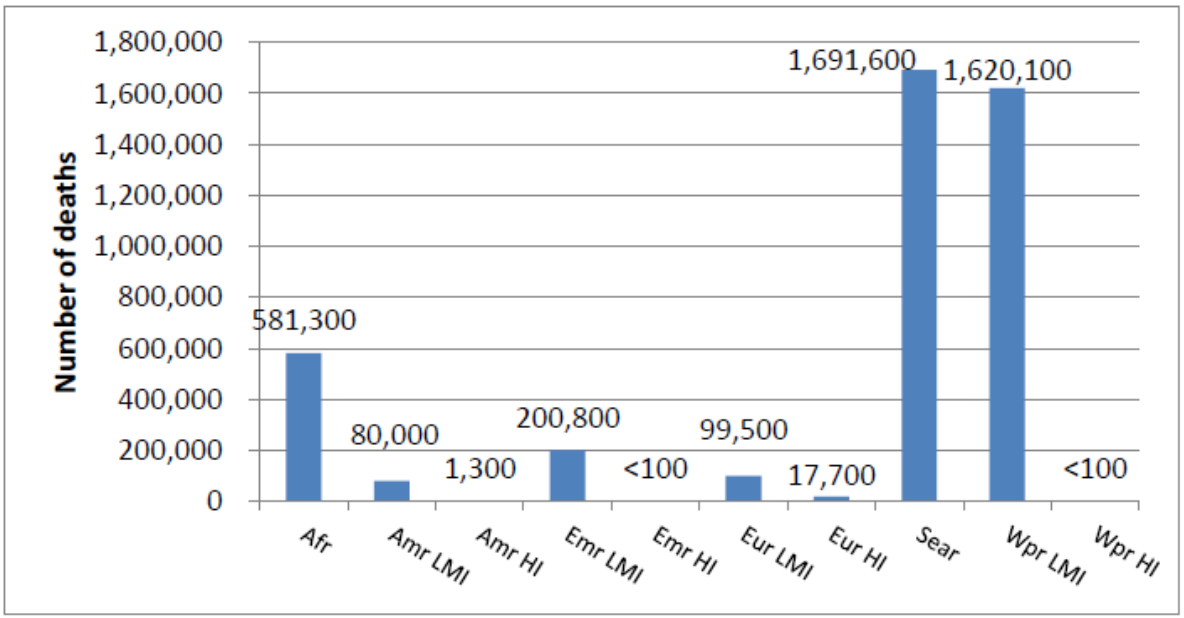
Access to modern cooking facilities

	Without access to electricity		Traditional use of biomass for cooking*	
	Population	Share of population	Population	Share of population
Developing countries	1 257	23%	2 642	49%
Africa	600	57%	696	67%
Sub-Saharan Africa	599	68%	695	79%
Nigeria	84	52%	122	75%
South Africa	8	15%	6	13%
North Africa	1	1%	1	1%
Developing Asia	615	17%	1 869	51%
India**	306	25%	818	66%
Pakistan	55	31%	112	63%
Indonesia	66	27%	103	42%
China	3	0%	446	33%
Latin America	24	5%	68	15%
Brazil	1	1%	12	6%
Middle East	19	9%	9	4%
World***	1 258	18%	2 642	38%

Source: IEA (2013)

Health consequences

Figure 1. *Total deaths attributable to HAP in 2012, by region*



HAP: Household air pollution; Amr: America, Afr: Africa; Emr: Eastern Mediterranean, Sear: South-East Asia, Wpr: Western Pacific; LMI: Low- and middle-income; HI: High-income.

