Timing the Transfer: Liquidity Constraints and the Transition to Clean Fuels*

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Abstract

Cash-back subsidies require households to pay full price upfront and be reimbursed later, creating extra liquidity hurdles that may be especially constraining for poor households. The unique setting of India's at-scale LPG subsidy program, where net-of-subsidy LPG prices remain constant while over-the-counter prices move exogenously, allows us to study the causal effects of liquidity constraints. We find large and significant liquidity sensitivity of low-asset households: a 1% increase in the over-the-counter price (with unchanged net-of-subsidy price) reduces LPG demand by 1.5% of the mean. Survey evidence further shows substitution away from LPG to polluting solid fuels and worsening of health outcomes of children. The results suggest that seemingly minor liquidity constraints can meaningfully reduce essential consumption, failure to account for the existence of such constraints may undermine the effectiveness of a subsidy design.

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1 Introduction

We have two main objectives in this paper. First, we leverage a unique opportunity to identify the impact of liquidity constraints on consumption, using large administrative data from a universal subsidy program in India. The program creates an exogenously varying liquidity hurdle that must be cleared in order to purchase the good. This would have no impact if liquidity constraints were non-existent or fairly slack in practice,[1] but if these constraints are non-negligible, purchases should be respond negatively to a larger liquidity hurdle. Thus the setting enables us to estimate the impact of liquidity constraints on demand for the subsidized good and provide evidence on the resulting externalities.

Second and related, we provide evidence helpful for effective subsidy delivery. Effective delivery of subsidies can be a critical component of public policy, particularly those that aim to encourage purchase of targeted goods and services.[2] But the mode of subsidy delivery can be critical. For example, consider the question of timing. The simplest approach may be to credit the subsidy at the point of sale, but this has several drawbacks and many subsidy programs include an ex-post subsidy design, where households pay the unsubsidized price upfront and then receive the subsidy later.[3]

The ex-post approach has its own potential drawbacks, this paper argues. In particular, even if the ex-post subsidized price would be affordable, the upfront payment required for the ex-ante unsubsidized good or service creates an extra liquidity hurdle that may stretch household liquidity too far – especially for poorer households. Thus, we may encounter (partial) policy failure: intended recipients, even some of the most targeted, may fail to avail of the subsidy.

To pursue these objectives, we study an at-scale, cash-back energy subsidy program of the Indian government designed to encourage household use of LPG ("liquefied petroleum gas") for cooking by keeping its price stable and affordable. The program holds the net-of-subsidy price of the product, 14.2-kg LPG refill cylinders, virtually unchanged over time by offering a time-varying subsidy; see Figure 1, which depicts the co-movement in the unsubsidized, over-the-counter LPG refill price and the household LPG refill subsidy, alongside the resulting constancy in the subsidized price of LPG refills.

The subsidy is delivered ex post; to purchase a refill, consumers must pay the current

[1] Liquidity constraints refer here to limitations on the availability of household assets to use as payment for a good or service today. Availability would come through efficient credit markets that enable households to tap into their assets (including human capital, i.e., future earnings), or could come partly through access to and ability to make optimal use of safe, liquid savings vehicles. A "liquidity hurdle" here is a feature of the environment that raises the household's need for access to its assets

[2] Governments across the world provide subsidies to correct for externalities, lack of information or other market failures, e.g., for preventive health, clean energy, schooling fees and opportunity costs, among others.

[3] For example, the ex post direct debit approach for nationwide LPG subsidies in India has been shown to decrease leakage and corruption (Barnwal, 2024). Other examples of ex-post subsidy design include electric vehicle or other green technology subsidies provided in the form of tax credit or rebate checks in the USA, Norway, Germany, China, and other countries (Bibra et al., 2021), the health expense tax credit in Canada (Canada Revenue Agency, 2025), and fertilizer subsidization through reimbursement in the Philippines (Department of Agriculture, Republic of the Philippines, 2020). Reasons for preferring the ex post subsidy design over crediting the subsidy at point of sale include lowering administrative cost, allowing more time to verify conditionalities, discouragement of over-consumption and waste, and opportunity to curb theft of public money, leakage, and black marketing.

over-the-counter price, and then receive the subsidy in their bank account after one week, on average. The key to our empirical strategy is that the over-the-counter price co-moves virtually one-for-one with the plausibly exogenous international price of LPG. Indeed, Figure 2 shows a nearly perfect correlation between the (domestic) over-the-counter LPG price and the international price of LPG lagged by a month during our study period. It follows that when the international price of LPG is high, consumers must pay a high price but get a high subsidy rebated; when it is low, the upfront price and the subsidy are also low. This creates a liquidity hurdle that varies exogenously while the effective (subsidized) price is held fixed, enabling us to identify the quantitative impact of monetary liquidity requirements on access to the subsidized good.[4]

We thus empirically investigate how variation in the over-the-counter price of LPG – which measures the size of the liquidity hurdle – impacts purchases of this clean fuel by both non-poor and poor households. We also estimate the impact of this over-the-counter LPG price on substitution towards inferior and more polluting solid fuels, and we trace the impact further toward a health burden on children likely resulting from the inferior fuels' indoor pollution. We further explore evidence pinpointing the liquidity effect and ruling out other explanations for the results.

Our analysis draws on four distinct data sources. First, we use transaction-level administrative records covering roughly one million LPG-using households in Indore, a major district in central India. These data document about 24 million LPG refill transactions over a 26-month period (November 2017–December 2019). Second, we link these administrative records to a primary survey of about 3,000 households from the same sample, conducted in two rounds between October 2018 and December 2019, which provides detailed information on biomass fuel consumption, demographic characteristics, and asset ownership. Finally, we incorporate two nationally representative secondary datasets: the Demographic and Health Survey (DHS) from India (also known as the National Family Health Survey or NFHS), which provides information on births and child-level health outcomes, and the Periodic Labor Force Survey (PLFS), which offers information on employment and households' cash flow.

Our results indicate a large and significant impact of the cash-back subsidy program's liquidity hurdle on LPG refill purchases by households. In particular, low-asset households decrease their refill purchases by 1.5% of their average when the over-the-counter refill price increases by 1%. The effect is similarly negative but much smaller and not always statistically significant for middle-to high-income households. There is also suggestive evidence that the effect is stronger the longer is the delay in subsidy receipt.

This core finding is bolstered by a second, that households respond to higher over-the-counter prices for LPG by substituting toward polluting solid fuels. Specifically, we find that monthly explicit expenditure on solid fuels by low-asset households increases by 1.2% of the mean in response to a 1% increase in the over-the-counter LPG price; the figure is 1.6% for implicit expenditure (including imputed time cost of gathering/making solid fuel). Substitution toward more-polluting solid fuels can impact health adversely, especially of

[4]We think of this natural experiment as approximating an experiment in which households can pay a fixed, subsidized price for an LPG refill on the condition of offering the government a short-term interest-free loan of random size (equal to the subsidy).

children. Results from the DHS data suggest a negative impact of LPG price increases on child health, measured by infant birthweight, incidence of child cough, and especially rapid breathing.

We provide further analysis aimed at pinpointing liquidity sensitivity as the key force behind the results. First, we show that the results are primarily driven by low-asset households, and that this conclusion is robust to using several alternative proxies for wealth. Second, we use the PLFS to construct a direct proxy for liquidity – specifically, cash on hand – by caste, month, and occupation, and show that the results are driven by low cash-on-hand household-months. Third, we restrict the analysis to harvest months and check for heterogeneous impacts by an exogenous liquidity shifter: growing-season rainfall. The harvest-time effects of over-the-counter price are significantly attenuated after good rainfall, suggesting again that the amount of available household liquidity is a key moderator of the estimated effect.

We finally explore and rule out alternative mechanisms. First, one might be concerned that LPG price increases are proxying for general inflation, or acting as a negative supply shock to the macroeconomy; if so, the effects we find could be interpreted as wealth or income effects rather than liquidity effects. But, we find no significant correlation between the overall Consumer Price Index and the over-the-counter price of LPG refills; and we find the results are robust to controlling for monthly unemployment, a proxy for macroeconomic conditions. Second, lack of 'subsidy salience', i.e. lack of awareness or understanding of the subsidy scheme, may be an issue for households, causing them to interpret changes in the over-the-counter price as real price changes. However, we find no heterogeneity in our results by measures of household awareness and understanding of the subsidy scheme. Related, we test for the possibility that imperfect trust in the government is driving results. If households doubted that the government would credit the subsidy, they could respond to the over-the-counter price as reflecting the true price with some probability. But we find no difference in effect by whether respondents exhibit trust in government functionaries. We also find that the results change little when we restrict the sample to experienced LPG user households, who have more exposure to faithful delivery of the subsidy. The results overall give confidence that the responsiveness of poorer households to the over-the-counter LPG price is due to liquidity constraints.

Our paper makes several contributions. First, we identify and quantify pure liquidity effects on purchases of a key household staple, and find that for poor households they can be substantial. This is all the more remarkable since the liquidity needs in our setting are moderate and quite temporary; reimbursement typically comes in a week. Thus, using a plausible identification strategy exploiting a natural experiment setting embedded in a developing country program at scale, we add to the literature documenting that liquidity constraints can be significant, especially for poorer households, and hence that credit markets operate imperfectly in developing countries. Seemingly minor liquidity constraints can reduce consumption of a valuable consumer

Previous literature on the relevance of liquidity constraints is extensive (for a seminal contribution, see Zeldes (1989)). However, causal effects of liquidity constraints are difficult to estimate, given the challenge of varying only liquidity availability or requirements while keeping wealth, prices, and preferences fixed. Much of the literature seeking to identify liquidity constraints examines consumption responses to variation in liquidity available to the

household, whether through anticipated or unanticipated income infusions (see, e.g., Aguila et al. (2017), Gelman et al. (2020), and Gross et al. (2022), and the references therein), exogenous credit availability (e.g. Tarozzi et al. (2014), Berkouwer and Dean (2022)) or savings opportunities (Brune et al. (2021), Kansikas et al. (2023)). But there are challenges involved in isolating liquidity effects using these methods. Timing purchases with anticipated income receipt may be more about cash management or optimal lumpy consumption (e.g. the occasional party) than truly distorted consumption, while credit can be viewed as a change in net worth (not merely liquidity) depending on what the household believes about the consequences for default.

A second approach to identifying liquidity constraints is much rarer: varying liquidity requirements rather than liquidity availability. Using RCT methodology, Casaburi and Willis (2018) and Levine et al. (2018) vary the timing of payment required to purchase two significant goods: crop insurance and cookstoves, respectively. Both find large effects of allowing households more time (at perhaps a better time) to come up with payment.[5] We follow this general approach in seeking to isolate liquidity impacts on consumption, with one key difference: we vary liquidity requirements not via timing of payment but via the size of the required payment itself. This enables us to cleanly identify a unique parameter: the response of purchases to the dollar value of extra liquidity required.

Second, we shed further light on a potentially critical issue in the design of programs featuring subsidies or conditional cash transfers, relevant to both equity and targeting: how should the transfers be timed? While not able to estimate the full tradeoffs involved, this paper documents a potentially significant cost to delay in providing the subsidy. The implications are relevant more broadly than for classic subsidy programs. Consider conditional cash transfer (CCT) programs, specifically the well-known Progresa and similar CCT programs aimed at increasing investment in human capital. To meet these programs' conditions, households had to attend school for some period of time before receiving the transfer. Thus households needed to pay any fees and the opportunity cost of foregone labor upfront; the logic of this paper is that they are thus facing liquidity hurdles that may have reduced program impact,[6] particularly on relatively poor households.Even minor delay creates liquidity hurdles and can limit access to the subsidized good or conditional transfer, this paper argues, and especially for poorer households.

The point extends beyond the timing of subsidies to the level of subsidies. Any required positive co-payment represents not only a marginal price, but also a liquidity hurdle. Thus, the optimal co-payment in the presence of liquidity constraints will typically be smaller than the one in the absence of such constraints. This applies to subsidized food, fuel, and even medicine (as Gross et al. (2022) argue).

Taken together with recent research on administrative reforms in welfare delivery in developing countries (Barnwal, 2024; Muralidharan et al., 2020) that aim at improving efficiency of public programs, the results highlight a possible equity-efficiency trade-off in overhauling public welfare programs, as outlined by Kleven and Kopczuk (2011). They suggest that delay may eliminate a significant amount of mistargeted benefits but also exclude key targeted

[5] As with credit, one might be concerned that the opportunity to default when delaying paying for the good affects the implicit price, not liquidity requirements alone.

[6] This does not contradict positive impact from these programs, but suggests the impact was not as large as it could have been without liquidity issues.

beneficiaries; and conversely for point-of-sale reimbursement. Put differently, reaching some of the poorest may be costly in terms of leakage. Ways to design subsidy policy that may soften or eliminate this tradeoff, however, are discussed in the Conclusion.

Third, we add to the existing evidence for policies seeking to reduce pollution and health externalities by encouraging transition to clean energy in developing countries.[7] Subsidy policies can be useful in such transitions, but how those subsidies are delivered can determine their effectiveness, and particularly for poorer households, which may be at the greatest risk of using more damaging technologies. Several countries run household subsidy programs to accelerate the transition to cleaner energy sources that reduce pollution and health externalities. For environmental justice reasons, energy subsidy programs often include provisions that target low-income households. But the effect of these programs' administrative design on efficiency and equity in the take-up of clean energy remains understudied. Policy-makers usually pay less attention to how the subsidy should be provided, focusing instead on what the subsidy level should be. The findings of our paper suggest that the design of these programs, in terms of their timing, can be critical for clean energy access. Recent research shows that households' financial constraints play a critical role in adoption of clean energy in low-income contexts. Using LPG sales records, Afridi et al. (2021) underscore the salience of financial constraints in switching to clean fuels inspite of the LPG subsidy program in rural India. Close to our setting, Berkouwer and Dean (2022) find that households' willingness to pay for energy-efficient cooking stoves increases when credit constraints are loosened via a loan offer. Our study provides evidence that liquidity constraints limit households' ability to sustain the transition to clean energy through regular usage of such fuels, and especially poorer households – even when they have already acquired more efficient cooking technology.

The remainder of the paper is organized as follows. We explain the institutional background in Section 2 before developing basic theoretical predictions for liquidity-constrained consumption choice in Section 3. Section 4 describes the data and presents summary statistics, while Section 5 outlines our empirical strategy. Baseline results on purchases of LPG and alternative fuels are in Section 6, while health results are in Section 7. Section 8 presents results buttressing the liquidity interpretation, and Section 9 concludes.

2 Institutional background

The first step a household has to take in order to use LPG is to obtain a "connection", or "account" – i.e. register with one of the three state-owned Oil Marketing Companies (OMCs), India's exclusive LPG suppliers, through their network of local "dealers". This is an upfront cost of about INR 3200 (45 USD), about two weeks' worth of household income in rural areas.[8] To expand access to LPG, the Government of India launched the *Pradhan Mantri*

[7]The impact of indoor air pollution on health and other related outcomes is extensively discussed in the literature. A smaller number of articles provide causal evidence on how the transition from biomass-based fuel to clean energy for cooking helps improve health outcomes (e.g. Cesur et al. (2017); Imelda (2020)), although this may not always be the case (Berkouwer and Dean, 2023; Thivillon, 2023). LPG subsidies have been particularly highlighted to have a high potential to reduce the USD 1.6 trillion global health burden of biomass-based fuel (Gould et al., 2024).

