

Annexures

Improving India's Clean Cooking Fuel Supply: Recommendations to Enhance Last-mile LPG Accessibility

Abhishek Kar, Sunil Mani, Adya Sharma, Surya Shekhar Auddy, Shruti Sharma, Paras Bhattarai, and Rahul Das

Annexure 1: Sampling methodology

To select the six states for a nationwide survey, a composite index was created (simple weighted average of the selected four variables), and states were arranged in decile classes as described in Section 2.1 of the report. This index was used to categorise all the states into six groups according to the increasing value of the index (Table A1). To select one state from each of the six groups, purposive/judgemental sampling, based on the factors relevant to this survey (geographic diversity, fuel diversity, and logistics involved in the delivery of LPG) was used. The states selected (**highlighted in Table A1 in red**) in Phase I of the survey are distributed equally across the deciles with no more than a one-point gap between them.

Table A1: The composite index (rank) represents the state's inclination (ascending order) towards adopting clean cooking fuel

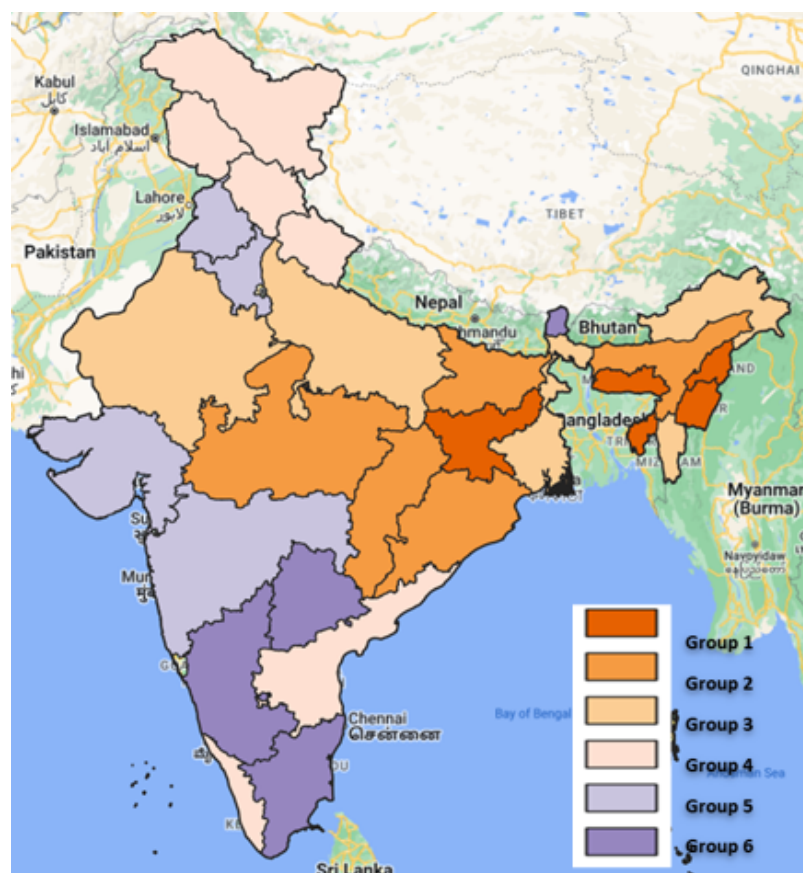
State	Phase 1 Selected State	Clean fuel	% Area without AGB	Per capita Net State Domestic Product (2020–21)	Average LPG consumption per person in FY 2021–22 (in kg)	Rank	Decile
Meghalaya		–1.41	–1.62	–0.92	–1.8	–1.43	0
Nagaland		–1.17	–1.63	–0.65	–0.8	–1.07	0
Jharkhand	1	–1.33	0.20	–1.03	–1.3	–0.87	0.1
Chhattisgarh		–1.33	–0.21	–0.60	–1.3	–0.86	0.1
Tripura		–0.73	–1.43	–0.42	–0.7	–0.81	0.1

Manipur		0.19	-1.69	-1.02	-0.5	-0.75	0.2
Odisha		-1.14	-0.004	-0.61	-0.8	-0.65	0.2
Assam	1	-0.75	-0.02	-0.91	-0.8	-0.61	0.2
Bihar		-1.00	1.05	-1.52	-0.9	-0.58	0.3
Madhya Pradesh		-0.95	0.32	-0.89	-0.8	-0.58	0.3
Arunachal Pradesh		-0.03	-1.66	0.16	-0.5	-0.51	0.3
Uttar Pradesh	1	-0.41	1.10	-1.28	-0.3	-0.22	0.4
West Bengal		-0.78	0.62	-0.60	0.1	-0.17	0.4
Rajasthan		-0.82	1.11	-0.56	-0.1	-0.08	0.4
Mizoram		1.33	-1.86	-0.07	0.7	0.01	0.5
Jammu & Kashmir		0.54	0.94	-0.74	-0.6	0.03	0.5
Uttarakhand	1	-0.37	-0.39	0.77	1.1	0.27	0.5
Himachal Pradesh		-0.09	0.28	0.67	0.6	0.36	0.6
Andhra Pradesh		1.55	0.48	0.27	-0.7	0.39	0.6
Gujarat		0.30	1.01	1.24	-0.4	0.53	0.6
Kerala		0.90	-0.70	0.70	1.4	0.57	0.7