Source: WHO (2014)

International initiatives

- AGECC $\longrightarrow$ universal access to modern, clean and efficient energy services by 2030
- Global Alliance for Clean Cookstove $\longrightarrow$ 100 million homes with clean and efficient cookstoves by 2020

- Scarce rigorous literature on barriers to adoption and impacts of improved cooking facilities

Barriers and drivers to technology adoption

- Liquidity constraints and information inefficiencies on health products and technology adoption: role of subsidies, (micro)credit and information campaigns
  - malaria bednets (Tarozzi et al. AER2014, Dupas ECTA2014),
  - water disinfectant (Ashraf et al. AER2010, Kremer et al.2011)
  - weather and health micro-insurance (Cole et al. AEJ2013, Bonan et al. 2014)
  - improved cookstoves (Levine et al. 2013),
- Intrahousehold decision making: women have stronger preference for healthier stoves, but lack the authority to make purchases (Miller and Mobarak, 2013)

Barriers and drivers to technology adoption

- Peer and social networks effects: imitation, social learning, herd behaviour
  - Influence of opinion leaders and members of social network on improved cookstoves adoption (Miller and Mobarak, MS2014)
  - Imitation effects within social network on weather insurance take-up (Cai et al. AEJ2014)
  - Peer effects in adoption and use of health products (Kremer and Miguel, QJE2007; Oster and Thornton, JEEA2012)
  - Bandwagon effects in electricity connection (Bernard and Torero, 2013)
  - Social learning of agricultural innovations (Bandiera and Rasul EJ2006; Conley and Udry AER2010)

Impacts of access to clean and efficient cookstoves

- RESPIRE (Smith et al. Lancet 2011): chimney stoves in Guatemala
  - ↓ carbon monoxide exposure by 50% for children and 60% for women
  - ↓ severe pneumonia episodes
  - limits of the study: sample size and high monitoring intensity
- Hanna, Duflo and Greenstone (2012): chimney stoves in India
  - ↓ carbon monoxide exposure by 7.5% after 1 year, no effect in the longer run
  - No effects on health and GHG emissions
  - Limited use and lack of maintenance
- Limited and inconclusive evidence on female time allocation, fuel saving, welfare (Bensh and Peters (2012), Belthramo and Levine (2013), Bruwen and Levine (2012))

Research questions

1. Role of informational barriers: to what extent presenting the product and its advantages increases the uptake?
2. Role of peer decision and social networks: what is the effect of knowing others' decisions on one's decision to purchase?
3. Role of spillover effects: to what extent observing for longtime people who adopt and use the new product influences the decision to purchase?
4. Impact of improved cookstoves on household welfare: what is the effect of purchase on usage, fuel expenditure, time allocation and saving?

Fuel and cookstoves

Main source of cooking fuel is charcoal (80%) and wood (18%)
Traditional cookstoves in 96% of households

Improved cookstoves in 20% of households

Product characteristics

- Locally produced
- Supervision and support of value chain by GERES, French NGO
- Up to 30% charcoal saving
- Higher price (3500-4000 FCFA, 5-6 euro) than traditional charcoal cookstoves (2500-3000 FCFA)
- Constant use allows to be rapaid in less than 3 months
- Available at some local markets in Bamako

Phase 1: sampling and baseline survey

Sampling Design: clustered, multi-stage, probability sample, following Afrobarometer sampling procedures

- selection of cluster and sampling starting points:
  - each of the 6 communes of Bamako is divided in square units of same dimension covering the entire area
  - random selection of a number of clusters proportional to the population in the commune (exclusion or wealthy clusters)
  - within each cluster, sampling starting points are randomly selected map

- selection of houses and respondents:
  - from each starting point, 25 houses are selected (pseudo-random process)
  - from each starting point, an enumerator walks 10 minutes in random direction and identifies a new starting point, from which 5 (control) houses are selected map
  - in each house/ concession there is likely to be an enlarged family (gwa), composed by several nuclear households. Women are usually involved in a cooking rotation
  - "la femme plus renseignée" in the cooking rotation is the targeted survey respondent

- Final sample:
  - 36 clusters
  - 30 women per sampling point $\longrightarrow$ **1077** women in the sample
  - 25 women are invited to participate to a training session to be held in a nearby school on Saturday (about 10 days after the visit) $\longrightarrow$ **898** women are invited
  - 5 women are not invited $\longrightarrow$ **179** women
- Baseline survey (Oct 14 - Jan 15):
  - 40 minutes questionnaire ($\sim$150 questions) in local language on small tablets, with iSURVEY
  - Demographics, socio-economic status, intra-household decision making, cooking habits and technologies, time allocation, trust and risk preferences
  - Invited women are told will be reimbursed (1000FCFA) for participation. Phone reminders one day before sessions.