[8]"Connection" is the official term that refers to registration for obtaining a gas pressure regulator, a consumer booklet with unique ID along with the first LPG cylinder refill. To register for a connection,

Ujjwala Yojana (PMUY) in April 2016. The PMUY is the largest program for access to clean fuel in the world, reaching 72 million poor families between April 2016 and June 2019. The program mandates that women in socioeconomically disadvantaged households can obtain an LPG account at no upfront cost. The government bears the beneficiary's security deposit and administrative charges for an LPG account (USD 25). The beneficiary also receives an interest-free loan (USD 20) to purchase the stove and the gas cylinder.[9]

An LPG account entitled the consumer to a universal, nationally set subsidy on refills of the LPG cylinder between 2014 and mid-2020. All residential LPG consumers in India, irrespective of PMUY status, received a subsidy or so-called "direct benefit transfer" (DBT), for up to 12 LPG cylinder refills a year.[10]

The DBT for LPG subsidy functioned in the following way during this period. The consumer paid the entire market price (over-the-counter) to her local LPG dealer at the time of refill cylinder purchase. The dealer recorded the refill purchase against the consumer's ID in a centralized database. The subsidy amount was then directly deposited into the consumer's linked bank account, on average within 7 days (see Figure A1 in Appendix A).

The subsidy program initially aimed to maintain a stable net nominal price (over-the-counter price minus subsidy) of around INR 500 per cylinder during our study period (equivalent to INR 350 in the base year 2012), which each consumer was entitled to for up to 12 cylinder refills per year. Districts are typically broken down into multiple LPG markets by distance from the LPG cylinder bottling plant. LPG refill prices vary by a small amount (INR 2 - 5) between markets, primarily depending on the transportation cost of moving refill cylinders from the bottling plant. Hence the variation in refill prices is mainly due to monthly changes in market price and minimally due to spatial variation. Beginning in April 2016, the government modified the pricing by implementing pre-announced small monthly increases (INR 2-4 per refill); this resulted in a roughly constant real price during our sample period, as Figure 1 shows. The Figure also shows that the subsidy delivered via DBT varied monthly with the LPG market price, which itself moves in tandem with the international market price of LPG. Specifically, the Indian government regulates the over-the-counter price every month based on the Saudi Aramco LPG price in the preceding month; see Figure 2. In short, consumers pay an exogenously varying over-the-counter price, and receive a subsidy debited to their bank account shortly thereafter, which is designed to keep the net real price constant. For instance, if the market price of an LPG cylinder happened to be INR 820, given a target net price of 500, a subsidy amount of INR 320 would be directly deposited into the consumer's bank account within 7 days of purchase on average.

a consumer has to provide proof of identity, residential address, bank account information, and submit a security deposit of 25 USD with her local LPG dealer. The consumer has to pay the market price separately for the gas in the cylinder (10 USD) and a stove (10 USD). Note that the average rural (urban) household income was approximately INR 7,215 (INR 10,000) (1 USD = INR 72) per month in 2011, the latest year for which reliable estimates are available (Desai et al., 2011).

[9]The loan from the OMC to the PMUY consumer was to be recovered from her LPG refill subsidy entitlement, discussed next, but this recovery was not effectuated during the period of our study.

[10]Throughout, we refer to the standard-sized LPG cylinder in the Indian market, which holds 14.2 kg of LPG. All registered consumers are assigned a unique consumer ID and a booklet that records, among other details, the date of LPG account creation, the LPG dealer holding the account, and every LPG refill purchase. Consumers can purchase refills from any of the three approved dealers. All dealers offer LPG accounts and cylinder refills at the same market price within their market.

Nationwide, an estimated 79% of all households had LPG accounts in 2018 but with a significant rural-urban gap of almost 40 percentage points (PPAC Report, 2018). The PMUY program has been successful in significantly improving rural households' access to LPG, but has yet to ensure widespread consistent LPG usage.[11] LPG use continues to be much lower in rural areas, where mean annual consumption is – at about four LPG cylinders – roughly half that in urban areas.[12]

3 Theory

We next present a model to illustrate how the liquidity hurdle imposed by the LPG subsidy program may negatively impact consumption of LPG. The model clearly separates the liquidity effect from price and wealth effects, and makes predictions about which kinds of households are most impacted by the liquidity requirements.

Time is divided into a short, current period – corresponding to the time a household must wait for its subsidy rebate, often a week – and the future. A household maximizes utility by choosing current consumption of a general good C, at price normalized to 1, and whether to make an indivisible fuel purchase $X \in \{0, 1\}$. The program fixes the subsidized price of X at p, but also requires the household to pay the market price $p + q$ for good X upfront, and only in the future get reimbursed q, the subsidy amount.

The household is endowed with net worth or "wealth" W (interpreted broadly to include future earnings, e.g.), so that $W - C - pX$ is available for future consumption.[13] The liquidity constraint is modeled as a fraction $\lambda \in [0, 1)$ of total wealth $W + qX$ being unavailable for purchases in the current period.[14] If credit markets are perfect, the household has immediate access to all its wealth and $\lambda = 0$. On the other hand, imperfect credit markets imply that the household is limited in ability to borrow from its wealth, whether future earnings, illiquid tangible assets, or the promised subsidy, leaving $\lambda > 0$.[15]

Assuming a log utility specification, for $a \in (0, 1)$ and $b > 0$, the household's problem is:

$$\begin{aligned} \max_{C,X \in \{0,1\}} \quad & (1-a)\, ln(C) + b\, X + a\, ln(W - C - pX) \\ s.t. \quad & C + (p+q)X \leq (1-\lambda)(W + qX) \end{aligned} \tag{1}$$

Consider first the unconstrained maximization problem, where $\lambda = 0$. If the household chooses $X = 0$, it is optimal to set $C = (1 - a)W$, leaving aW for future consumption. If the household chooses $X = 1$, it is optimal to set $C = (1 - a)(W - p)$, leaving $a(W - p)$ for

[11] Media report.

[12] Media report

[13] $W - C - (p + q)X + qX = W - C - pX$ is the amount available after current period purchases and subsidy receipt, i.e. for future consumption.

[14] Counting total net worth for current-period borrowing purposes as $W + qX$ rather than W is equivalent to assuming that the promised future subsidy can be borrowed against, conditional on X being purchased, as well (or poorly) as other sources of net worth. This symmetric treatment allows the liquidity constraint to be captured by a single parameter (λ), but could be generalized without changing results.

[15] Savings constraints, whether structural or behavioral, are unmodeled but may be thought of as incorporated in λ in a reduced-form way; if saving is difficult, the fraction of net worth that can be accessed in the short run $(1 - \lambda)$ may be lower.

future consumption. It is straightforward to show that buying fuel gives greater utility than abstaining from fuel in this unconstrained case iff $W \geq p/(1-e^{-b})$. Households of sufficiently low net-worth decide that buying a unit of fuel would leave the rest of their consumption too low.

Thus, key determinants of gas purchase in the absence of liquidity constraints are the subsidized price p and net worth W. The liquidity hurdle q has no impact, however. This provides a testable implication of the absence of liquidity constraints: if subsidized price and net worth are held fixed, varying liquidity requirements should have no impact on consumption of good X.

Consider next the constrained problem. Note that the liquidity constraint is not binding at the optimum when $X = 0$ if $(1-a)W < (1-\lambda)W$, i.e. $\lambda < a$; for brevity, we restrict attention to this case. The liquidity constraint does not bind at the optimum when $X = 1$ iff $(1-a)(W-p) + p + q \leq (1-\lambda)(W+q)$, i.e. $W \geq (ap + \lambda q)/(a-\lambda)$.

Putting these facts together, it is clear that $X = 1$ is optimal if

$$W \geq \max\left\{\frac{p}{1-e^{-b}}, \frac{ap+\lambda q}{a-\lambda}\right\},$$

since the unconstrained allocation with $X = 1$ is both feasible and preferable to the unconstrained allocation with $X = 0$. It is also clear that if $W < p/(1-e^{-b})$, $X = 0$ is optimal because the unconstrained allocation with $X = 0$ is both feasible and preferable to the unconstrained allocation with $X = 1$.

The remaining possibility involves

$$W \in \left(\frac{p}{1-e^{-b}}, \frac{ap+\lambda q}{a-\lambda}\right).$$

In this interval,[16] purchasing X would be preferable if there were no liquidity constraints, but the unconstrained C is not affordable if the household purchases X. So, the choice is between purchasing X by underconsuming C in the current period, or abstaining from X. One can show that there is a $\widehat{W}(q)$ in the interior of this interval such that the household purchases X iff $W > \widehat{W}(q)$.[17] One can also show that $\widehat{W}'(q) > 0$. This is because as q rises, the sacrifice in C required in order to purchase X gets larger, so marginal households – for whom W and C are lowest and the marginal utility from C highest – abstain from X.

The optimal purchase decision is pictured in (q, W)-space in Figure 3.[18] It is clear that as q rises, so does the wealth cutoff for purchasing fuel, $\widehat{W}(q)$. Thus, **we should see fewer fuel purchases when q is higher**: fewer households find it optimal to purchase when they must pay a higher upfront cost, since in the presence of binding liquidity constraints this

[16] This interval is non-empty iff $q > p(a-\lambda e^b)/[\lambda(e^b-1)]$, which the rest of the paragraph assumes.

[17] If W is near the top of this interval, the unconstrained allocation with $X = 1$ is nearly affordable, and strictly preferable; so the household does better to purchase X. If W is near the bottom of this interval, the household is almost indifferent between the unconstrained allocations with $X = 0$ and $X = 1$, but is not close to affording the unconstrained allocation with $X = 1$; so abstaining is better.

[18] The Figure is for parameter values satisfying $\lambda \in (a/e^b, a)$, which guarantees that the above interval is non-empty for any $q \geq 0$. The case where $\lambda \in (0, a/e^b)$ is similar for $q \geq p(a-\lambda e^b)/[\lambda(e^b-1)]$ but flat for $q \in [0, p(a-\lambda e^b)/[\lambda(e^b-1)]]$.

necessitates greater sacrifice in current consumption. Further, the model predicts that **the drop in fuel purchases resulting from a higher q is concentrated among households with relatively low wealth**. The lowest wealth households, e.g. those with $W < p/(1 - e^{-b})$, are so poor they would never purchase fuel, even without liquidity constraints. But of those who would ever purchase fuel, it is the lowest-wealth households that are sensitive to q; see Figure 3. We should thus see the effects most strongly among the poorest of those households ever purchasing fuel. The focus of this paper is on empirically testing this paragraph's predictions.

The model is stylized and does not fully capture the dynamics of the decision-making involved in purchasing LPG refills. For example, it does not model the dependence of demand for fuel next period on whether fuel was purchased this period. While a fully dynamic model is beyond the scope of this paper, the basic impact of liquidity constraints in distorting purchases should be robust to that setting.

4 Data

Our main data come from Madhya Pradesh (MP), the second-largest Indian state by area and the fifth largest by population with over 75 million residents. Over 60% of MP households (rural and urban) had LPG access in January 2018 (PPAC Report, 2018). We focus on the richest district of MP, Indore.

We use two main sources of data: (1) administrative, consumer-level data from the LPG sales records of all three OMCs for all household-level LPG consumers in Indore district, and (2) household-level survey data from approximately 3000 randomly sampled rural households in Indore district.[19]

4.1 Administrative sales data

The OMC administrative sales data cover all LPG refill transactions of all consumers for all three OMCs in Indore for 26 months, November 2017 – December 2019. Besides unique consumer IDs, the data contain information on the date of LPG account registration, PMUY status, LPG dealer, residential address of each consumer, and date (day, month and year) of every LPG refill transaction of each consumer. Using a machine learning algorithm, we generated the gender variable of the consumer (from PMUY status and the consumer's name) and their rural-urban location (using Google API and address pin-code), allowing us to present results on Rural and Urban subsamples.

Monthly market prices from the 26 markets of Indore district are available from all three OMCs' (i.e. IOCL, BPCL and HPCL) administrative data. Note that refill prices vary slightly between markets but not between dealers within a market. The administrative data link all LPG dealers to their corresponding market and thus to the corresponding monthly LPG price. Given that each consumer's dealer is identified in the data, we have information on the monthly market-level LPG refill price data for all consumers for the entire study period.

[19] We use the term consumer and household interchangeably because each household typically has only one LPG account with their local LPG dealer.

In addition to monthly price data for refill cylinders, we also have the LPG subsidy per refill in each month during the study period. After merging, we have a database of all customers' LPG refill purchase quantities, refill subsidy in each month, and refill market price for 676 market-months (26 Indore markets x 26 months). We drop outliers, consumers who purchased an abnormally high number of LPG refills (0.024% of the administrative sample, who consumed more than 40 refills in a year).

The administrative data are unbalanced – LPG refill consumption is missing in months prior to registration for consumers who registered for an LPG account during our sample period. We balance the sample by recoding these missing values to 0. For instance, if the consumer's account was registered in January 2018, her LPG refill purchase is entered as 0 in November and December 2017. Appendix B reproduces all main results with the unbalanced panel that results from coding LPG consumption as missing prior to account initiation.

Data from one OMC, BPCL, also contain the date the subsidy is credited to the consumer for a majority of transactions. This allows us to measure delay, defined as the number of calendar days between the delivery date of a refill and the associated subsidy bank deposit. These are aggregated to the mean or median level within-month to create a proxy for the typical delay prevailing in the month a refill is purchased.

4.2 Household-level data

We utilize data from a cluster randomized control trial (RCT) implemented in rural areas of Indore district by Afridi et al. (2021) between October 2018 and December 2019.

150 villages were randomly sampled from four census blocks in Indore district excluding the city of Indore. In the sampled villages, a household was deemed eligible for the study if it had a currently residing member younger than 10 or older than 55. Twenty eligible households were randomly sampled in each of these villages by systematic random sampling during a baseline survey in November and December 2018. Following the completion of a cluster-randomized information campaign on the health benefits of LPG and information on the universal LPG subsidy between January and September 2019, the endline survey was conducted between October and December 2019. Thus, the households surveyed in the baseline were revisited during the same season approximately a year later, with negligible attrition ($< 2\%$).

Households in the sample were asked whether they currently had an LPG account. If they did, account details, including their unique consumer ID and number of refills in the past year, were recorded from their consumer booklets and photographed. Detailed information on household composition, assets,[20] socio-economic characteristics, use and collection of fuel in the previous month, PMUY status, and health awareness was gathered for all households irrespective of whether they had an LPG account or not. The same household level data were gathered at baseline and endline.

Households with LPG accounts were linked to the OMCs' sales data (described above) using the unique consumer ID, enabling us to track these households' LPG consumption in all 26 months of the administrative data. This paper's analysis is restricted to the subsample

[20]We use the first component of a principal component analysis over several indicators measuring the economic status of a household to generate the asset index. These indicators include ownership of land and farm animals, *pucca* house, and a list of consumer durables.

of surveyed households who either already had an LPG account or obtained one during the sample period of the administrative data, November 2017 – December 2019.[21]

4.3 Other datasets

Since we did not collect information on income or expenditure in our household Survey, we use individual and household level data from multiple rounds of the nationally representative Periodic Labor Force Survey (PLFS rounds 2017-18, 2018-19 and 2019-20) that overlap with our study period of November 2017 – December 2019. Data from the rural sample is used to estimate total monthly household income (earned, unearned, self-employment, and other sources of income) and total monthly household expenditure. The difference between the two is our estimate of a household's "cash-on-hand" in a month.[22] Data on caste and occupation is then used to average cash-on-hand by month-caste-occupation cells, using 4 main occupation categories (salaried, self-employed on-farm, self-employed off-farm and casual labor) and 4 caste groups (SC, ST, OBC and General or higher-caste categories).

We use the DHS 2019-21 India data to construct household-level health outcomes: (i) at the infant level, birth weight for births within a year prior to the survey, and (ii) at the young child level, indicators for cough and rapid breathing in the two weeks before interview for living children under five. To cover the birth recall window, we extend the monthly LPG price series backward to June 2018 and forward to May 2021 using BPCL–Indore price data and the CPI to build a continuous real, month-level series. Pregnancy timing for birth outcomes is recovered from the DHS reproductive calendar and linked to the mother's location-month. For birth weight, we average the real LPG price over the gestation months; for cough and rapid breathing, we use the interview-month price.