Maharashtra	1	1.02	0.68	0.67	0.7	0.77	0.7
Karnataka		1.17	0.50	1.11	0.8	0.90	0.7
Tamil Nadu		1.37	0.56	0.89	0.9	0.94	0.8
Sikkim		0.71	-0.58	2.90	1.2	1.07	0.8
Telangana	1	1.95	0.53	0.87	1.0	1.09	0.8
Haryana		0.23	1.19	1.35	1.7	1.13	0.9
Punjab		1.08	1.20	0.23	2.0	1.13	0.9

Source: Authors' analysis

Figure A1: The geographical representation of the spread of these states in six groups



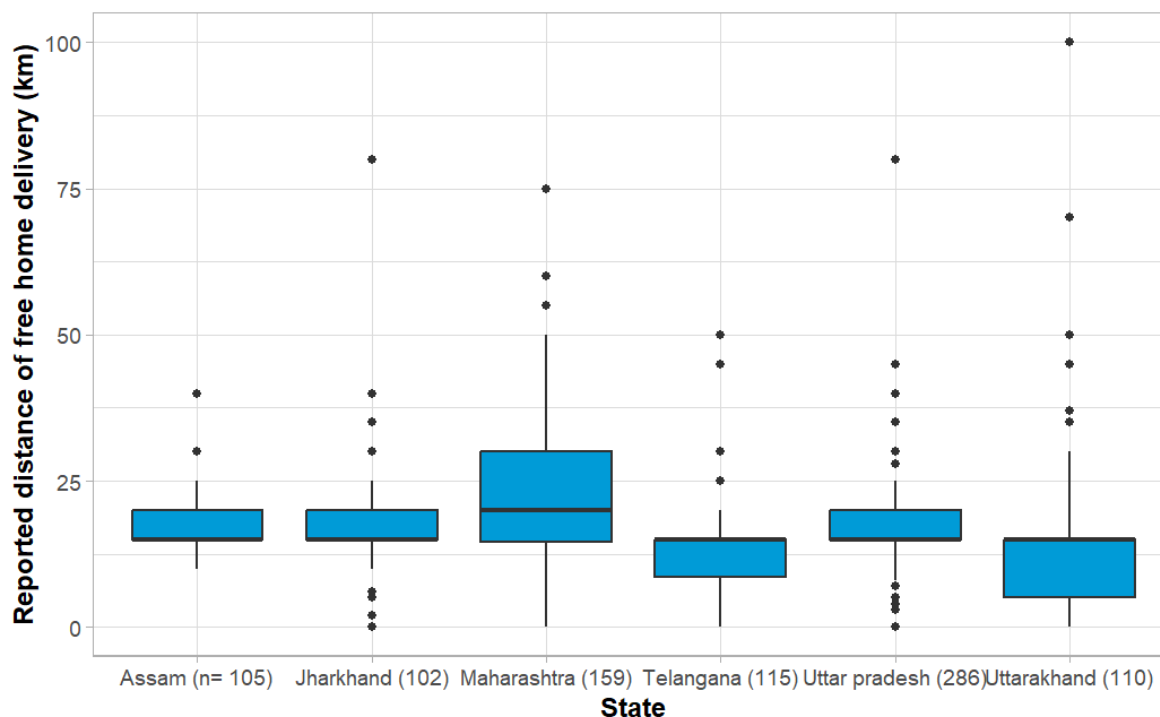
Source: Authors' analysis

Annexure 2: Biases encountered during the survey

In any self-reported primary survey, it is impossible to completely eliminate survey biases (which could be related to social desirability and non-response, among others). In the presence of survey biases, the collected data may not accurately reflect the on-ground situation. This section explores the possibility of such biases in the survey.

In a self-reported survey, the respondents might choose to answer certain questions in a socially favourable manner. This is widely referred to as social desirability bias, a type of survey response bias. The respondents may also find certain questions to be of a sensitive nature and under- or over-report certain figures. The survey found significant state-wise variations in responses relating to diversion and non-compliance levels for cash-and-carry discounts. For instance, in Assam, the reported non-compliance and diversion rates were significantly lower compared to other states. Nearly 85 per cent of distributors in Assam reported that all distributors in their area provide the cash-and-carry discount. Further, almost all distributors in Assam reported that they provide free home delivery for a distance of up to at least 10 km (Figure A2). Qualitative insights from the field show that distributors in Assam have also requested increased stringency in compliance oversight in order to curb the diversion of domestic cylinders to commercial entities, and have even suggested the establishment of a regulatory authority for the same in the state. Results in this particular instance hint towards potential under-reporting of diversion and over-reporting of delivery distances by the distributors during the telephonic survey, which could be contributing to the large state-wise variations.