Phase 2: informational treatments

- Training session by professional promoters:
  - presentation of fourneau Sewa, its advantages and market price
  - cooking show: same dish prepared with traditional and improved cookstove, after weighing charcoal
- Mapping social networks:
  - each woman is asked about all other women who are present at the session: family, friendship, same informal group, common events in the last 3 months, indication of those (max 6) whose opinion one respects

- Peer information treatment:
  - after demostration, women are individually invited in another room and are proposed to buy a fourneau Sewa at 3500FCFA
  - a random subsample is provided the information about purchase decision of another random woman in the session
  - women can decide to buy immediately, to buy in five days leaving an advance of 500FCFA, or not to buy
- Second sale visit:
  - all women who did not buy immediately are revisited after five days and proposed to buy again

Phase 3: monitoring usage

- Stove Use Monitoring System (SUMS) are installed on 150 sold cookstoves in a random subsample of informational sessions
- Record temperatures (accuracy of +/- 1.3°C up to 85°C), at fixed intervals of time (about 40 minutes) for 60 days
- 2 rounds of visits (Jan and Mar 15) to download data: about 4 months of observations
- 91 buttons are tracked at first round, 86 at the second round

Phase 4: midline survey and spillover effects

- Midline survey (June 15):
  - follow-up questions to the whole sample on purchase and usage of improved cookstoves, fuel expenditure, saving, time allocation, welfare
  - mapping social network of all sampled women
- Spillover/imitation effects:
  - sale proposal (at same conditions) to women who did not participate in the training sessions
  - possible repetition of peer information treatment

Phase 5: endline survey

- Endline survey (Nov-Dec 15):
  - follow-up questions to the whole sample on purchase and usage of improved cookstoves, fuel expenditure, saving, time allocation, welfare

The organization

- 7 researchers from 6 universities in 4 countries. 2 on the field in crucial phases
- 10 local young enumerators, trained and employed for 2 months
- 5 local staff, trained and employed for 6 months
- 2 promoters for 36 training sessions in 3 months

Informational barriers

1. Role of informational barriers: to what extent informing about the product and its advantages increases the adoption of improved cookstoves (at a slightly discounted price)?

$$y_i = \alpha Inv_i + \mathbf{x}_i'\boldsymbol{\beta} + \varepsilon_i$$

- $y = 1$ if new improved cookstove at the midline
- $Inv = 1$ if invited to participate in the session, α measures ITT of our intervention
- $\mathbf{x}$: vector of individual and household characteristics
- Imperfect compliance: self-selection of participants
- We compute TTE, using IV (actual participation is instrumented by invitation)
- Sample: whole

Peers and social network effects

2. Role of peer decisions and social networks: what is the effect of knowing others' decisions on one's decision to purchase?

$$y_i = \gamma SN_{ij} + \mathbf{x}_i'\boldsymbol{\beta} + \mathbf{x}_j'\boldsymbol{\beta} + \varepsilon_i$$

- $y = 1$ if woman i takes the same decision of woman j (the peer she received information about)
- SN: variables on the relationship between i and j (peer relationships and network centrality)
- Sample: attendants to sessions

3. Role of spillover effects: to what extent observing for longtime people who adopt and use the new product influences the decision to purchase?

$$y_{ik} = \alpha N\_treat_k + \mathbf{x}'_{ik}\boldsymbol{\beta} + SC_{ik} + \varepsilon_{ik}$$

- $y = 1$ if non-participants to session have a new improved cookstove at the midline (or decide to buy after the new proposal)
- N_treat: n. of women attendeding the k^{th} session (it can also be n. of women who purchased and/or used)
- SC_i : measures of social connectedness of woman i within sampled neighbours
- Sample: women who were invited to sessions

4. Impact of improved cookstoves on household welfare: what is the effect of purchase on usage, fuel expenditure, time allocation and saving at household level?

$$\triangle y_i = \alpha Purch_i + \mathbf{x}_i'\boldsymbol{\beta} + \varepsilon_i$$

$$\triangle y_i = \alpha Usage_i + \mathbf{x}_i'\boldsymbol{\beta} + \varepsilon_i$$