4.4 Summary statistics

The domestic, over-the-counter market price of an LPG cylinder is determined by the government, based on the international market price for LPG. Specifically, the domestic price of LPG is expected to be reset by the government every month to reflect the world price. This can be seen in Figure 2 – the domestic (over-the-counter) price of LPG is nearly perfectly correlated with the one-month lag of the international LPG price in INR (correlation coefficient of 0.99, p-value=0.0004) (Barnwal, 2024).

The administrative sales data are summarized in Table 1, which shows LPG refill consumption from administrative sales records of all three OMCs for the entire district of Indore, Nov 2017 - Dec 2019. The data are at the consumer level and represent almost a million customers. 7.4% of the consumers are PMUY account holders, while 32% are women and 57.2% are rural, as shown in Panel A. Panel B provides statistics on LPG refill transactions, overall and by rural-urban residence. The average number of LPG refills per month is 0.578, but just 0.252 for PMUY consumers. This PMUY–non-PMUY consumption gap holds in both rural and urban areas.

[21] The earliest (latest) LPG account date is July 1986 (September 2019) in our household survey data.

[22] More extensive data that could better capture stock rather than flow of cash-on-hand, e.g. using techniques of Samphantharak and Townsend (2010), is unfortunately lacking.

The average LPG over-the-counter price and subsidy amount per kg of gas for each of the 26 months in our data are shown in Figure 1. Note that the LPG refill subsidy tracks the over-the-counter price as it varies each month, leaving the real effective price (over-the counter price minus subsidy) essentially constant during our study period at approximately INR 25 per kg.[23] Note that the subsidy amount ranges from less than 20% to almost 100% of the subsidized price during this time period.

Table 2 summarizes the characteristics of the rural households with an LPG account in our Survey data. Of the 3003 households in the sample, almost 70% had an LPG account during the study period (i.e. 2091 households), of which 39.1% were PMUY consumers. Self-employment or casual labor are the dominant occupations of household heads, as shown in Panel A. Panel B shows that the explicit, average monthly expenditure on solid fuels purchased by the households is INR 56.8 and INR 151.2 for firewood and dung cakes, respectively. However, monetizing the reported time spent by the household in solid fuel collection/making in the survey data by multiplying the time spent in fuel collection/making with the minimum unskilled wage in rural MP, we find that the implicit monthly household expenditure on either solid fuel is more than INR 500 – higher than the average effective price of one LPG refill (see Appendix Table A1). Households spent almost 4 hours in a typical week of the previous month collecting or making solid fuels, according to our survey data. Panel C shows that average LPG refills purchased per month by households with LPG accounts was 0.41 (using OMC sales data from Nov 2017 - Dec 2019), lower than from the full administrative data (Table 1). PMUY households' annual refill consumption was just over half of non-PMUY households' consumption.

In Appendix Table A2 we compare the characteristics of the PMUY and non-PMUY consumers using the household survey data. PMUY households have a lower asset index, are less likely to belong to the general caste group (relative to socio-economically disadvantaged Scheduled Caste (SC), Scheduled Tribe (ST) or Other Backward Castes (OBC)), are less likely to own or lease land, have lower education and are more likely to have casual labor as their main occupation. These data, therefore, underline the fact that PMUY households are significantly more impoverished, and thus more likely to be liquidity constrained, than non-PMUY households.

Appendix Figure A2 shows the average per month cash-on-hand (COH) of rural households in India, calculated by taking the difference in monthly total household income (from all sources) and the total household expenditure in the PLFS data. The figure indicates that households have less cash-on-hand during the off-agricultural season (April-September, prior to the winter cropping season), suggesting cyclicality of liquidity. In Appendix Table A3, we summarize the cash-on-hand data that we obtain for the 416(=4x4x26) occupation-caste-month groups, which we use later to analyze heterogeneous effects of over-the-counter price on LPG refill take-up in our Survey sample of households in rural Indore.[24]

[23] Appendix Table A1 summarizes these prices for a standard 14.2 KG refill cylinder for the 676 market-months in our data. As mentioned earlier, the over-the-counter price of LPG may slightly vary across LPG distributorship markets in a given month, due to small differences in transport costs and local taxes.

[24] The PLFS data are not representative at the district level, and the rural MP sample is relatively small, especially within occupation-caste-month cells. Hence we compute cash-on-hand at the all-India level.

5 Empirical strategy

Our empirical strategy is to estimate responses of LPG purchases to variation over time in the over-the-counter LPG price, and with it the subsidy amount, particularly among low-wealth households. Since the effective (net) LPG price – over-the-counter price net of subsidy – remains essentially constant over time, while the amount that must be paid upfront varies significantly and exogenously, our setting provides a unique opportunity to quantify the impact of liquidity requirements.

Equation 2 shows our main specification to estimate the impact of changes in the over-the-counter price of LPG (or cash-back subsidy) on outcomes pertaining to LPG and solid fuel usage:

$$Y_{it} = \alpha + \beta Price_t + \gamma Price_t \times PMUY_i + \mu_i + \delta_{m(t)} + \tau_{y(t)} + \epsilon_{it} \ . \tag{2}$$

Y_{it} denotes two main outcomes of interest – (1) the number of 14.2kg LPG refills purchased and (2) the expenditure on solid fuels, by household i at time t. $Price_t$ denotes our main variable of interest: the monthly over-the-counter (real) price for an LPG refill (alternatively, the cash-back subsidy amount), which varies mainly over time.

We are especially interested in estimating the effect of changes in over-the-counter price (or cash-back subsidy) on low-wealth households; according to theory (Section 3), this is where liquidity constraints should have their greatest impact. The binary variable $PMUY_i$ equals 1 if the household has its gas connection under PMUY, a strong indicator of lower socio-economic status, and 0 otherwise. Thus, β captures the change in the monthly number of refills purchased by a regular (non-PMUY) household due to a one percent increase in the over-the-counter price of LPG (or cash-back subsidy), while γ captures the differential effect on the number of refills purchased by a PMUY household.

For causal interpretation of our β and γ estimates, the key assumption is that the over-the-counter price varies exogenously, independently of local supply and demand factors.[25] That local factors do not affect the price is virtually certain, since the over-the-counter price of LPG follows the international market price for LPG. Even national-level factors generally have a non-negligible effect; India can be considered a price-taker for petroleum products in the world market. To interpret the price impacts as liquidity effects, the further necessary assumption is that the LPG price only impacts LPG purchases through the liquidity channel. This also is likely, first and foremost since the price channel is ruled out by the publicly observable constancy of the net price. An income or wealth effect on LPG purchases is also possible, if LPG price changes impact or reflect general macroeconomic activity, and thus real wealth or incomes. This too appears implausible, as the LPG price does not go to extremes over the sample period (see Figure 1), and anyway is not seen as a significant driver of the Indian business cycle or consumer price index. Nonetheless, we variously control for time effects and macroeconomic variables like unemployment (in Section 8.2.1) to bolster this assumption.

Our preferred specification (Equation 2) includes household fixed effects (μ_i) to control for time-invariant household-specific factors. This fixed effect subsumes the PMUY indicator and any persistent market-specific variation. Controlling for arbitrary time effects (ν_t) is not

[25] This guarantees the same for the cash-back subsidy, since it is nearly perfectly correlated with the price.

possible since our empirical strategy relies primarily on monthly variation in the LPG price p_t; more generally, there is a tradeoff between absorbing generic time variation and retaining sufficient variation in the LPG price. Bearing in mind the tradeoff, we take a middle ground by including month and year effects in some specifications, to control flexibly for seasonality and time trends: $\delta_{m(t)}$ and $\tau_{y(t)}$, respectively.[26] The error term is captured by ϵ_{it}, and we allow for clustering at the market-time level.

6 Results

6.1 Impact of LPG refill price and subsidy on refill purchase

We first analyze how changes in the over-the-counter price (or cash-back subsidy) affect LPG refill purchases. Recall that since the net price (post-subsidy) is not changing, this is intepretable as the effect of liquidity requirements on participation in the program. Table 3 shows our main results. Negative effects of the price and cash-back subsidy on non-PMUY household purchases are estimated, though magnitude and statistical significance depend on whether year FE are included (even vs odd columns). But for PMUY (i.e., low-income) households, differential and total purchases are highly sensitive to changes in over-the-counter prices. In the specification controlling for year FE (Column 2, Panel A), the full-sample coefficients suggest that a 1% increase in the over-the-counter price leads PMUY households to purchase 0.0039 fewer LPG refills per month. Given a mean of 0.25 refills per month purchased by PMUY households, this translates to a roughly 15% decrease in LPG purchases from a 10% increase in the over-the-counter price.[27] A very similar pattern emerges in the rural and urban samples of our administrative data (Panels B and C in Table 3). If anything, the effects are more pronounced in rural areas, perhaps because liquidity constraints are generally tighter in rural areas, or because PMUY households in rural areas are poorer than PMUY households in urban areas. Columns 3 and 4 show consistent results when we estimate the impact of changes in cash-back subsidy instead of the over-the-counter price. The magnitudes are smaller as expected, since gross price and subsidy co-move essentially one-for-one in levels, and any absolute change is a larger percentage change in the subsidy.[28]

Next, Table 4 shows that results are similar when we use the much smaller sample derived from the rural household survey matched to administrative data. A key difference, compared to the most relevant results of Table 3 in Panel B (rural sample), is that the effect for non-PMUY households is larger and more statistically significant. One plausible explanation is that non-PMUY households in the survey sample are relatively poorer than the non-PMUY rural households in the administrative data; the gap in the average monthly LPG refill purchase between the two samples, as shown in Tables 1 and 2, lends some credence to this

[26] The functions $m(t)$ and $y(t)$ extract the month and year, respectively, from monthXyear t.

[27] The standard deviation of over-the-counter price is about 12% of its mean; see Appendix Table A1.

[28] Thus, their effect in levels rather than logs should be essentially identical; we verify this in Appendix Table A4. Specifically, our estimates suggest a 0.01 reduction in LPG refills purchased by PMUY households from a one INR per kg increase in over-the-counter price or cash-back subsidy (Columns 2 and 4 of Panel A, Appendix Table A4). Thus a one standard deviation increase in the per kg price, i.e. INR 4.4 (or about INR 62 for a 14.2 kg cylinder, see Appendix Table A1), lowers PMUY refill purchases by about 0.044, about 17% of the PMUY mean LPG refill of 0.25.

possibility. Effects on our focal PMUY households are quite consistent with Table 3 results, if slightly smaller.[29]

In summary, the estimated elasticity of LPG demand to liquidity requirements – captured by the over-the-counter price or cash-back subsidy *holding subsidized price constant* – is substantial for poorer households. Hence, the usage of LPG for cooking is likely to fall in these households with an increase in the over-the-counter LPG price, in spite of the subsidy program designed to keep the effective price basically constant for consumers. To contextualize these results, note the following. First, an increase in the over-the-counter price raises the liquidity hurdle regardless of whether the subsidy responds; so changes in upfront price in general could lead to simultaneous changes in both liquidity requirements and net price. What is unique about this setting is that the subsidy moves in tandem with the over-the-counter price, neutralizing the price effect and isolating the liquidity effect. Second, overall household income levels are important. Our study area is located in a state that has low rural household income. In contrast, using data from one of the richest states in India, Jeuland et al. (2023) estimate the price elasticity of LPG demand to be 1 among PMUY households. Third, the biomass alternatives to LPG are readily accessible in rural and semi-urban areas; hence the cost that households face to switch away from LPG temporarily may not be high.

Do the liquidity constraints driving this behavior operate mostly on the extensive or the intensive margin? That is, does it matter how long households have to part with their money before reimbursement, or does simply having to pay upfront drive the result, however fast or slow is the reimbursement? To understand this, we explore the length of the reimbursement delay as an intermediating factor. We measure delay – day of reimbursement minus day of purchase – as the median across delays for consumer transactions within a given monthXyear from BPCL (the only OMC with available delay data); see Appendix Figure A1. As shown in Appendix Table A5, purchases are generally more responsive to the over-the-counter price the *longer* the delay in reimbursement is. For example, based on Column 2 estimates both non-PMUY and PMUY households respond more negatively to a one percent increase in price by about -0.085 refills per monthly median day of delay.[30] Given a standard deviation of median delay days across months of about 2/3, a standard deviation increase in delay increases the magnitude of the price impact on PMUY households by about 19% of the impact at the mean ($(2/3) * 0.086/0.296$).

While delay is not necessarily exogenously varying, the results are suggestive that the intensive margin matters, i.e. that households are sensitive to the length of time they have to part with the expected subsidy.[31] Parting with cash for longer, even a few days, may indeed be harder.

[29]The difference could be due in part to the fact that PMUY households in the survey sample appear slightly richer than those in the larger sample.

[30]Specifically, the estimated response in refills purchase to a one percent price increase is $-0.023 - 0.084 * Delay$ for non-PMUY and $-0.296 - 0.086 * Delay$ for PMUY, where $Delay$ is demeaned. Thus the effect at mean delay is close to zero for non-PMUY and about -0.3 for PMUY.

[31]Drawing conclusions about the extensive margin from these results would require extrapolation well outside the range of the data.

6.2 Impact of LPG refill price on solid fuel expenditure

Solid fuels, particularly firewood and dung, are regularly used for cooking in rural India. A major part of the motivation behind the LPG subsidy policy and the PMUY program is precisely to discourage solid fuel usage because of its negative health and pollution externalities (Barua and Agarwalla, 2018; Kar et al., 2019) and to encourage energy transition to a clean fuel. In our survey data, although 70% of households have an LPG account, 75% report using either firewood or dung for cooking in the previous month. Since solid fuels and LPG are substitutes, an increase in the LPG over-the-counter price that lowers LPG purchases is likely to affect solid fuel usage.[32]

We use two measures of household expenditure on solid fuels - explicit and implicit. Rural households often collect (e.g. firewood) or make (e.g. cow dung cakes) solid fuels themselves, in addition to buying them on the market. Explicit firewood and dung expenditure per month by the household is reported in the survey, as is the time spent on solid fuel collection. "Implicit" expenditure is constructed by multiplying the total number of hours the household spent collecting/making the solid fuel in a typical week (in the previous month) by four and by the minimum hourly wage in MP for unskilled labor (i.e., INR 35 per hour x hours spent on fuel collection/making per week x 4) to get a monthly estimate of the implicit expense on solid fuels.

Table 5 shows the effect of an increase in over-the-counter price on explicit (Columns 1-2), implicit (Columns 3-4) and total (explicit + implicit, Columns 5-6) monthly solid fuel expenditure by the household. The results document substitution toward solid fuels when the LPG over-the-counter price or subsidy rises. This is true for both explicit and implicit expenditure for all households, but especially for PMUY (i.e. the poorer) households. A ten percent increase in the over-the-counter price leads to INR 25 more explicit expenditure (12% of the unconditional mean) and INR 163 more implicit expenditure (15% of the unconditional mean) for PMUY households. Including year fixed effects, which is not preferred due to having only five months, leads to noisier but qualitatively similar results (see Appendix Table A21). Thus, upfront price increases with the net-of-subsidy price held fixed impact substantially not only LPG purchases but also usage of solid fuels that the program is seeking to discourage.

6.3 Robustness

Our results are robust to a host of checks. First, to address concerns regarding the potential endogeneity of the domestic LPG price, we run 2SLS estimation using 1-month lags of the international LPG price as an instrument for the over-the-counter price (and cash-back subsidy). Our results are virtually unchanged for both the administrative data (Appendix Table A6) and the household survey data (Appendix Table A7) analyses. Second, we alternatively cluster-bootstrap the standard errors at the LPG market level (26 markets), instead of market-month as in our standard analysis, and show that our findings do not change in Appendix Table A8 (administrative data) and Appendix Table A9 (household survey data).

[32] We asked the household primary cook to list all the fuels used in preparing the last meal. More than half of the households reported using solid fuels exclusively, even though more than two-thirds had LPG connections. Only 29% of households report using LPG exclusively in preparing the last meal.