Figure A2: Large state-wise variations exist in free home delivery services

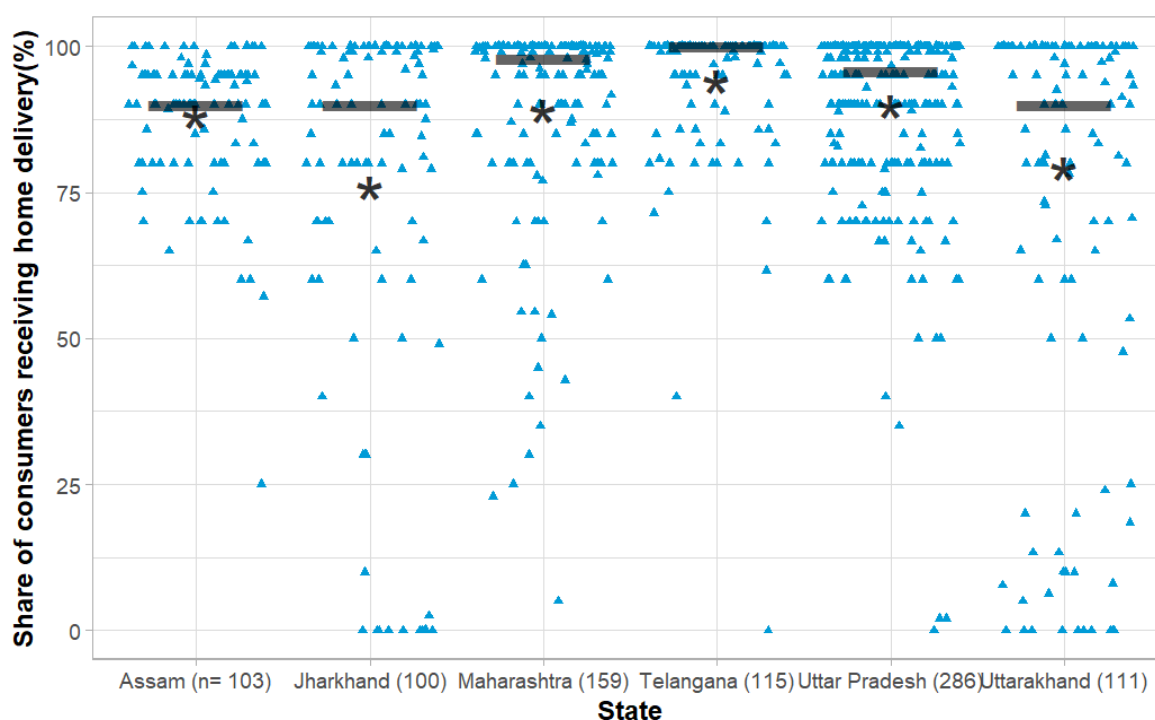


Source: Authors' analysis

Note: 7 entries were removed from this analysis, as 7 distributors had not responded to the question on the share of consumers receiving home delivery.

Figure A3 shows the variations between the reported share of consumers being provided home delivery by distributors in the six states where the survey was conducted. Distributors in Jharkhand and Uttarakhand reported a significantly lower proportion of consumers provided with home delivery, which may be due to improper road infrastructure or difficult terrain.

Figure A3: There are significant variations in the reported share of consumers being provided with home delivery of LPG refills across the six states



Source: Authors' analysis

Notes: 10 entries were removed from this analysis, as 10 distributors had not responded to the question on the share of consumers receiving home delivery. Additionally, 1 impossible value above 100 percent was removed from the graph for visual clarity.

Furthermore, non-response bias, which involves choosing not to respond to certain questions provided in the telephonic survey, is the most common form of survey response bias. For instance, out of the 904 distributors who responded to the survey, about 37 per cent of the respondents chose not to respond to the question on their annual expenditure and approximately 36 per cent chose not to respond to the question on their annual profit figures. The results, therefore, indicate the possibility of variation between the actual expenditure and profit per refill sale and the results derived during the analysis.

Table A2 shows that the non-response rate for sensitive questions is much higher (Q15, Q16, Q19, and Q20) compared to less-sensitive questions, and the results, therefore, may not completely reflect the ground reality, on account of non-response bias. The table also highlights the same trend (of sensitive questions having higher non-response rates) across the six states covered in the survey.