- $\triangle y$: changes in outcomes of interest between midline/endline and baseline: time allocation, fuel consumption, saving
- $Purch = 1$ if purchased, *Usage* is a proxy of the use of the improved cookstove
- αs are IV estimates using *Inv* as instrument
- Sample: whole

Outcome variables
Participation and Purchases

- 407 (45%) women participated to training sessions, average n. of attendants: 11 women
- 156 women purchased at the training session, 127 after 5 days: final purchase rate of 65% (over participants) and 30% (over invited to the session)
- Among control women, after phone calls to half of them (90 women), only one purchased fourneau Sewa (at 3250F) between baseline and end of sessions

Outcome variables
Woman welfare

	N	Mean	S.D.
Monthly fuel expenditure,gwa	1073	13440	11766
Personal savings	1077	0.31	0.46
Total monthly saving	1077	6674	16424
Has income generating activity	1077	0.45	0.50
Formal work	1077	0.02	0.14
Informal work	1077	0.43	0.50
Weekly time working, in hours	485	13.64	11.03
Monthly income	1029	1922	34100

Controls and heterogeneous effects

Woman demographics and preferences

	N	Mean	S.D.
Is head of household	1077	0.33	0.47
Age	1075	33.07	11.59
Lives in couple	1077	0.88	0.33
Polygamous	1077	0.20	0.40
Age at marriage	926	18.62	3.54
Difference of age with husband	724	11.04	4.56
Living in the neighourhood for less than 2 years	1077	0.15	0.36
Education			
No schooling	1077	0.43	0.50
Primary school	1077	0.15	0.35
Secondary school	1077	0.11	0.32
High-school or above	1077	0.31	0.46
Generalized trust, 0-10	1076	8.02	2.32
Risk averse, small stake	1077	0.67	0.47
Risk averse, large stake	1077	0.71	0.45

Controls and heterogeneous effects

Household decision-making

	Respondent		Head		Both	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
Respondent's money	0.71	0.46	0.03	0.16	0.02	0.14
Respondent's health treatment	0.10	0.29	0.66	0.47	0.24	0.43
Purchase of main food	0.33	0.47	0.62	0.48		
Purchase of condiment	0.57	0.50	0.23	0.42		
Purchase of fuel	0.62	0.49	0.27	0.44		
Purchase of kitchen tools	0.73	0.44	0.20	0.40		
Hypothetical purchase of sewa	0.68	0.47	0.25	0.43		

household characteristics

Controls and heterogeneous effects

Fourneau Sewa

	N	Mean	S.D.
Know Sewa	1077	0.94	0.24
Source of information			
Have or had one	1077	0.38	0.48
Market	1077	0.56	0.50
Media or promotional campaigns	1077	0.34	0.48
Friends, relatives, neighbours	1077	0.61	0.49
Own Sewa	1077	0.20	0.40
Reason for not owning Sewa			
Too expensive	1077	0.31	0.46
No need	1077	0.05	0.22
Impossibility to find/buy	1077	0.39	0.49
Lack of confidence in the product	1077	0.00	0.05
Decision to buy belongs to others	1077	0.04	0.20
Had in the past	1077	0.11	0.31

Controls and heterogeneous effects

Fourneau Sewa

	N	Mean	S.D.
Know price	1077	0.53	0.50
Estimated price	997	4676.23	1355.20
Positive characteristics			
Efficient, allows saving time and fuel	1077	0.78	0.41
Good quality, durable, modern	1077	0.38	0.49
More healthy, less IAP	1077	0.16	0.37
Negative characteristics			
Too expansive	1077	0.16	0.36
Not functioning	1077	0.00	0.05
Not needed, not appreciated	1077	0.02	0.13
Not lasting	1077	0.53	0.50