Finally, our results are robust to an alternative model of Poisson pseudo-maximum likelihood estimation (Appendix Table A10). We also recode consumer refills as missing (instead of 0 as in our main analysis) in months where the consumer had not yet obtained an LPG account, and rerun our analysis with an unbalanced panel in Appendix B. The results are qualitatively unchanged, though magnitudes decline somewhat.

To summarize, our results so far indicate that poor households are extremely sensitive to increases in the market price of LPG despite a public subsidy program that holds the subsidized price essentially constant. We hypothesize that the take-up of this clean cooking fuel is adversely affected due to liquidity constraints faced by low-income households.

7 Impact on health

In this section, we focus on the health rationale for the LPG subsidy program.[33] While an overarching objective of the LPG subsidy program is to protect consumers from increases in the price of LPG, our analysis shows that the program falls short of achieving this goal. Poor consumers are less likely to purchase LPG at higher prices and switch instead to biomass-based solid fuels. Burning solid fuels, in turn, increases indoor air pollution and thus leads to adverse health effects, especially for young children and pregnant women. What are the health consequences of households' sensitivity to LPG price fluctuations despite the active subsidy program?

Relevant data are available from the Demographic and Health Survey or the National Family Health Survey (2019-21) of India, summarized in Appendix Table A11 for the entire country. Combining this with our administrative data on LPG refill prices, we estimate the effects of over-the-counter prices of LPG on infant and child health, using Equation 3:

$$Y_{it}^{ds} = \alpha + \beta Price_{it} + \mu Child_i + \gamma_d + \delta_{m(t)} + \tau_{y(t)} + \phi_s * t + \epsilon_{it}^{ds} \ . \tag{3}$$

For our infant health analysis, Y_{it}^{ds} denotes the birth weight (in kilograms) of infant i, born in district d, state s, and conceived at time (monthXyear) t. The sample includes pregnancies conceived within one year prior to the DHS interview date. $Price_{it}$ in the infant health analysis is the log of the average over-the-counter LPG refill price during the mother's gestation period (including less than full-term pregnancies) for birth i.[34] For the child (under 5 years of age) health analysis, Y_{it}^{ds} denotes the other two main outcomes of interest – an indicator variable that equals 1 if there is an incidence of (1) cough and (2) rapid breathing during the previous two weeks in child i in district d, state s, interviewed at time (monthXyear) t. $Price_{it}$ for child health outcomes denotes the log of over-the-counter LPG price at the time of the survey interview. We include infant- or child-specific characteristics along with

[33] There are several rationales for providing LPG subsidies, including to reduce indoor pollution (Gould et al., 2024) and the resulting health burden, and to save time spent on using, collecting or making solid fuels (Afridi et al., 2023).

[34] We do not have refill price data for all districts of India. Instead, we impute our refill prices from the district of Indore (rural and urban) to all districts in our India-wide health analysis here. There are negligible differences in LPG price levels across districts, and marginal changes in prices occur more or less in tandem across India (Appendix Figure A3). The alternative strategy of restricting the DHS sample to only MP, Indore's state, would result in a very small sample.

mother and household controls in $Child_i$ (e.g. gender, birth order, whether child is part of a multiple birth, quadratics in age of child (for child health outcomes) and age of mother, mother's education, religion, and caste), as well as district-level unobservables (γ_d), seasonal and year effects ($\delta_{m(t)}, \tau_{y(t)}$), and state-specific linear time trends. The error term is captured by ϵ_{it}^{ds} and is clustered by time (of conception for infant weight outcomes, of interview for child outcomes). We report standard p-values of the estimates and p-values after correcting for multiple hypothesis testing for all the outcomes and samples.

Identification comes from quasi-random variation in the price of LPG over different gestational periods in the infant health case, and across different interview times in the child health case.

Columns 1 and 2 (Panel A) in Table 6 show the effect on birth weight of the over-the-counter refill price (or subsidy), in log terms after averaging over the gestation period. Though not quite significant at conventional levels, a 10% increase in the over-the-counter LPG refill price during gestation is associated with a 44 gram reduction in infant birth weight, 1.6% of the mean.

The more immediate effects of LPG price increases on child health are seen in Columns 3-6 (Panel A) of Table 6. A 10% increase in the over-the-counter LPG refill price is associated with a 0.85 percentage point increase in the likelihood of reported coughing during the previous two weeks (7% of the mean) and a 1.01 percentage point increase in the likelihood of reported rapid breathing (16% of the mean) among children under five (Columns 3 and 5, respectively). Table 6 further suggests that these results are stronger for rural households (Panel B), especially for the rapid breathing outcome, consistent with our main results.

Results are weaker but similar when we run household weighted regression analysis, as shown in Appendix Table A12. They are also mostly robust to cluster-bootstrapping the standard errors, as shown in Appendix Table A13, which may be preferred given the small number of month-year clusters for 'cough' and 'rapid breathing' outcomes.[35] Furthermore, we run a falsification exercise to rule out spurious findings by analyzing the effect of LPG refill prices on child height-for-age and weight-for-age Z-scores, outcomes that are less likely to be significantly impacted by contemporaneous exposure to smoke inhalation. We find no detectable effects, as reported in Appendix Table A14.

Overall, our estimated health effects are substantial, and likely a lower bound for the impacts on LPG-using low-income households.[36] These findings are unsurprising given our earlier results that higher upfront LPG prices, with the subsidized price held fixed, decrease LPG purchases and push households to more household-polluting cooking fuel. Further, they demonstrate that these liquidity effects on consumption can have real health consequences.

We turn next to further evidence that this responsiveness to LPG gross price with net price fixed is due to liquidity constraints.

[35] We have only 18 clusters for month-year of interview in the DHS sample.

[36] The DHS does not provide information on households' LPG usage, PMUY status, or income/expenditure. Thus, we cannot condition the DHS sample on whether the household uses LPG.

8 Mechanism - Liquidity constraints

In this Section, we bolster the liquidity interpretation of our results by showing robustness to alternative measures and sources of liquidity, including direct evidence from exogenous weather shocks, and by ruling out alternative non-liquidity based explanations. This increases confidence that the sensitivity of poor households to fluctuations in LPG prices despite the subsidy program is attributable to liquidity constraints.

8.1 Alternative Measures and Sources of Liquidity

First, given that these constraints are likely more frequently binding for poor households, we use our Survey data to test for heterogeneous impacts by alternative household proxies for wealth. Table 7 shows that the observed responsiveness to over-the-counter LPG price depends significantly on household wealth, measured along multiple dimensions: an asset index (Columns 1 and 2), a dummy for belonging to General or upper caste category (0 if SC/ST or OBC) (Columns 3 and 4), and a dummy for household head being a casual laborer (Columns 5 and 6).

The negative impact of higher over-the-counter LPG prices on refill purchases is significantly larger for households with lower asset holdings, as shown in Column 1 of Table 7. A two standard-deviation increase in the asset index (about 1.5, see Table 2) lowers the impact magnitude by 60% of the mean effect. This pattern suggests that poorer households are more price-sensitive, likely due to greater liquidity constraints. Appendix Table A15 breaks down the analysis by asset quartiles. We find consistent results, i.e. the observed effect is significantly higher for households with below median assets and in the lower asset quartiles.

Furthermore, LPG refill purchases by higher caste (i.e., general caste) households, who are economically better-off on average, decline less when the over-the-counter price rises than do purchases of lower caste households (i.e. SC, ST or OBC), as shown by the interaction term in Columns 3 and 4 in Table 7 (p-value$<$0.10).

Finally, households that are engaged in more precarious sources of livelihood, e.g. daily wage earners from casual labor, are also likely to be poorer and experience more frequently binding liquidity constraints. The estimated coefficients in Column 5 therefore support the liquidity interpretation, as the negative interaction coefficient (p-value$<$0.10) implies that casual laborers' LPG refill purchases are more responsive to the over-the-counter price.

As Appendix Table A2 shows, the PMUY program with its one-time start-up subsidy to obtain an LPG account effectively targeted less well-off households, by the measures used here (Table 7). Our results thus indicate that lower-wealth households, proxied by a number of measures, differentially reduce take-up of LPG in response to increases in the over-the-counter price, even though the LPG net price is held fixed. These impacts are interpretable as a consequence of the trade-off these households face between the cost and inconvenience of using solid fuel and/or cooking less, and paying the upfront though soon-to-be reimbursed higher cost of the more convenient, clean cooking gas.

Second, we construct a direct measure of household liquidity – cash-on-hand in a month – to test whether households with higher monthly cash on hand are less affected by an increase in the over-the-counter refill price. Using the information on monthly income and expenditure in the PLFS for rural India (see Section 4.3), our constructed measure of household liquidity

provides a proxy for mean cash-on-hand (income minus expenditure) at the caste-occupation-month level.[37] These measures are merged into the household Survey data by matching cash-on-hand to household at the caste-occupation-month level. Table 8 shows the association of our measure of log monthly cash-on-hand and its interaction with log over-the-counter price, with monthly refill purchases of rural households in our Sample between November 2017 to December 2019. (See Table A3 for summary statistics.) Unsurprisingly, more cash on hand is associated with higher LPG refill purchases (Column 1). The coefficients on over-the-counter price remain negative across all specifications (Columns 2 and 3). Importantly, the positive coefficient on the interaction of over-the-counter price with cash on hand (Column 3) indicates that more cash on hand significantly attenuates the negative effect of an over-the-counter price increase on LPG purchases, consistent with liquidity constraints driving the observed behavior.

Third, we analyze a plausibly exogenous driver of liquidity: favorable rainfall during the agricultural sowing season. High rainfall during a sowing season results in better crop yields and therefore generally greater liquidity during the associated harvest season. Thus if liquidity constraints drive the results, good growing season rainfall should attenuate the negative effect of price on refill purchases in the harvest season.

To test this mechanism, we examine how refill behavior during harvest months responds to LPG prices, conditional on rainfall conditions in the preceding sowing season. The two main crops in Indore are soy (a Kharif crop) and wheat (a Rabi crop). Soy is sown during the monsoon (June–September) and harvested in October–December, while wheat is sown in the winter (October–January) and harvested in February–April. We restrict the analysis to harvest-season months (February–April and October–December) and define a High_Rain_Harvest indicator that equals 1 if any month in the preceding sowing season received normal, excess, or large excess rainfall, based on IMD classifications; 57% of harvest months are coded as High_Rain (Indore District Website.; ICRISAT).[38]

Results in Table 9 show that while for non-PMUY households the expected greater sensitivity of LPG refill purchases to price after low rainfall does not hold, it does for the PMUY (i.e., low-income) households, who are more likely to face binding liquidity constraints. For them, differential and total purchases are much less sensitive to changes in over-the-counter prices after good rainfall. In the full-sample specification controlling for year FE (Column 2, Panel A), a 1% increase in the over-the-counter price leads PMUY households to purchase 0.00402 fewer LPG refills in harvest months after good rainfall but 0.00964 fewer after bad rainfall. Compared to non-PMUY households, they respond more negatively to a 1% price increase by 0.00304 refills after good rainfall but 0.0124 after bad rainfall, four times as much. The results suggest that better rainfall during the sowing season, by boosting liq-

[37] We use 4 occupation categories (salaried, self-employed on-farm, self-employed off-farm and casual labor) and 4 caste groups (SC, ST, OBC and General or higher-caste categories). Ideally we would construct this measure for each household in our Survey, but the needed income and expenditure data are not available. The monthly variation in our PLFS measure of household liquidity aligns with the harvest cycle of the three major crops grown in Indore - wheat, chickpea and soy. As depicted in Figure A2, average cash on hand for rural households exhibits peaks during the harvest months for wheat and chickpea (Feb - May), and soy (Oct - Dec).

[38] The IMD (India Meteorological Department) categorizes rainfall in each month relative to long-period averages for each district. Rainfall $\geq 60\%$ is classified as 'Large Excess', 20% to 59% as 'Excess', -19% to $+19\%$ as 'Normal', -59% to -20% as 'Deficient', and -99% to -60% as 'Large Deficient'. Source: IMD.

uidity, mitigates the adverse impact of higher LPG prices on refill consumption for PMUY households during the harvest season.

Since rainfall shocks tend to exogenously shift liquidity, these results provide helpful evidence in favor of our liquidity interpretation.[39] Caveats are the limited power in restricting the sample only to harvest months (14/26 months) and that high rainfall is seasonal (perfectly correlated in our sample with Kharif crops).

8.2 Alternative non-liquidity explanations

In this section, we assess and rule out mechanisms other than liquidity constraints that could explain our results on sensitivity to price.

8.2.1 Macro-level factors – General inflation and unemployment

Increases in the LPG price may be causing, or symptomatic of, a general increase in prices. Inflation could lower households' real wealth, leading them to reduce consumption of LPG by cooking less and/or substituting toward biomass-based solid fuels; such real impacts are likely regressive, affecting poorer households more. Indeed, in the theory, even without liquidity constraints, LPG purchases fall with a drop in wealth past some likely low threshold (Section 3). Appendix Table A16 shows the correlation of domestic LPG refill price with each component of the Consumer Price Index (CPI) in our study period. Other than a marginally significant coefficient ($p<0.10$) on the 'Fuel and Light' Price Index, all other components (including overall CPI) are uncorrelated with the changes in the over-the-counter price of LPG refill. Thus LPG price changes do not appear to be simply proxying for overall inflation. Further, since our data capture high frequency, generally small variations in the LPG refill price (standard deviation of INR 62.45 per refill during our study period), LPG price fluctuations are unlikely to be causing inflationary trends. We thus rule out the story that price changes actually proxy for general inflation-based wealth effects as an explanation of our results.

A slightly different macroeconomic explanation for our results could be that the international price of gas acts as a supply shock that affects real macroeconomic activity, and thus households' economic prospects. This would again lead to LPG purchases responding to the LPG price via a wealth effect rather than a price or liquidity effect. However, this seems *a priori* unlikely, since the Indian macroeconomy is not generally significantly impacted by the international LPG price, and the price changes in our data are moderate. To further cast doubt on this story, we control for the monthly unemployment rate in the specification used for our main results (Table 3). As shown in Appendix Table A20, the effects of over-the-counter price and cash-back subsidy remain very similar for PMUY households after controlling for the monthly unemployment rate.

[39] Rainfall can also affect wealth or net worth at harvest, but absent liquidity constraints, a wealth shock should not alter the effect of over-the-counter price on purchases, since the net-of-subsidy price is held fixed.

8.2.2 Subsidy salience

A potential alternative explanation for the observed effects of over-the-counter refill price is subsidy salience. If households are not fully aware of the subsidy and the fact that net-of-subsidy price is held constant, their response may be due to a pure price effect rather than a liquidity effect. Afridi et al. (2021) find a 13% increase in the monthly demand for LPG refills when information on the refill subsidy is bundled with improving awareness of the adverse health effects of using solid fuels. Chetty et al. (2009) show that the grocery demand goes down by 8% when tax-inclusive prices are displayed. In our setting, lack of salience of the rebate could lead consumers to mistakenly respond to over-the-counter price changes as if the net-of-subsidy price is also changing.

We explore this alternative explanation using survey data on households' understanding of the LPG subsidy program. Household knowledge is measured using self-reported responses to five statements about the program in the second round of household survey (October - December 2019). The household was asked to agree or disagree with each statement, some of which were true and others false in random order.[40] The variable for each statement is coded 1 iff the respondent correctly responds to the statement; thus each variable is an indicator of the household having accurate knowledge of the LPG subsidy program. Appendix Table A17 shows estimates of heterogeneous price impacts by each household knowledge indicator. We find no significant difference in effect of over-the-counter price based on different knowledge of the program for non-PMUY and PMUY households, with one exception: non-PMUY households who state they believe the subsidy is only for PMUY households are more responsive to over-the-counter price than those who state that the subsidy is for all. However, these results offer no supporting evidence that subsidy salience is driving our main results.