Table A2: Variation in non-response rates for different questions

	Q7a	Q7b	Q9	Q11	Q15	Q16	Q19	Q20
	Registered consumers (%)	PMUY consumers (%)	Monthly refill sales (%)	Distance for free home delivery (%)	Annual expenditure (%)	Annual profit (%)	Cash-and-carry discount (%)	Diversion rates (%)
Overall non-response rate	1	2	1	1	37	36	26	13
Assam (n = 113)	7	7	6	4	22	23	5	2
Jharkhand (103)	0	1	1	0	53	40	47	25
Maharashtra (167)	1	1	0	0	9	9	20	9
Telangana (115)	0	1	0	0	49	49	16	0
Uttarakhand (119)	2	2	1	2	43	43	25	14
Uttar Pradesh (287)	0	1	0	0	44	48	33	21

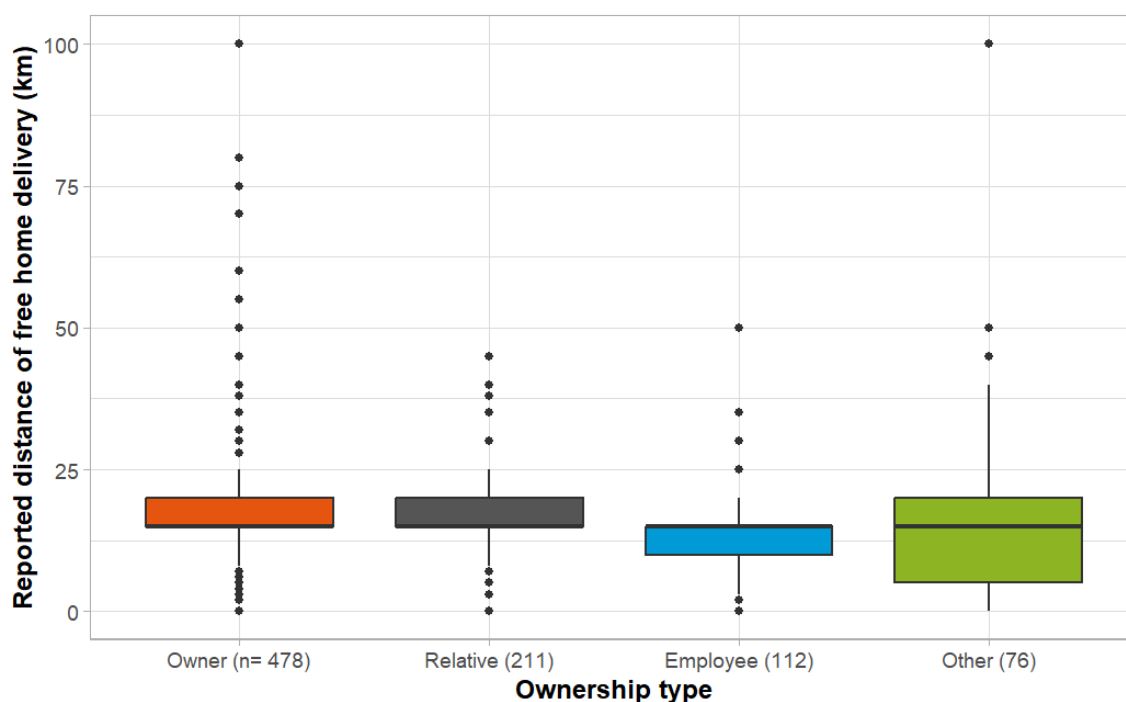
Source: Authors' analysis

On average, shorter distances of free home delivery were reported by relatives of the primary licensee (who worked in the distributorship) and employees, as compared to those reported by the owners (licensees) of the distributorship.¹ A potential reason for this could be that owners could have over-reported their distances for free home delivery in order to avoid fines, or, employees managing the agencies might have been more conservative while responding to certain questions as compared

¹ The average distance of free home delivery is significantly lower according to relatives and employees as compared to owners of the distributor agency (using ANOVA and *t*-tests with *p*-values <0.05). No significant difference was found in the reported distance of free home delivery between relatives and employees..

to the owners.

Figure A4: Reported distance of free home delivery is significantly higher among owners of distributor agencies



Source: Authors' analysis

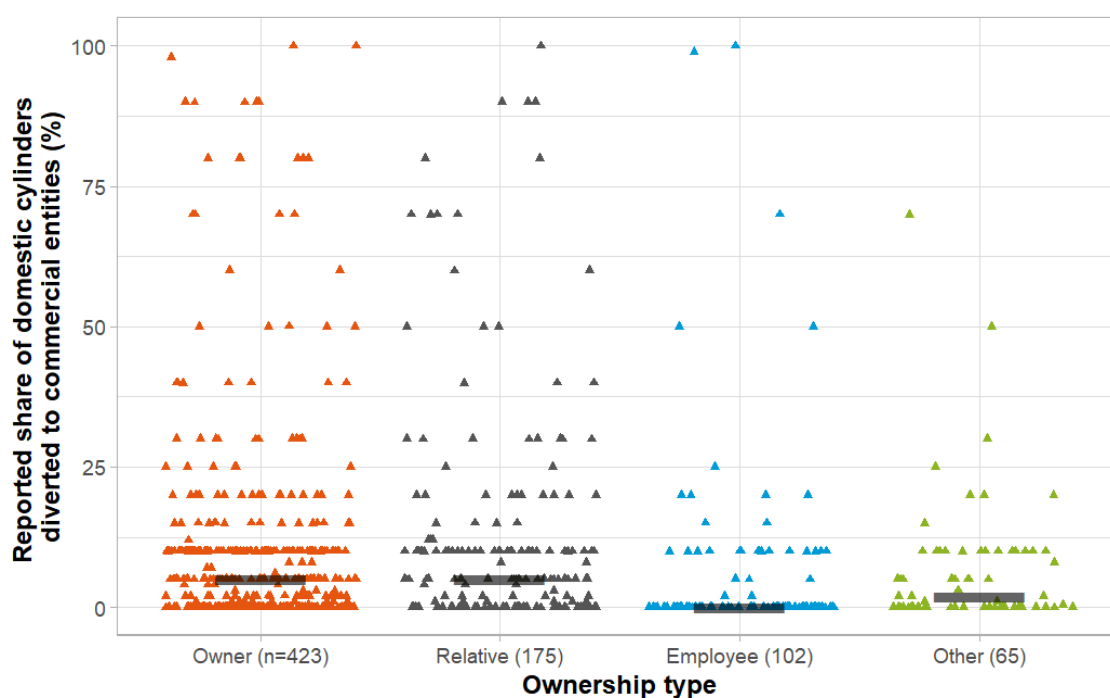
Note: 7 entries were removed from this analysis, as 7 distributors had responded with 'I don't want to respond.' The 'other' category included distributors who mentioned Garhwal Mandal Vikas Nigam (GMVN), Kumaon Mandal Vikas Nigam (KMVN), Defence Area Enterprise, partnerships with kin, etc., when asked if they legally owned the agency.