Conclusions

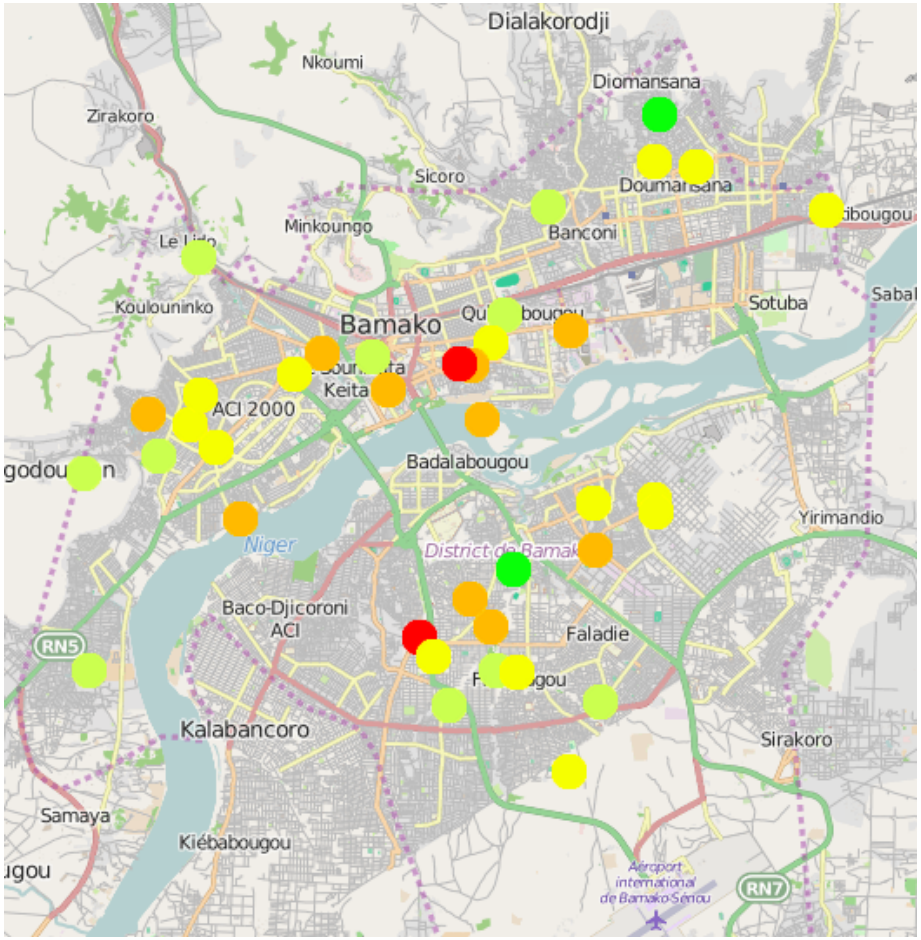
- Women can be a good target for the promotion of the product:
  - relative economic independence in purchases
  - potential interest in investing in fuel (charcoal) saving technology
- Relatively high knowledge of the product and its characterisics
- High effectiveness of training session in increasing purchase
- Relevance of cash constraint and availability of supply

Next steps with data to collect

- Midline survey (June 2015)
  - Impact evaluation of the intervention
  - Mid-term impacts of improved cookstoves purchase and use
  - Analysis of spillover effects
- Endline survey (Nov-Dec 2015)
  - Long-run impacts of improved cookstoves purchase and use