8.2.3 Trust in government

A related possible explanation of our findings is that households do not trust the government to transfer the cash-back subsidy into their bank accounts after they purchase the LPG refill. Consequently, they respond to the market price rather than the effective post-subsidy price, or at least to a probability-weighted average of the two. Our observed results could then be interpreted as a price effect rather than a liquidity effect.

A priori this seems unlikely: the DBT scheme was implemented across the country much before our study period, in 2014, while the PMUY program began in 2016. The fact that the government was indeed depositing the subsidy into consumers' bank accounts was well-acknowledged.

Nevertheless, we address this issue in two ways. First, we directly asked our survey households (at baseline) whether they trusted information provided by the government-appointed accredited social health activist (ASHA) of their village; about 83% respond affirmatively.

[40] The survey collects self-reported information on respondents' knowledge of the program. Conditional on having an LPG account, about 33% of respondents did not agree with the statement that the government deposits a subsidy in their bank account after they purchase an LPG cylinder, and a little over half agreed that their net out-of-pocket expenditure was less than the over-the-counter market price of an LPG refill. About 32% of respondents stated that only PMUY customers are eligible to receive the subsidy. The specific statements are listed in the notes to Appendix Table A17.

(This is a community health worker responsible for encouraging households to immunize newborns and ensure ante and post-natal care for mothers, among other health information and assistance.) We test whether the response to over-the-counter price varies by the household's reported trust in ASHA as a proxy for trust in government. There is no detectible difference based on trust for either non-PMUY or PMUY households in their responsiveness to price, as seen in Appendix Table A18. Second, we analyze a subsample of the administrative data representing relatively experienced LPG users, i.e. only households who had obtained LPG accounts by the beginning of 2017, well before the beginning of our study period (November 2017). These households are more likely to be aware of the reliability of the cash-back subsidy design, since they have had longer exposure to the historically reliable DBT scheme. If our main results are due to lack of trust in government, then our coefficients of interest should be smaller or insignificant for this sample. The estimates, however, are similar in both size and significance to those of our main results; see Appendix Table A19. Lack of trust in the government is, therefore, unlikely to be the primary mechanism.

9 Conclusion

This paper underscores the importance of the administrative design of energy subsidy programs. Policy discussions often focus primarily on the rate or amount of energy subsidies. The results presented in this paper highlight that the *method* of delivery of energy subsidies is no less policy-relevant than *how much* subsidy is delivered.

Our results show that clean fuel usage decreases and dirty, solid fuel usage increases, due to the liquidity constraints amplified by delayed transfer of the subsidy amount. The associated health and environmental externalities, especially for the women and children who spend more time indoors and near the solid-fuel cooking stoves, are likely to be significant, although our analysis is limited (by lack of data) to only two sets of health outcomes – for newborns and children. Overall, our analysis of India's cooking gas subsidy program highlights the interaction of the cash-back subsidy design with households' liquidity constraints, which is counter to the policy intent behind subsidizing clean fuel take-up of low-income households.

More broadly, our results show that the administrative design of subsidy and conditional cash transfer programs, especially the *timing* of transfers, matters. While cash transfers are replacing in-kind transfer programs across the world, it is important to understand the welfare implications of their design. India, alone, runs more than 300 public programs where the government provides cash benefits to citizens through direct bank transfers. Policy reforms aiming to improve the efficiency in welfare delivery by replacing in-kind or point-of-sale subsidies with delayed bank transfers may also impose an unintended regressive cost on households, when any time lag embedded in a cash transfer program interacts with households' liquidity constraints.

Our findings carry implications for designing subsidy transfers that soften or eliminate this tradeoff. In the context of the program we study, for example, the results suggest that the length of reimbursement delay matters, so minimizing delay subject to clean verification is an implicit recommendation. Beyond that, allowing at least the poorer consumers to use program-backed credit to purchase the good, at least the subsidized portion, could alleviate

the concerns here. Alternatively, a digital banking approach that provides electronic vouchers to be used at the point of sale can help low-income households. While these program design alternatives may come with new tradeoffs, e.g., increased cost, this paper at least illuminates the tradeoffs involved and points out directions for possible improvement. Subsidy and CCT programs should, thus, be designed with careful attention to liquidity constraints faced by low-income households.

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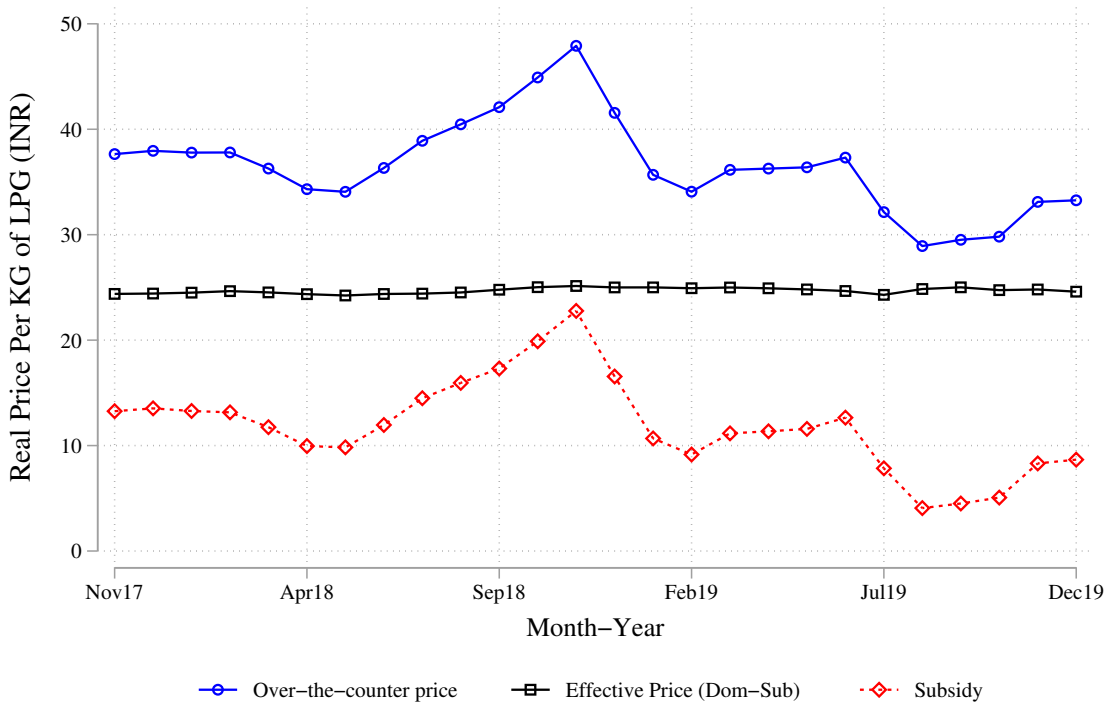
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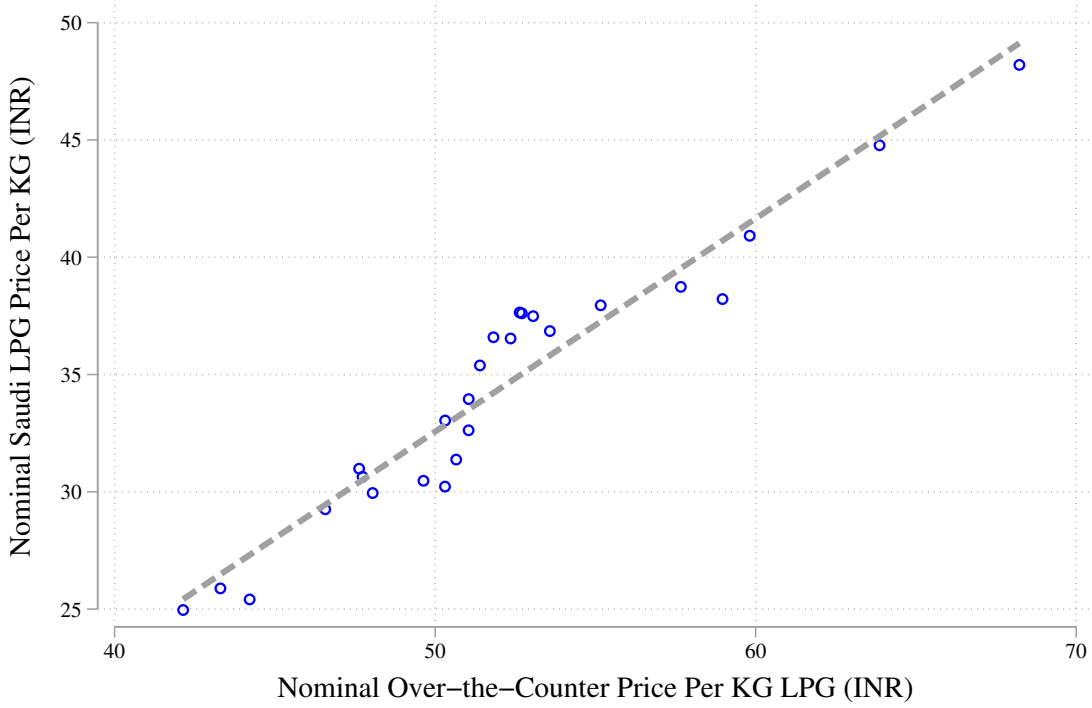
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Figure 1: Over-the-counter Price, Effective Price and Subsidy on LPG
(November 2017 - December 2019)



Notes: LPG prices obtained from the OMC administrative dataset. Over-the-counter price of LPG is the price paid by consumers upfront to purchase LPG. Effective price is over-the-counter price minus the cash-back subsidy to LPG to consumers. The cash-back subsidy floated in tandem with the over-the-counter price. The Y-axis shows all three prices in real (2012) INR for 1 kg of LPG. The X-axis shows the corresponding month, from November 2017 to December 2019 (26 months). All prices are averaged across all markets and dealers.

Figure 2: Correlation between International LPG Price and Over-the-counter Domestic LPG Price (November 2017 - December 2019)



Notes: Saudi Aramco LPG price (defined as price of butane (60%) and price of propane (40%)) obtained from here. The domestic price of LPG obtained from the OMC administrative dataset. Each observation on the Y-axis is the monthly price of Saudi Armco (lagged by 1 period). The X-axis shows the domestic price of LPG spanning 26 months from November 2017 to December 2019. All prices are in nominal INR per KG of LPG. The dashed line shows the coefficient of correlation between the lagged international price and domestic market price, which is 0.99 (p-val = 0.0004).

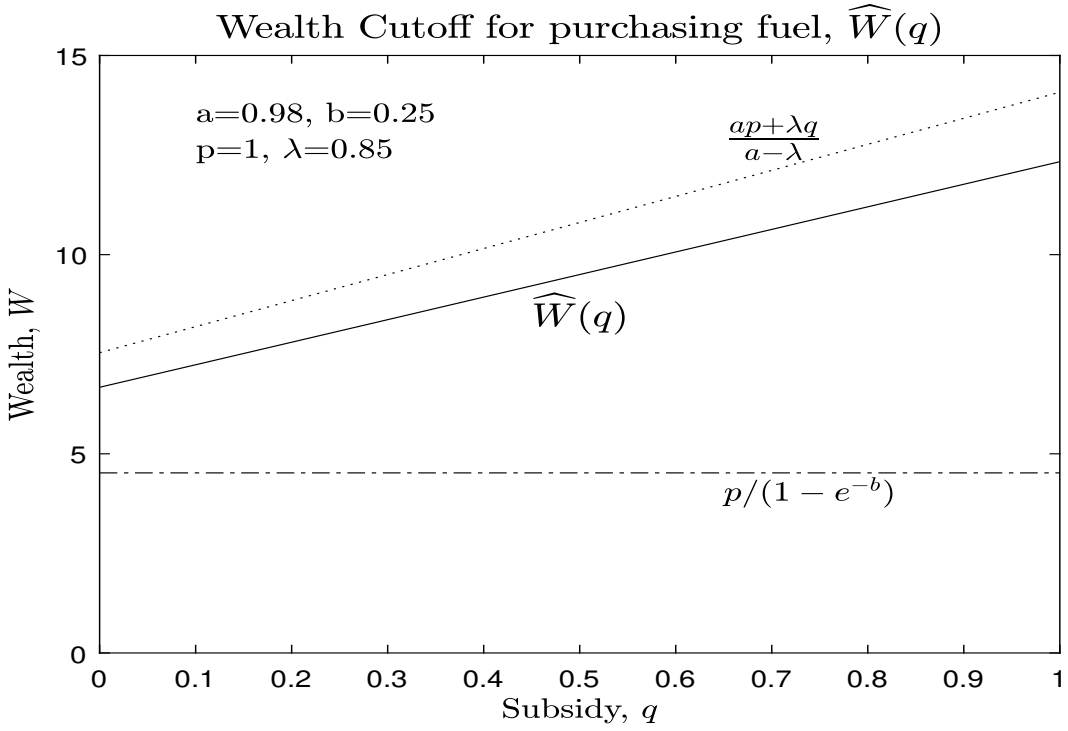


Figure 3: Households with wealth higher than $\widehat{W}(q)$ purchase fuel, while those with lower wealth do not. The wealth cutoff would be the dash-dotted line absent any liquidity constraints.

Table 1: LPG Consumer Characteristics (Administrative Data)

	Obs	Mean	SD	Minimum	Maximum
		Panel A: Attributes			
PMUY	911,454	0.074	0.262	0.000	1.000
Female	911,099	0.320	0.466	0.000	1.000
Rural	908,650	0.572	0.495	0.000	1.000
		Panel B: LPG Refills			
All	23,697,794	0.578	0.638	0.000	16.000
PMUY	1,754,298	0.252	0.495	0.000	12.000
Non-PMUY	21,943,496	0.604	0.640	0.000	16.000
Rural	13,522,165	0.576	0.643	0.000	16.000
PMUY	1,242,540	0.259	0.503	0.000	12.000
Non-PMUY	12,279,625	0.608	0.646	0.000	16.000
Urban	10,102,717	0.580	0.631	0.000	13.000
PMUY	510,276	0.235	0.475	0.000	11.000
Non-PMUY	9,592,441	0.598	0.633	0.000	13.000

Notes: This table summarizes the OMCs administrative data from Nov 2017 to Dec 2019. **Panel A** summarizes the demographics of all consumers in the district of Indore. PMUY is a dummy which equals 1 if the consumer has a PMUY LPG connection, and 0 otherwise. Female is a dummy which equals 1 if the LPG account is in the name of a woman and 0 otherwise. Rural is a dummy which equals 1 if the consumer resides in a rural area. Some observations could not be classified as female or rural, hence the total observations vary. **Panel B** summarizes LPG refill transactions from Nov 2017 to Dec 2019 overall, by rural/urban, and PMUY status of the LPG consumers.