A variation in responses was observed based on the respondents' relation to the owner of the distributor agency. This difference is especially stark when comparing the reported rates of diversion of domestic LPG for commercial use; there is a statistically significant difference between the reported rates of diversion based on the type of respondent (the person who responded to the survey, whether it be the owner, a relative, or employee). Those managing their own or their family distributorships were more likely to report higher mean diversion rates of domestic LPG among other distributors.² In contrast, employees of a distributor were more likely to report lower diversion rates

² Average diversion rates are significantly lower (using ANOVA and t-tests with p-value<0.05) according to employees as compared to reported diversion rates by owners or relatives of the primary licensee. However, we did not find any significant differences between owners and relatives. The category of 'other owner' is excluded from this analysis as it was a free-text field which served as a miscellaneous option.

among their peers (Figure A5).

Figure A5: Statistically significant differences in reported diversion based on the respondents' relation to the owner of the agency

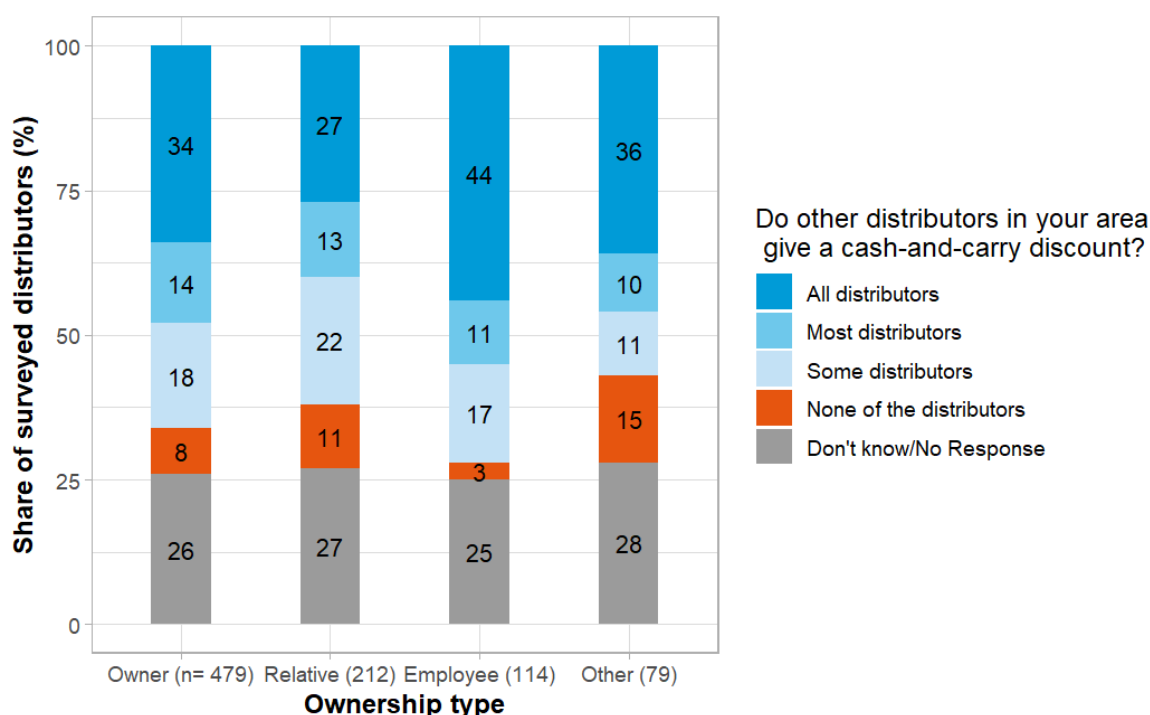


Source: Authors' analysis

Note: 119 entries were removed from this analysis as 80 distributors responded with 'I don't want to respond,' 38 responded with 'I don't know' to the question on domestic cylinders diverted to commercial entities, and 1 'NA' value was also removed.