Next steps with collected data

- Investigate peer effects:
  - does the identity of the peer matter?
  - does direct relationship matter?
  - which social dimensions matter more (time spent together, parental relationship, geographical distance, friendship)?
- Investigate network effects:
  - does network centrality matter?
- Analyse big data on usage:
  - Link purchase - usage
  - Spillover/ imitation effects in usage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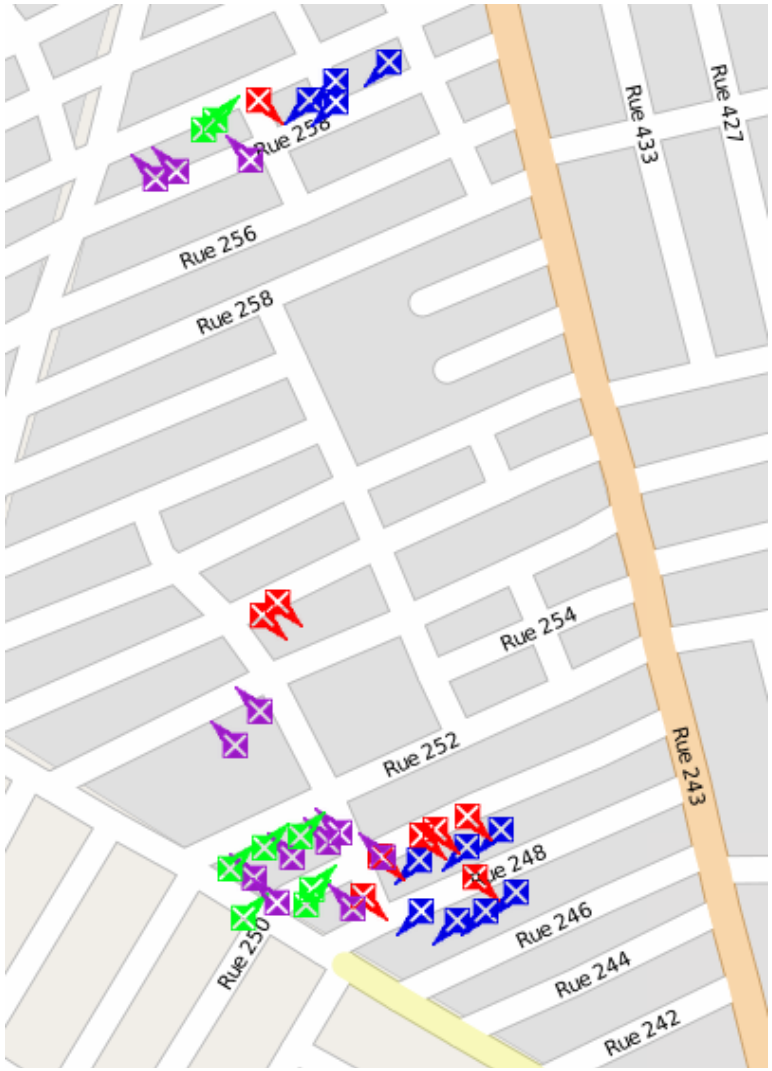
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Household characteristics

	N	Mean	S.D.
Size of enlarged household (gwa)	1073	12.89	8.72
N. of children 0-5, gwa	1077	2.24	2.13
N. of children 6-16, gwa	1077	2.89	2.56
House ownership	1077	0.71	0.45
Floor			
Clay	1077	0.12	0.33
Cement	1077	0.74	0.44
Tile	1077	0.13	0.34
Roof			
Concrete	1077	0.36	0.48
Iron sheet	1077	0.64	0.48
Tiles	1077	0.00	0.03
Water source			
Water seller	1077	0.14	0.35
Weel inside the concession	1077	0.31	0.46
Tap (inside or outside the house)	1077	0.55	0.50
Private toilet	1077	0.37	0.48
Electricity for lighting	1077	0.97	0.17

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Assets

	N	Mean	S.D.
Animals	1077	1.00	0.05
Fridge	1077	0.47	0.50
Gaz cylinder	1077	0.52	0.50
Camera	1077	0.11	0.32
TV	1077	0.93	0.25
Sofa	1077	0.75	0.43
Table and chairs	1077	0.75	0.43
Bike	1077	0.25	0.43
Motorcycle (Jakarta)	1077	0.84	0.37
Car	1077	0.24	0.42
Sewing machine	1077	0.47	0.50
Beds in wood or metal	1077	0.52	0.50
Air conditioning	1077	0.11	0.32
Fan	1077	0.93	0.25
Mobile phone	1077	0.81	0.39

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Sample differences

- Invited VS non invited: over 114 baseline variables considered, 13 variables are significantly different between two samples at 10%, 2 at 5% $\longrightarrow$ satisfactory randomization
- Participants VS non-participants in sessions: 4 variables are significantly different between two samples at 10%, 8 at 5%, 11 at 1% $\longrightarrow$ self-selection issue

Controls and heterogeneous effects

Cookstoves

	N	Mean	S.D.
Main fuel for cooking			
Wood	1077	0.19	0.39
Charcoal	1077	0.81	0.40
Gas	1077	0.00	0.05
Cookstoves, gwa level			
Traditional stove (wood or charcoal)	1077	0.96	0.19
Improved wood stove	1077	0.10	0.30
Improved coal stove	1077	0.18	0.39
Gaz stove in the gwa	1077	0.51	0.50