Table 2: Household Characteristics (Survey Data)

	Obs	Mean	SD	Minimum	Maximum
	Panel A: Household Attributes (Baseline)				
PMUY	2,091	0.391	0.488	0.000	1.000
Asset Index	2,091	1.620	0.748	-0.150	3.965
General Caste	2,091	0.150	0.357	0.000	1.000
Salaried HH Head	2,091	0.106	0.308	0.000	1.000
Agri Self-Employed HH Head	2,091	0.305	0.461	0.000	1.000
Agri Casual Laborer HH Head	2,091	0.391	0.488	0.000	1.000
Land Owner	2,091	0.522	0.500	0.000	1.000
Land Owner/Leaser	2,091	0.535	0.499	0.000	1.000
HH Head Education	2,091	0.411	0.492	0.000	1.000
Latrine in HH	2,091	0.879	0.326	0.000	1.000
	Panel B: Household Solid Fuel				
Baseline & Endline					
Explicit firewood expenditure (Rs.)	4,150	56.791	282.530	0.000	6,000.000
Implicit firewood expenditure (Rs.)	4,150	543.258	833.181	0.000	4,480.000
Explicit dung expenditure (Rs.)	4,150	151.177	470.125	0.000	6,000.000
Implicit dung expenditure (Rs.)	4,150	503.106	626.538	0.000	9,800.000
	Panel C: Household Refills Matched to Admin Data				
All Refills	54,366	0.411	0.576	0.000	7.000
PMUY refills	21,268	0.285	0.505	0.000	7.000
Non-PMUY refills	33,098	0.492	0.604	0.000	6.000

Notes: **Panel A** provides information on household characteristics collected in 2018 (at baseline). Asset Index is the first component of a principal component analysis over several indicators measuring the economic status of a household including, ownership of land and farm animals, *pucca* house, and a list of consumer durables. Education of the head of the household is measured by an indicator that takes value one for above primary education and zero otherwise. General Caste is a dummy for household that is neither SC/ST nor OBC category. Salaried, Self-Employed, Casual Laborer, Land Owner, Land Owner/ Leaser are dummies equal to 1 if the household head belongs to the respective category. Latrine in HH is a dummy if the household has a pit or flush toilet built inside house. **Panel B** summarizes the explicit and implicit expenditure on firewood and dung. Implicit expenditure is calculated as total number of hours household spent collecting/making the solid fuel in a week times the minimum hourly wage in Madhya Pradesh for unskilled labor (i.e. INR 35) and then times 4 to get a monthly estimate of implicit expense on solid fuels. Explicit firewood and dung expenditure per month is reported in the survey. **Panel C** summarizes the LPG refill transactions for the sampled households over 26 months by matching them to the administrative records.

Table 3: Impact of Over-the-counter Price and Cash-back Subsidy on Monthly Refills (Administrative Data)

	(1)	(2)	(3)	(4)
Panel A: Full Sample				
Over-the-counter price	-0.091***	-0.043		
	(0.026)	(0.034)		
PMUY × Over-the-counter price	-0.349***	-0.347***		
	(0.049)	(0.053)		
Cash-back subsidy			-0.025***	-0.007
			(0.007)	(0.009)
PMUY × Cash-back subsidy			-0.110***	-0.110***
			(0.012)	(0.013)
Mean of Dependent Var.	0.578	0.578	0.578	0.578
Mean of Dependent Var. for PMUY	0.252	0.252	0.252	0.252
Mean of Dependent Var. for Non-PMUY	0.604	0.604	0.604	0.604
Observations	23,697,794	23,697,794	23,697,794	23,697,794
Panel B: Rural Sample				
Over-the-counter price	-0.098***	-0.046		
	(0.026)	(0.035)		
PMUY × Over-the-counter price	-0.374***	-0.372***		
	(0.041)	(0.046)		
Cash-back subsidy			-0.028***	-0.008
			(0.007)	(0.009)
PMUY × Cash-back subsidy			-0.116***	-0.115***
			(0.011)	(0.012)
Observations	13,522,165	13,522,165	13,522,165	13,522,165
Panel C: Urban Sample				
Over-the-counter price	-0.083***	-0.041		
	(0.026)	(0.034)		
PMUY × Over-the-counter price	-0.275***	-0.275***		
	(0.073)	(0.074)		
Cash-back subsidy			-0.023***	-0.006
			(0.007)	(0.008)
PMUY × Cash-back subsidy			-0.094***	-0.093***
			(0.018)	(0.018)
Observations	10,102,717	10,102,717	10,102,717	10,102,717
Month FE	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes
Household FE	Yes	Yes	Yes	Yes

Notes: This table shows the impact on monthly refills of changes in log of "Over-the-counter price" – the price paid upfront per kg of LPG – and log of "Cash-back subsidy" – the subsidy per kg of LPG that the consumers get back after purchase – using the OMC administrative data. Panel A shows the estimates for the full sample, Panel B for the rural sub-sample, and Panel C for the urban sub-sample. The dependent variable is the total monthly purchases of 14.2 kg LPG cylinder refills. The unit of observation is consumer-month-year, leading to a total of 23.7 million observations, corresponding to monthly refills for 26 months of the 911,454 unique included consumers. Refill is coded zero if the consumer does not have a gas connection or did not purchase in a given month. PMUY is a dummy that equals 1 if the consumer has a PMUY connection, 0 if it's a regular gas connection. Standard errors, clustered at the market-month-year level (676 clusters in Full Sample), reported in parentheses. Significance at * 10%, ** 5% and *** 1% level. The sum of the coefficient for price or subsidy and of the coefficient for its interaction with PMUY is significant at 1% in every specification.

Table 4: Impact of Over-the-counter Price and Cash-back Subsidy on Monthly Refills (Survey Data)

	(1)	(2)	(3)	(4)
Over-the-counter price	-0.172***	-0.082**		
	(0.033)	(0.041)		
PMUY × Over-the-counter price	-0.255***	-0.254***		
	(0.051)	(0.051)		
Cash-back subsidy			-0.046***	-0.015
			(0.010)	(0.012)
PMUY × Cash-back subsidy			-0.079***	-0.078***
			(0.016)	(0.016)
Mean of Dependent Var.	0.411	0.411	0.411	0.411
Mean of Dependent Var. for PMUY	0.285	0.285	0.285	0.285
Mean of Dependent Var. for Non-PMUY	0.492	0.492	0.492	0.492
Observations	54,366	54,366	54,366	54,366
Month FE	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes
Household FE	Yes	Yes	Yes	Yes

Notes: This table shows the impact on monthly refills of changes in log of "Over-the-counter price" – the price paid upfront per kg of LPG – and log of "Cash-back subsidy" – the subsidy per kg of LPG that the consumers get back after purchase – using the household survey data. The dependent variable is the total monthly purchases of 14.2 kg LPG cylinder refills. The unit of observation is household-month-year, leading to a total of 54,366 observations, corresponding to monthly refills for 26 months of the 2091 unique included consumers. Refill is coded zero if the consumer does not have a gas connection or did not purchase in a given month. PMUY is a dummy that equals 1 if the consumer has a PMUY connection, 0 if it's a regular gas connection. Standard errors, clustered at the market-month-year level (598 total clusters), reported in parentheses. Significance at * 10%, ** 5% and *** 1% level. The sum of the coefficient for price or subsidy and of the coefficient for its interaction with PMUY is significant at 1% in every specification.

Table 5: Impact of Over-the-counter Price and Cash-back Subsidy on Solid Fuel Expenditure (Survey Data)

	Explicit Expenditure		Implicit Expenditure		Total Expenditure	
	(1)	(2)	(3)	(4)	(5)	(6)
Over-the-counter price	78.088**		706.871***		784.959***	
	(34.149)		(80.369)		(89.208)	
PMUY × Over-the-counter price	181.004**		1,002.342***		1,183.346***	
	(86.126)		(140.107)		(184.085)	
Cash-back subsidy		25.145**		230.826***		255.971***
		(10.659)		(21.657)		(23.465)
PMUY × Cash-back subsidy		58.804**		329.690***		388.494***
		(28.121)		(46.411)		(60.514)
Mean of Dependent Var.	208.975	208.975	1,047.526	1,047.526	1,256.501	1,256.501
Observations	4,118	4,118	4,118	4,118	4,118	4,118
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No

Notes: This table shows the impact on monthly expenditure on solid fuels of changes in log of over-the-counter price and log of cash-back subsidy using the survey data. "Over-the-counter price" is the log of the price paid upfront per kg of LPG. "Cash-back subsidy" is the log of the subsidy per kg of LPG that the consumers get back after purchase. Dependent variable in columns 1 and 2 is the explicit expenditure on solid fuel, which is the amount the household reports to have spent out-of-pocket on firewood and dung (combined) in the previous month. Dependent variable in columns 3 and 4 is the implicit expenditure on solid fuel which is defined as number of times person responsible in a households went to collect solid fuel (firewood and dung) in the previous month multiplied by number of hours spent in collection multiplied by the hourly wage of INR 35, to get implicit expenditure per month. Columns 5 and 6 show the impact on the sum of implicit and explicit expenditure on solid fuel. All specifications include month and household fixed effects. Unit of observation is consumer-month-year. In the survey, each household is asked information on solid fuel collection for only one month, hence, this dataset is a panel of 2-month observations (baseline survey in 2018 and endline survey in 2019) for each LPG-using household. PMUY is a dummy, which is 1 if the consumer has a PMUY connection and 0 if it's a regular gas connection. Standard errors, clustered at the market-month-year level are reported in parentheses. Significant at * 10%, ** 5% and ***1% level.

Table 6: Impact of Over-the-counter Price and Cash-back Subsidy on Birth and Post-birth Child Health Outcomes

	Birth Weight		Cough		Rapid Breathing	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Full Sample						
Over-the-counter price	-0.463		0.089*		0.106**	
	(0.333)		(0.044)		(0.040)	
Cash-back subsidy		-0.021		0.005		0.029***
		(0.026)		(0.010)		(0.005)
Mean of Dependent Var.	2.784	2.784	0.129	0.129	0.065	0.065
Observations	16,801	16,801	223,764	223,764	223,862	223,862
FDR-adjusted p-value	[0.102]	[0.65]	[0.066]	[0.65]	[0.057]	[0.001]
Panel B: Rural Sample						
Over-the-counter price	-0.497		0.085		0.135**	
	(0.323)		(0.054)		(0.056)	
Cash-back subsidy		-0.025		0.005		0.030***
		(0.027)		(0.010)		(0.009)
Mean of Dependent Var.	2.780	2.780	0.130	0.130	0.066	0.066
Observations	13,566	13,566	177,951	177,951	178,035	178,035
FDR-adjusted p-value	[0.099]	[0.557]	[0.099]	[0.677]	[0.094]	[0.015]
Panel C: Urban Sample						
Over-the-counter price	-0.479		0.083		0.081**	
	(0.574)		(0.070)		(0.038)	
Cash-back subsidy		-0.013		-0.003		0.054**
		(0.040)		(0.029)		(0.019)
Mean of Dependent Var.	2.800	2.800	0.124	0.124	0.059	0.059
Observations	3,235	3,235	45,813	45,813	45,827	45,827
FDR-adjusted p-value	[0.379]	[1]	[0.339]	[1]	[0.164]	[0.035]
Mother and Child Controls	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State × Month-Year Trend	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the impact of changes in log of over-the-counter LPG price and log of cash-back subsidy on child health outcomes. Over-the-counter prices and Cash-back subsidy is from the administrative dataset for BPCL Indore (June 2018 - May 2021); health outcomes from the Demographic and Health Survey (DHS) Round 5, 2019-21 (previous 12 months is the reference period for interviews conducted during June 2019 to May 2021) for both rural and urban sample. 'Birth Weight' is weight at birth measured in kilograms. LPG price and subsidy for birth weight is the average price and subsidy during the gestation period, with the sample restricted to births whose conception was within a year prior to the DHS survey (pregnancies conceived from June 2018 to Dec 2020). Gestational length includes both month of conception and month of birth/outcome. 'Cough' is a dummy that equals 1 if the child (under 5 years of age) has been ill with cough in last two weeks and 'Rapid breathing' equals 1 if the child (under 5 years of age) suffered from rapid breathing in last two weeks. LPG price and subsidy for cough and rapid breathing is as of the month of the interview. Time controls correspond to conception month-year of child in columns 1 and 2 and interview month-year of household in columns 3 - 6. Child controls include gender, whether the child is part of a multiple birth and birth order of the child. For cough and rapid breathing, age of child (and age squared) are additional controls. Mother controls include mother's age at birth (including age squared), mother's education level, if household is located in rural/urban area, religion, caste and wealth index. State x Month-Year trend is 'i.state x c.month-year' of conception/interview. p-values of coefficients reported for Multiple Hypothesis Testing using the Anderson's sharpened q-values to control for the false discovery rate. Standard errors clustered at month-year of conception in columns 1 and 2 and at month-year of interview in columns 3 - 6. Significant at * 10%, ** 5% and ***1% level.

Table 7: Impact of Over-the-counter Price on Monthly Refills: Heterogeneity by Household Attributes (Survey Data)

	Z					
	Asset Index		General Caste		Casual Laborer	
	(1)	(2)	(3)	(4)	(5)	(6)
Over-the-counter price	-0.300***		-0.197***		-0.152***	
	(0.057)		(0.036)		(0.038)	
Over-the-counter price × Z	0.073***		0.103*		-0.076*	
	(0.026)		(0.058)		(0.039)	
Cash-back subsidy		-0.079***		-0.049***		-0.037***
		(0.018)		(0.011)		(0.012)
Cash-back subsidy × Z		0.021***		0.031*		-0.019
		(0.008)		(0.018)		(0.012)
Mean of Dependent Var.	0.411	0.411	0.411	0.411	0.411	0.411
Observations	54,366	54,366	54,366	54,366	54,366	54,366
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the impact on monthly refills of changes in log of over-the-counter price and log of cash-back subsidy interacted with household attributes at baseline using the survey data. "Over-the-counter price" is the log of the price paid upfront per kg of LPG. "Cash-back subsidy" is the log of the subsidy per kg of LPG that the consumers get back after purchase. The dependent variable is refills, which is the total monthly refills of a 14.2 kg LPG cylinder. Each estimate comes from a separate regression. Columns 1 - 2 show the impact on refills of changes in the log of over-the-counter price and cash-back subsidy interacted with the asset index. Columns 3 - 4 show the impact on refills of changes in log of over-the-counter price and cash-back subsidy interacted with a dummy indicating whether household belongs to general (upper) caste. Columns 5 - 6 show the impact on refills of changes in log of over-the-counter price and cash-back subsidy interacted with a dummy indicating whether household head is a casual laborer. Unit of observation is household-month-year, leading to a total of 54,366 observations, corresponding to monthly refills for 26 months of the 2091 unique consumers. Refill is coded zero if the consumer does not have a gas connection or did not purchase in a given month. All specifications include month, year and household fixed effects. PMUY is a dummy which is 1 if the consumer has a PMUY connection, 0 if it's a regular gas connection. Standard errors, clustered at the market-month-year level, reported in parentheses. Significant at * 10%, ** 5% and ***1% level.

Table 8: Impact of Over-the-counter Price and Cash on Hand (COH) on Monthly Refills (Survey Data)

	(1)	(2)	(3)	(4)	(5)
COH	0.088***	0.088***	0.088***	0.088***	0.088***
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
Over-the-counter price		-0.231***	-0.235***		
		(0.016)	(0.011)		
Over-the-counter price × COH			0.097***		
			(0.011)		
Cash-back subsidy				-0.067***	-0.067***
				(0.004)	(0.003)
Cash-back subsidy × COH					0.014
					(0.008)
Mean of Dependent Var.	0.409	0.409	0.409	0.409	0.409
Observations	49,192	49,192	49,192	49,192	49,192
Month FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the impact on monthly refills of changes in cash on hand (COH) and log of over-the-counter price and log of cash-back subsidy using the survey data. COH is constructed from 3 rounds of the Periodic Labor Force Survey (PLFS), 2017-18, 2018-19 and 2019-20. We average the COH data at the occupation-caste-month-year level; with 26 months, 4 occupations and 4 caste groups, this gives 416 COH values. We merge COH into the RCT Survey household data by matching on the same caste–occupation–month. This matching drops about 9% of household–month observations that cannot be assigned a valid caste × occupation cell in the RCT or cannot be matched to a corresponding PLFS cell for that month. "Over-the-counter price" is the log of the price paid upfront per kg of LPG. "Cash-back subsidy" is the log of the subsidy per kg of LPG that the consumers get back after purchase. The dependent variable is refills, which is the total monthly refills of a 14.2 kg LPG cylinder. Standard errors, clustered at the month-year level, are reported in parentheses. Significant at * 10%, ** 5% and ***1% level.