Similarly, variations in adherence to the cash-and-carry discount were observed based on the type of respondent. As seen in Figure A6, more than 40 per cent of distributors who manage their own or their family distributorships (sometimes informally, as reported in qualitative interviews) have reported that distributors in their area do not provide a discount on delivery commission when a cylinder is picked up from the godown. In contrast, 32 per cent of the employees reported that the discount is not provided.

Figure A6: Variation in cash-and-carry discount compliance based on respondent's relation to the owner of the agency

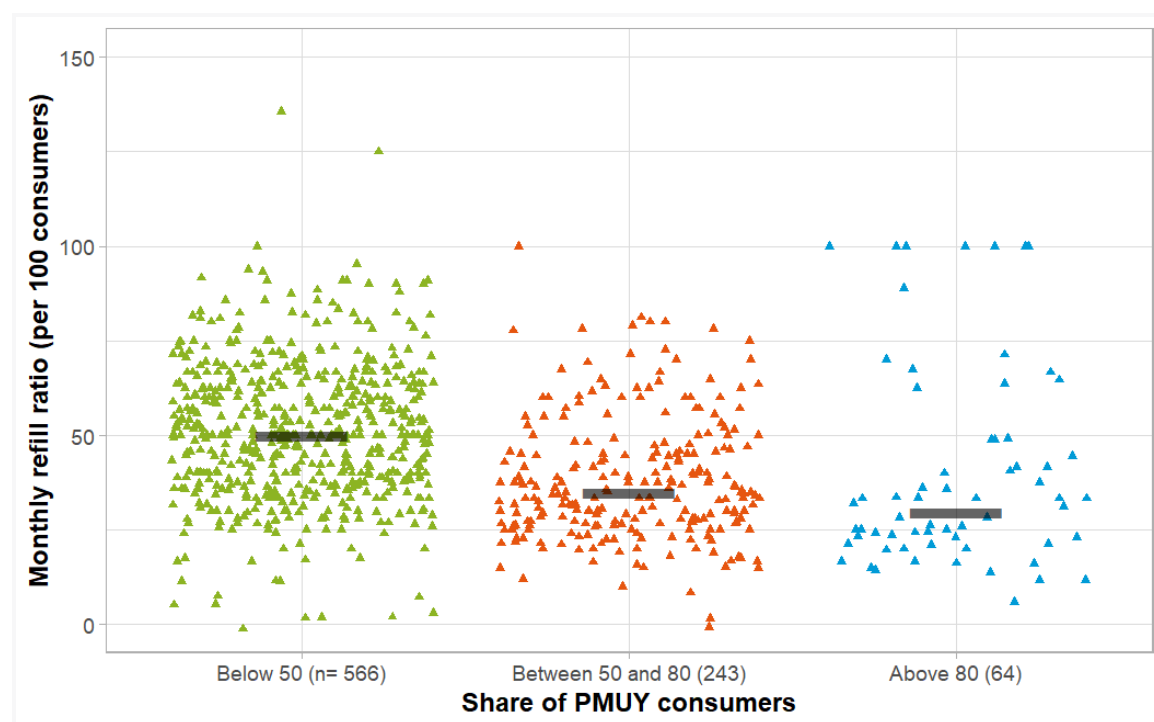


Source: Authors' analysis

Annexure 3: Additional analyses on distributor-reported metrics

The monthly refill ratio (per 100 consumers) was compared for distributors with varying proportions of PMUY consumers - less than 50 percent, between 50 and 80 percent, and greater than 80 percent. The analysis revealed that the monthly refill ratios for distributors with 50 to 80 per cent and more than 80 per cent of PMUY consumers were significantly lower (using ANOVA and t-tests with p-value <0.05) than the monthly refill ratios for distributors with less than 50 per cent of PMUY consumers (Figure A7).

Figure A7: Distributors with a higher share of PMUY consumers have significantly lower median monthly refill ratios per 100 consumers

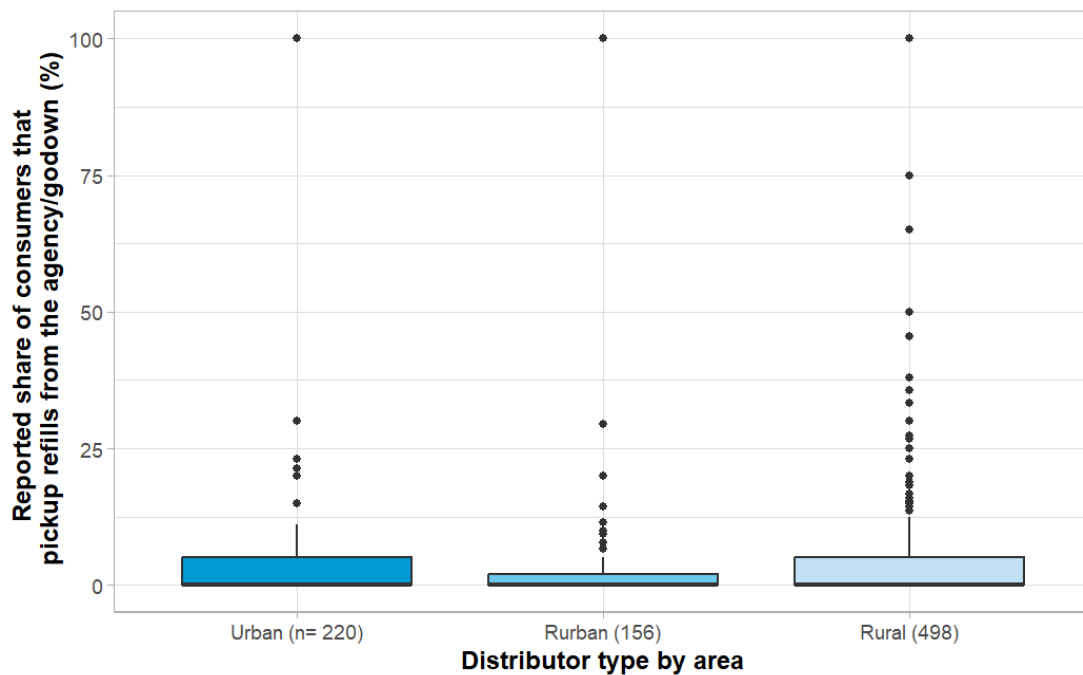
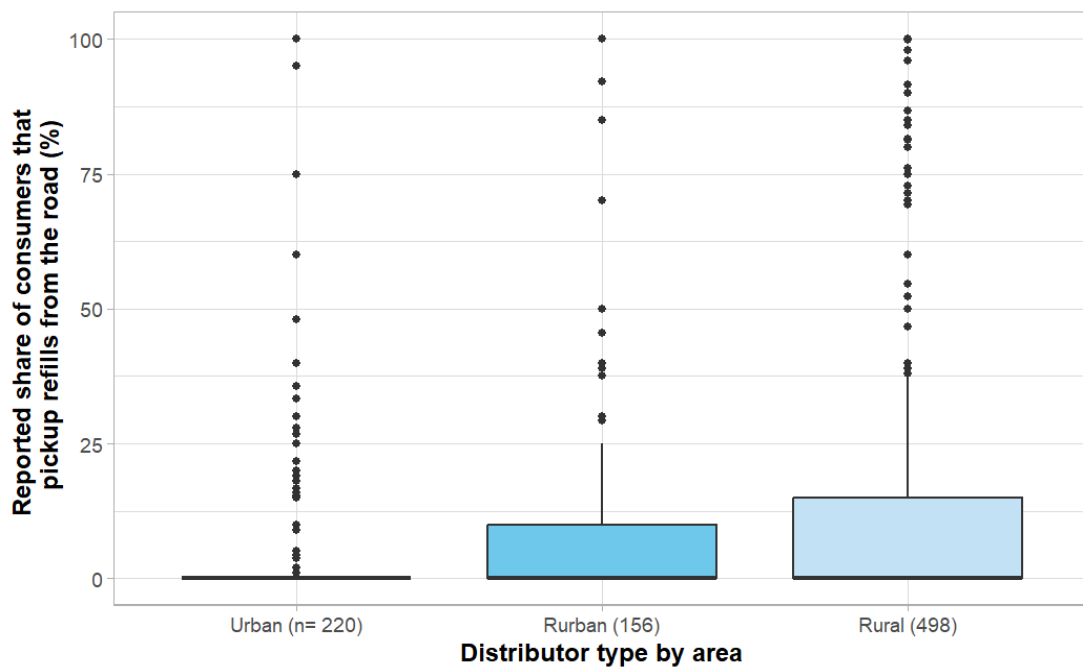


Source: Authors' analysis

Notes: In this panel, 5 entries were removed from the analysis due to impossible values for the share of PMUY consumers to registered consumers. Further, 6 impossible values for the monthly refill ratio have been removed, and the y-axis has been truncated to 150. This does not affect the calculation of medians.

According to distributor self-reports, most consumers received home delivery for their LPG refills. A small section of these consumers picked up their refills from a pickup point on the roadside or the distributor's agency/godown; 28 percent of rural distributors reported that more than 10 percent of their consumer base picked up refills from a pickup point on the road. This could be due to the low spatial density of these consumers, indicating a potential need for the expansion of stock points in and near their villages.