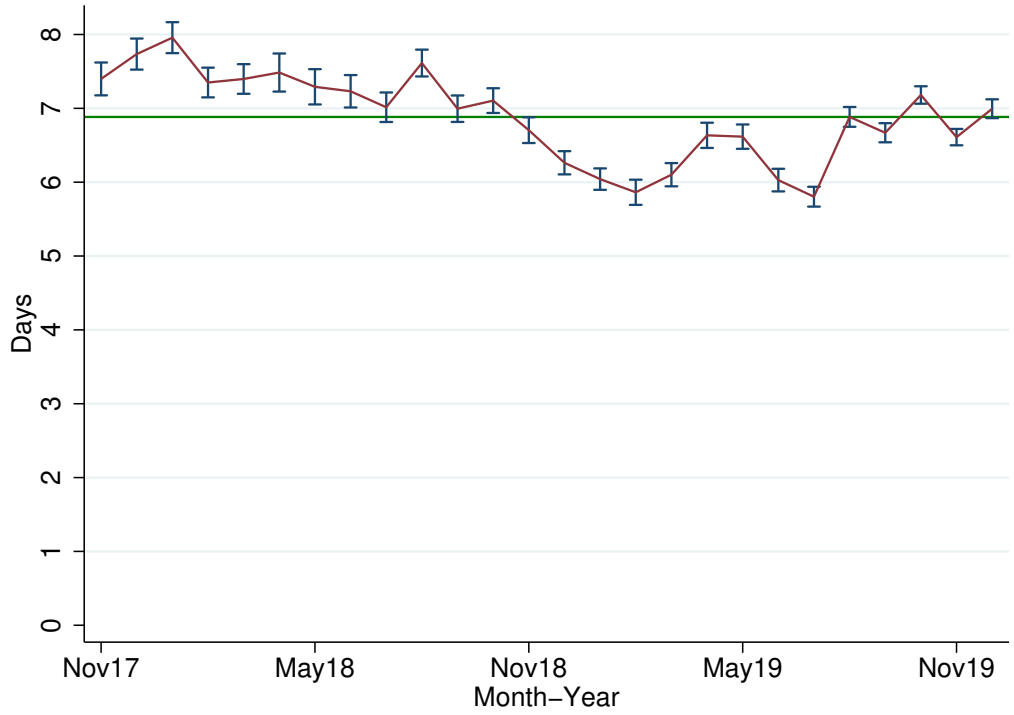
Table 9: Effect of High Rainfall in Sowing Season on Harvest Season Refills

	(1)	(2)
Panel A: Full Sample		
Price	0.025	0.276*
	(0.167)	(0.149)
PMUY × Price	-1.235***	-1.240***
	(0.211)	(0.254)
High Rain Harvest=1 × Price	-0.157	-0.374**
	(0.172)	(0.186)
PMUY × High Rain Harvest=1 × Price	0.929***	0.936***
	(0.221)	(0.265)
Mean of Dependent Var.	0.586	0.586
Mean of Dependent Var. for PMUY	0.243	0.243
Mean of Dependent Var. for Non-PMUY	0.613	0.613
Observations	12,760,353	12,760,353
Panel B: Rural Sample		
Price	0.043	0.293*
	(0.179)	(0.154)
PMUY × Price	-1.227***	-1.232***
	(0.172)	(0.201)
High Rain Harvest=1 × Price	-0.184	-0.392**
	(0.183)	(0.191)
PMUY × High Rain Harvest=1 × Price	0.901***	0.908***
	(0.181)	(0.211)
Observations	7,281,167	7,281,167
Panel C: Urban Sample		
Price	-0.001	0.253*
	(0.156)	(0.146)
PMUY × Price	-1.253***	-1.257***
	(0.428)	(0.451)
High Rain Harvest=1 × Price	-0.120	-0.350*
	(0.160)	(0.182)
PMUY × High Rain Harvest=1 × Price	1.010**	1.014**
	(0.439)	(0.462)
Observations	5,439,925	5,439,925
Month FE	Yes	Yes
Year FE	No	Yes
Household FE	Yes	Yes

Notes: This table estimates the effect of high rainfall in the sowing season on harvest season refill consumption. The sowing season for Rabi (winter) crops is Oct-Jan, and the corresponding harvest season is Feb-Apr. The sowing season for Kharif (monsoon) crops is Jun-Sep, and the corresponding harvest season is Oct-Dec. The sample is restricted to harvest months (Feb-Apr & Oct-Dec). "High_Rain_Harvest" = 1 for each harvest season if the preceding sowing season experienced normal, excess or large excess rainfall. "PMUY" and (Over-the-counter) "Price" are defined as in Table 3. Standard errors, clustered at the market-month-year level, reported in parentheses. Significant at * 10%, ** 5% and ***1% level.

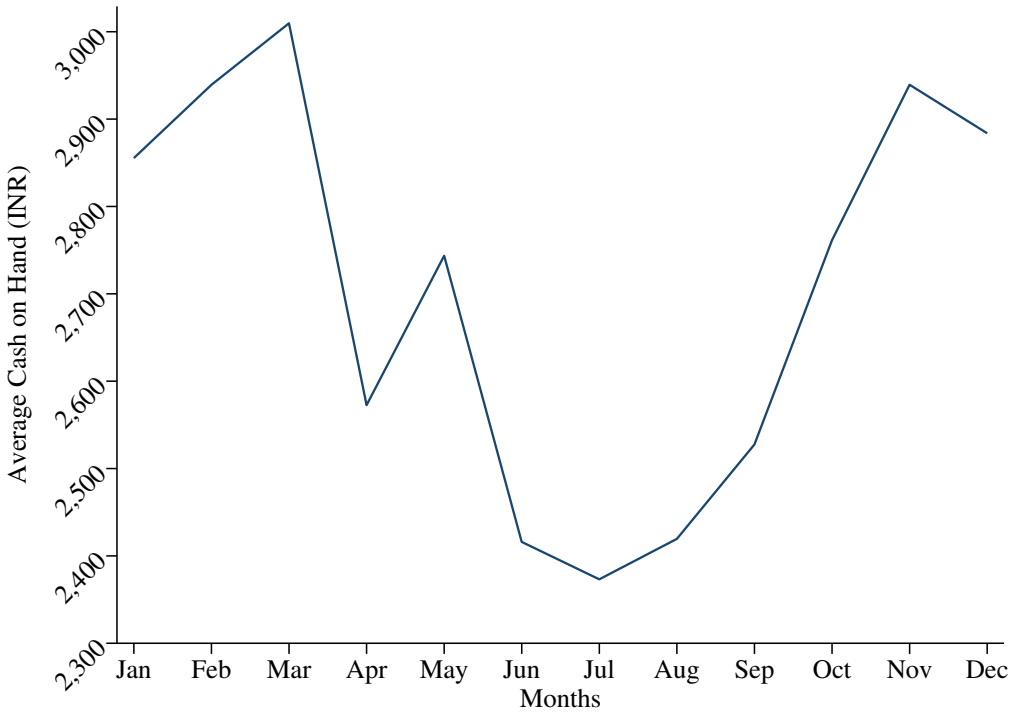
A Appendix: Additional Results

Figure A1: Delay in LPG Subsidy Transfer



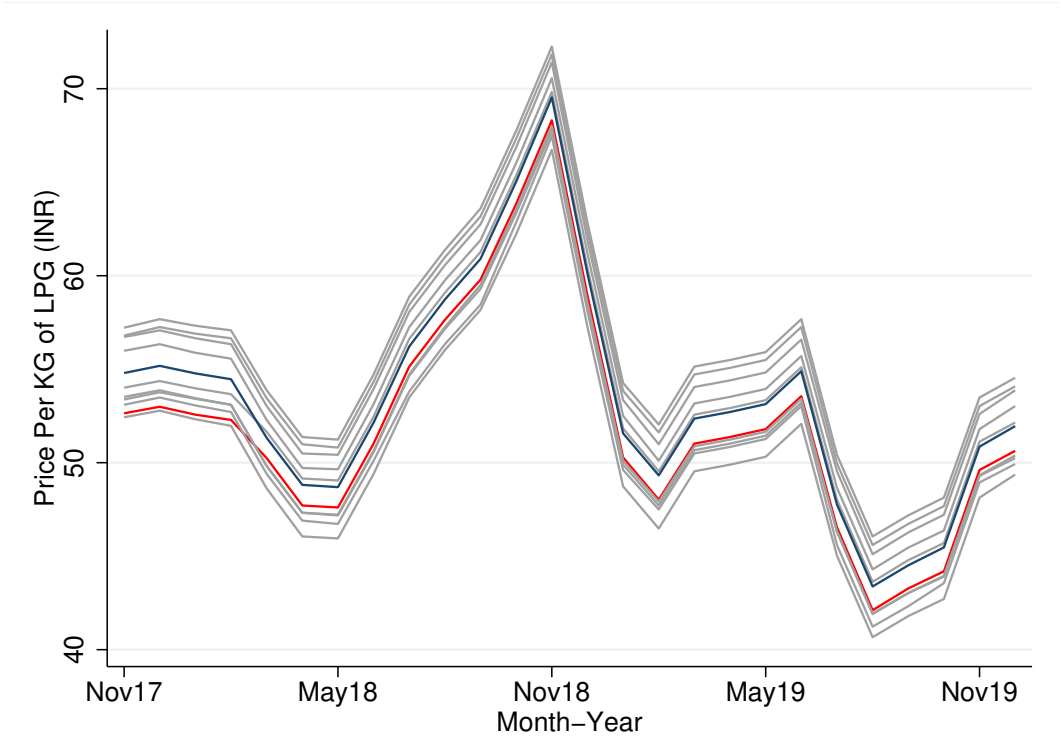
Notes: This figure shows the mean number of days it takes for the subsidy to be transferred after refill cylinder delivery, for refill transactions from BPCL, within a monthXyear. 'Days' is defined as the difference between the date of transfer of LPG subsidy to the consumer's bank account and the date of delivery of the LPG cylinder to the consumer. Subsidy date is available for the majority of BPCL transactions, but for neither other OMC. Data are restricted to 14.2kg cylinder deliveries between Nov 2017 to Dec 2019 in Indore. The average delay in this period is 6.89 days (green line) while the median delay is 5.

Figure A2: Average Cash on Hand (Rural Households)



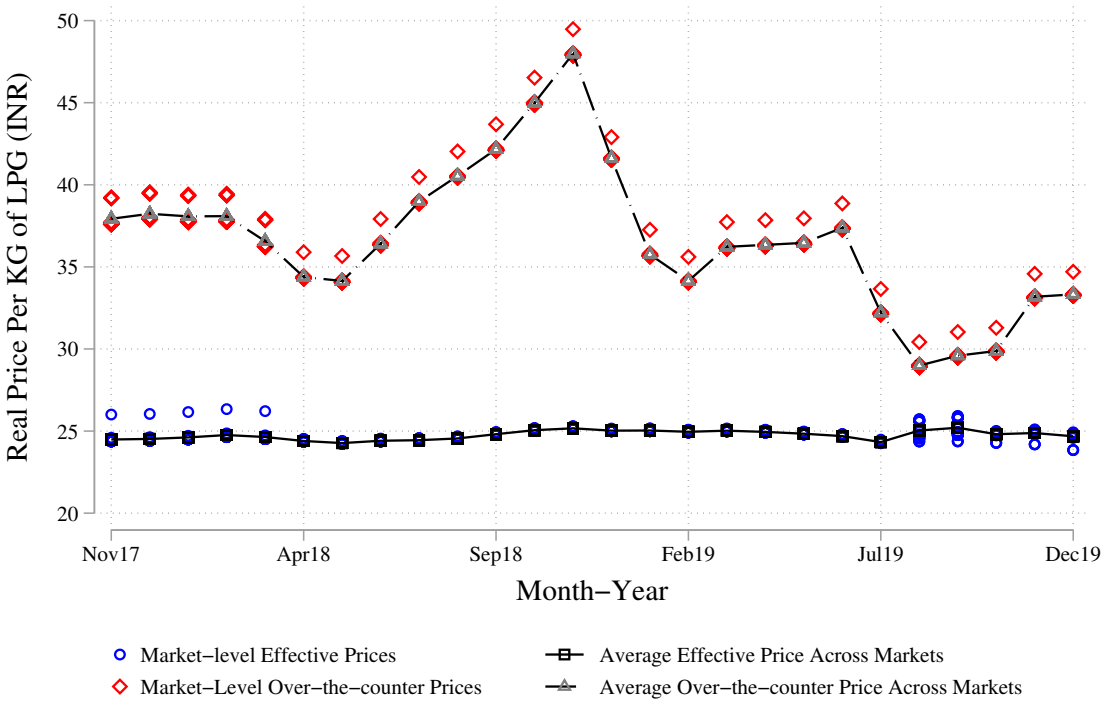
Notes: This figure shows how Cash on Hand (COH) varies by month from June 2017 to Oct 2020 for rural households in India, using data from the Periodic Labor Force Survey 2017-18, 2018-19 and 2019-20 rounds. The correlation coefficient of COH for 12 (collapsed) calendar months during this period between rural households in India and Madhya Pradesh is 0.6967 (p=0.0118).

Figure A3: Correlation of Over-the-counter LPG Price Across Districts (November 2017 - December 2019)



Notes: The domestic price of LPG is obtained from the administrative dataset of BPCL for 10 districts across 5 states - Telangana, Andhra Pradesh, Karnataka, Punjab, Madhya Pradesh and Uttar Pradesh (2 districts per state). The X-axis denotes the duration of study period (spanning 26 months from November 2017 to December 2019).The red line represents Over-the-counter LPG Price for Indore. The grey lines represent the Over-the-counter LPG Price for each of the remaining 9 districts. The blue line represents the average Over-the-counter LPG Price for 9 districts (excluding Indore). All prices are in nominal INR per KG of LPG. The coefficient of correlation between the over-the counter domestic per kg price for Indore and the average of the 9 districts (excluding Indore), is 0.9981 (p-val = 0.0000).

Figure A4: Market-level Over-the-counter and Effective LPG Prices
(November 2017 - December 2019)



Notes: This figure depicts the monthly over-the-counter and effective LPG prices (obtained from the OMC administrative dataset) in each of the 26 markets and averaged across markets in each month. "Over-the-counter price" is the price paid upfront per kg of LPG. "Effective price" is the over-the-counter price minus the cash-back subsidy. The Y-axis shows prices in real (2012) INR for 1 kg of LPG. The X-axis shows the corresponding month, from November 2017 to December 2019 (26 months).

Table A1: Average Cash-back Subsidy, Over-the-counter Price, and Effective Price

	Obs	Mean	SD	Minimum	Maximum
Cash-back Subsidy	676	169.31	62.11	46.90	343.32
Over-the-counter Price	676	520.82	62.45	410.43	702.60
Effective Price	676	351.51	4.98	338.59	374.01

Notes: This table summarizes the cash-back subsidy, over-the-counter price, effective price in the administrative data. Over-the-counter price of LPG is the price paid by consumers upfront to purchase a standard 14.2 kg LPG cylinder. The government kept the effective price (over-the-counter price minus cash-back subsidy) of LPG to consumers relatively constant by letting the cash-back subsidy float in tandem with the over-the-counter price. All prices are in real 2012 INR and vary at market-month level. There are 26 months in our sample (November 2017-December 2019), and 26 markets.

Table A2: Characteristics of Non-PMUY and PMUY Households (Survey Data)

	Non-PMUY			PMUY			Difference
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Obs	Mean	SD	Obs	Mean	SD	(PMUY - Non-PMUY)
Asset Index	1,273	1.85	0.74	818	1.27	0.61	-0.580***
General Caste Category	1,273	0.18	0.39	818	0.10	0.30	-0.088***
Salaried Head of HH	1,273	0.12	0.33	818	0.08	0.27	-0.046***
Self Employed Head of HH	1,273	0.36	0.48	818	0.22	0.41	-0.142***
Casual Laborer Head of HH	1,273	0.31	0.46	818	0.51	0.50	0.198***
Land Owning HH	1,273	0.57	0.50	818	0.45	0.50	-0.116**
Land Owning or Leasing HH	1,273	0.58	0.49	818	0.46	0.50	-0.116**
Above Primary Level Edu of HH Head	1,273	0.47	0.50	818	0.32	0.47	-0.151***
Has Latrine in House	1,273	0.93	0.26	818	0.81	0.39	-0.117***

Notes: This table compares Non-PMUY and PMUY households along several dimensions using the household survey data. All the variables are as defined in Table 2. Columns 1 - 3 (4 - 6) show the number of observations, mean and standard deviation of the characteristics of Non-PMUY (PMUY) households. Column 7 is the difference between Columns 5 and 2. Standard errors are clustered at the market-month-year level. Significant at * 10%, ** 5% and ***1% level.