Figure A8: A few rural distributors report that a large portion of their consumers pick up refills from the roadside



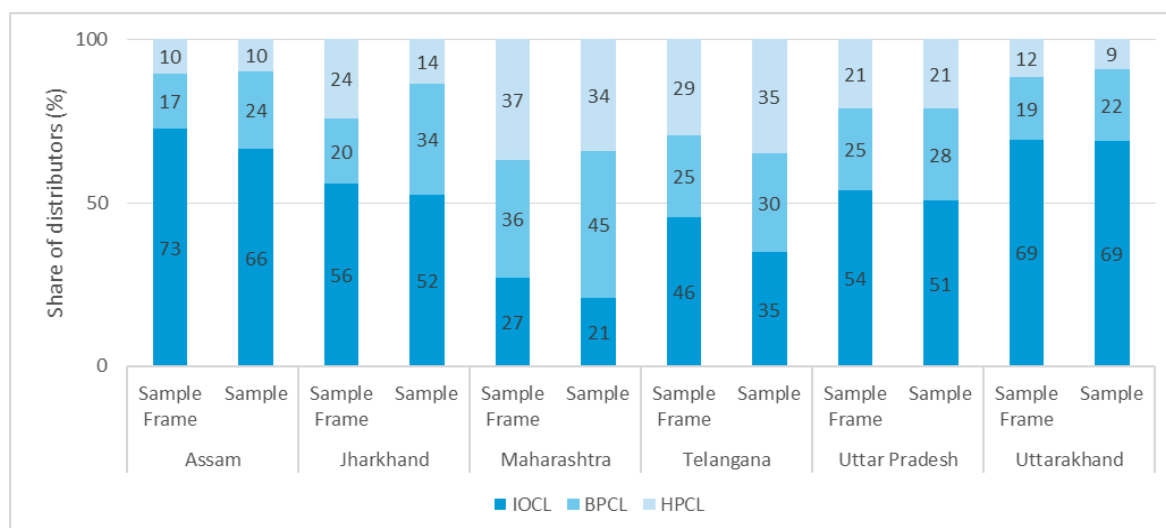
Source: Authors' analysis

Note: In this panel, 10 entries were removed for this analysis as 10 of them were 'NA' values.

Annexure 4: State-level disaggregation

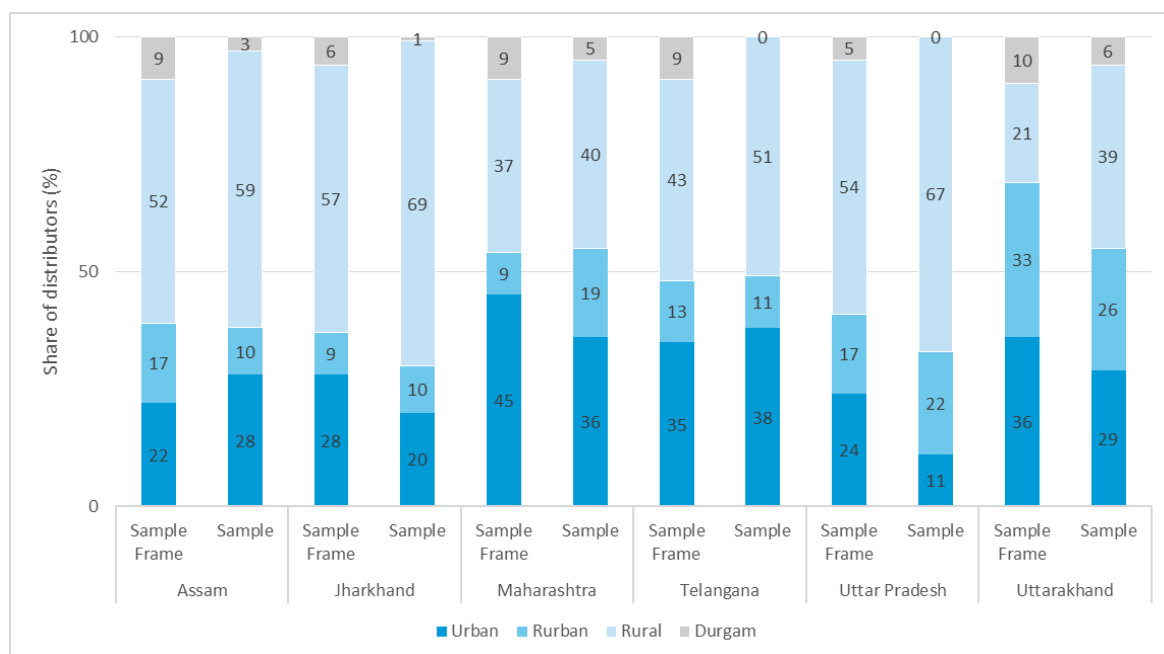
The share of distributors (from both the sample frame and the sample) belonging to the three OMCs was compared across the six states: Assam, Jharkhand, Maharashtra, Telangana, Uttar Pradesh, and Uttarakhand. Maharashtra has slight over-representation of BPCL whereas Jharkhand has both over-representation and under-representation of BPCL and HPCL respectively.

Figure A9: The surveyed sample closely resembles the sample frame on a state level across the three OMCs



Source: Authors' analysis

Figure A10: The surveyed sample closely resembles the sample frame on a state level across the four distributor types



Source: Authors' analysis