Table A3: Cash on Hand (COH)

	Obs	Mean	SD	Minimum	Maximum
Overall (level)	416	3,677.909	2,134.991	1,033.349	9,579.672
Overall (logs)	416	8.057	0.548	6.941	9.167
Overall (logs, mean-centered)	416	0.000	0.548	-1.116	1.111
Occupation Groups (level)					
Self-employed on farm	104	2,354.889	348.274	1,621.442	3,146.331
Self-employed on non-farm	104	3,736.082	560.424	2,579.580	4,762.813
Casual labor	104	1,746.024	368.519	1,033.349	2,706.314
Salaried	104	6,874.640	1,391.700	4,341.544	9,579.672
Caste Groups (level)					
Scheduled Caste (SC)	104	3,010.946	1,460.813	1,069.227	6,046.346
Scheduled Tribe (ST)	104	4,265.653	2,586.253	1,349.773	9,579.672
Other Backward Caste (OBC)	104	3,372.786	1,732.264	1,033.349	7,147.221
General	104	4,062.250	2,345.418	1,260.421	8,905.957

Notes: This table summarizes the monthly cash-on-hand (COH) in levels (INR), logs and mean-centered (log COH - mean (log COH)) constructed from the Periodic Labor Force Survey (PLFS), rounds 2017-18, 2018-19 and 2019-20. We attribute the COH data to households in the survey data by collapsing the COH and survey data to occupation-caste-month level. With 26 month-years, 4 occupations (Salaried, Self-employed on farm, Self-employed on non-farm, Casual labor) and 4 caste groups (SC, ST, OBC, and General) we have 416 observations.

Table A4: Impact of Over-the-counter Price and Cash-back Subsidy on Monthly Refills (Administrative Data)

	(1)	(2)	(3)	(4)
Panel A: Full Sample				
Over-the-counter price	-0.003***	-0.001		
	(0.001)	(0.001)		
PMUY × Over-the-counter price	-0.009***	-0.009***		
	(0.001)	(0.001)		
Cash-back subsidy			-0.003***	-0.001
			(0.001)	(0.001)
PMUY × Cash-back subsidy			-0.009***	-0.009***
			(0.001)	(0.002)
Mean of Dependent Var.	0.578	0.578	0.578	0.578
Mean of Dependent Var. for PMUY	0.252	0.252	0.252	0.252
Mean of Dependent Var. for Non-PMUY	0.604	0.604	0.604	0.604
Observations	23,697,794	23,697,794	23,697,794	23,697,794
Panel B: Rural Sample				
Over-the-counter price	-0.003***	-0.002		
	(0.001)	(0.001)		
PMUY × Over-the-counter price	-0.010***	-0.010***		
	(0.001)	(0.001)		
Cash-back subsidy			-0.003***	-0.002
			(0.001)	(0.001)
PMUY × Cash-back subsidy			-0.010***	-0.010***
			(0.001)	(0.001)
Observations	13,522,165	13,522,165	13,522,165	13,522,165
Panel C: Urban Sample				
Over-the-counter price	-0.002***	-0.001		
	(0.001)	(0.001)		
PMUY × Over-the-counter price	-0.007***	-0.007***		
	(0.002)	(0.002)		
Cash-back subsidy			-0.002***	-0.001
			(0.001)	(0.001)
PMUY × Cash-back subsidy			-0.008***	-0.007***
			(0.002)	(0.002)
Observations	10,102,717	10,102,717	10,102,717	10,102,717
Month FE	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes
Household FE	Yes	Yes	Yes	Yes

Notes: Same as in Table 3 in the main paper but with over-the-counter price and cash-back subsidy in levels.

Table A5: Effect of LPG Subsidy Delay on Refill Demand, by PMUY status (Administrative Data)

	(1)	(2)		
Over-the-counter price	-0.030	-0.023		
	(0.029)	(0.033)		
Over-the-counter price × Delay	-0.119**	-0.084**		
	(0.051)	(0.035)		
PMUY × Over-the-counter price	-0.275***	-0.273***		
	(0.055)	(0.059)		
PMUY × Over-the-counter price × Delay	-0.001	-0.002		
	(0.093)	(0.094)		
Cash-back subsidy			-0.008	0.001
			(0.009)	(0.009)
Cash-back subsidy × Delay			-0.022*	-0.019**
			(0.013)	(0.009)
PMUY × Cash-back subsidy			-0.100***	-0.099***
			(0.017)	(0.018)
PMUY × Cash-back subsidy × Delay			0.026	0.026
			(0.024)	(0.025)
Mean of Dependent Var.	0.578	0.578	0.578	0.578
Mean of Median Delay Days	4.808	4.808	4.808	4.808
Observations	23,697,794	23,697,794	23,697,794	23,697,794
Month FE	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes
Household FE	Yes	Yes	Yes	Yes

Notes: "Over-the-counter price" is the log of the price paid upfront per kg of LPG. "Cash-back subsidy" is the log of the subsidy per kg of LPG that the consumers get back after purchase. The dependent variable is refills, which is the total monthly refills of a 14.2 kg LPG cylinder. Unit of observation is consumer-month-year, leading to a total of 23.69 million observations, corresponding to monthly refills for 26 months of the 911,454 unique consumers. Refill is coded zero if the consumer does not have a gas connection or did not purchase in a given month. "PMUY" is a dummy that equals 1 if the consumer has a PMUY connection, 0 if it's a regular gas connection. "Delay" (in days) is the month-year median number of days it takes for the cash-back subsidy to be transferred to the consumer (date of subsidy transferred minus date of refill delivery), demeaned across time. Delay data are available only from BPCL and assigned to each consumer (irrespective of their dealer's OMC) who bought refills in the corresponding month-year. Delay and PMUY x Delay are included in all regressions but not reported. Standard errors, clustered at the market-month-year level, reported in parentheses. Significant at * 10%, ** 5% and ***1% level.

Table A6: IV Estimation: Impact of Over-the-counter Price and Cash-back Subsidy on Monthly Refills (Administrative Data)

	(1)	(2)	(3)	(4)
Panel A: Full Sample				
Over-the-counter price	-0.104***	-0.044		
	(0.026)	(0.033)		
PMUY × Over-the-counter price	-0.346***	-0.346***		
	(0.051)	(0.056)		
Cash-back subsidy			-0.031***	-0.014
			(0.008)	(0.010)
PMUY × Cash-back subsidy			-0.102***	-0.102***
			(0.014)	(0.015)
Mean of Dependent Var.	0.578	0.578	0.578	0.578
Mean of Dependent Var. for PMUY	0.252	0.252	0.252	0.252
Mean of Dependent Var. for Non-PMUY	0.604	0.604	0.604	0.604
Observations	23,697,794	23,697,794	23,697,794	23,697,794
Panel B: Rural Sample				
Over-the-counter price	-0.111***	-0.046		
	(0.027)	(0.034)		
PMUY × Over-the-counter price	-0.368***	-0.369***		
	(0.043)	(0.048)		
Cash-back subsidy			-0.033***	-0.014
			(0.009)	(0.011)
PMUY × Cash-back subsidy			-0.109***	-0.109***
			(0.012)	(0.013)
Observations	13,522,165	13,522,165	13,522,165	13,522,165
Panel C: Urban Sample				
Over-the-counter price	-0.095***	-0.042		
	(0.026)	(0.033)		
PMUY × Over-the-counter price	-0.280***	-0.280***		
	(0.080)	(0.082)		
Cash-back subsidy			-0.028***	-0.013
			(0.008)	(0.010)
PMUY × Cash-back subsidy			-0.082***	-0.082***
			(0.021)	(0.022)
Observations	10,102,717	10,102,717	10,102,717	10,102,717
Month FE	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes
Household FE	Yes	Yes	Yes	Yes

Notes: This table shows the impact on monthly refills of changes in log of over-the-counter price and log of cash-back subsidy. **Panel A** shows the estimates for the full OMC administrative sample, **Panel B** shows the estimates for rural sub-sample, and **Panel C** shows the estimates for the urban sub-sample. "Over-the-counter price" is the log of the price paid upfront per kg of LPG. "Cash-back subsidy" is the log of the subsidy per kg of LPG that the consumers get back after purchase. 1 month lag of international LPG price is used as an IV for over-the-counter price and cash-back subsidy. The dependent variable is refills, which is the total monthly refills of a 14.2 kg LPG cylinder. Unit of observation is consumer-month-year, leading to a total of 23.69 million observations, corresponding to monthly refills for 26 months of the 911,454 unique consumers. Refill is coded zero if the consumer does not have a gas connection or did not purchase in a given month. PMUY is a dummy which equals 1 if the consumer has a PMUY connection, 0 if it's a regular gas connection. Standard errors, clustered at the market-month-year level, reported in parentheses. Significant at * 10%, ** 5% and ***1% level.

Table A7: IV Estimation: Impact of Over-the-counter Price and Cash-back Subsidy on Monthly Refills (Survey Data)

	(1)	(2)	(3)	(4)
Over-the-counter price	-0.165***	-0.069		
	(0.034)	(0.042)		
PMUY × Over-the-counter price	-0.259***	-0.260***		
	(0.053)	(0.053)		
Cash-back subsidy			-0.049***	-0.022*
			(0.010)	(0.013)
PMUY × Cash-back subsidy			-0.078***	-0.078***
			(0.016)	(0.016)
Mean of Dependent Var.	0.411	0.411	0.411	0.411
Mean of Dependent Var. for PMUY	0.285	0.285	0.285	0.285
Mean of Dependent Var. for Non-PMUY	0.492	0.492	0.492	0.492
Observations	54,366	54,366	54,366	54,366
Month FE	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes
Household FE	Yes	Yes	Yes	Yes

Notes: This table shows the impact on monthly refills of changes in log of over-the-counter price and log of cash-back subsidy using the survey data. "Over-the-counter price" is the log of the price paid upfront per kg of LPG. "Cash-back subsidy" is the log of the subsidy per kg of LPG that the consumers get back after purchase. 1 month lag of international LPG price is used as an IV for over-the-counter price and cash-back subsidy. The dependent variable is refills, which is the total monthly refills of a 14.2 kg LPG cylinder. Unit of observation is household-month-year, leading to a total of 54,366 observations, corresponding to monthly refills for 26 months of the 2091 unique consumers. Refill is coded zero if the consumer does not have a gas connection or did not purchase in a given month. PMUY is a dummy which equals 1 if the consumer has a PMUY connection, 0 if it's a regular gas connection. Standard errors, clustered at the market-month-year level, reported in parentheses. Significant at * 10%, ** 5% and ***1% level.

Table A8: Impact of Over-the-counter Price and Cash-back Subsidy on Monthly Refills (Administrative Data with Bootstrapped Standard Errors)

	(1)	(2)	(3)	(4)
Panel A: Full Sample				
Over-the-counter price	-0.091**	-0.043**		
	[0.012]	[0.036]		
PMUY × Over-the-counter price	-0.349***	-0.347***		
	[0.000]	[0.000]		
Cash-back subsidy			-0.025**	-0.007*
			[0.018]	[0.070]
PMUY × Cash-back subsidy			-0.110***	-0.110***
			[0.000]	[0.000]
Mean of Dependent Var.	0.578	0.578	0.578	0.578
Mean of Dependent Var. for PMUY	0.252	0.252	0.252	0.252
Mean of Dependent Var. for Non-PMUY	0.604	0.604	0.604	0.604
Observations	23,697,794	23,697,794	23,697,794	23,697,794
Panel B: Rural Sample				
Over-the-counter price	-0.098**	-0.046*		
	[0.021]	[0.064]		
PMUY × Over-the-counter price	-0.374***	-0.372***		
	[0.000]	[0.000]		
Cash-back subsidy			-0.028**	-0.008
			[0.025]	[0.151]
PMUY × Cash-back subsidy			-0.116***	-0.115***
			[0.000]	[0.000]
Observations	13,522,165	13,522,165	13,522,165	13,522,165
Panel C: Urban Sample				
Over-the-counter price	-0.083**	-0.041*		
	[0.046]	[0.058]		
PMUY × Over-the-counter price	-0.275***	-0.275***		
	[0.000]	[0.000]		
Cash-back subsidy			-0.023*	-0.006**
			[0.064]	[0.024]
PMUY × Cash-back subsidy			-0.094***	-0.093***
			[0.000]	[0.000]
Observations	10,102,717	10,102,717	10,102,717	10,102,717
Month FE	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes
Household FE	Yes	Yes	Yes	Yes

Notes: This table shows the impact on monthly refills of changes in log of over-the-counter price and log of cash-back subsidy for the administrative sample. Panel A shows the estimates for the full OMC administrative sample, Panel B shows the estimates for the rural sub-sample, and Panel C shows the estimates for the urban sub-sample. "Over-the-counter price" is the log of the price paid upfront per kg of LPG. "Cash-back subsidy" is the log of the subsidy per kg of LPG that the consumers get back after purchase. The dependent variable is refills, which is the total monthly refills of a 14.2 kg LPG cylinder. Unit of observation is consumer-month-year, leading to a total of 23.69 million observations, corresponding to monthly refills for 26 months of the 911,454 unique consumers. Refill is coded zero if the consumer does not have a gas connection or did not purchase in a given month. PMUY is a dummy which equals 1 if the consumer has a PMUY connection, 0 if it's a regular gas connection. Standard errors are bootstrapped at market level, and significance corresponds to bootstrapped p-values reported in square brackets. Significant at * 10%, ** 5% and ***1% level.

Table A9: Impact of Over-the-counter Price and Cash-back Subsidy on Monthly Refills (Survey Data with Bootstrapped Standard Errors)

	(1)	(2)	(3)	(4)
Over-the-counter price	-0.172***	-0.082		
	[0.003]	[0.188]		
PMUY × Over-the-counter price	-0.255***	-0.254***		
	[0.000]	[0.000]		
Cash-back subsidy			-0.046***	-0.015
			[0.005]	[0.391]
PMUY × Cash-back subsidy			-0.079***	-0.078***
			[0.001]	[0.001]
Mean of Dependent Var.	0.411	0.411	0.411	0.411
Mean of Dependent Var. for PMUY	0.285	0.285	0.285	0.285
Mean of Dependent Var. for Non-PMUY	0.492	0.492	0.492	0.492
Observations	54,366	54,366	54,366	54,366
Month FE	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes
Household FE	Yes	Yes	Yes	Yes

Notes: This table shows the impact on monthly refills of changes in log of over-the-counter price and log of cash-back subsidy for the survey data. "Over-the-counter price" is the log of the price paid upfront per kg of LPG. "Cash-back subsidy" is the log of the subsidy per kg of LPG that the consumers get back after purchase. The dependent variable is refills, which is the total monthly refills of an LPG cylinder (which is an indivisible object of 14.2 kg). Unit of observation is household-month-year, leading to a total of 54,366 observations, corresponding to monthly refills for 26 months of the 2091 unique consumers. Refill is coded zero if the consumer does not have a gas connection or did not purchase in a given month. Columns 1 and 3 include month and household (i.e. customer) fixed effects, and columns 2 and 4 add year fixed effects. PMUY is a dummy which is 1 if the consumer has a PMUY connection, 0 if it's a regular gas connection. Standard errors are bootstrapped at market level, and significance corresponds to bootstrapped p-values reported in square brackets. Significant at * 10%, ** 5% and ***1% level.

Table A10: Impact of Over-the-counter Price and Cash-back Subsidy on Monthly Refills (Administrative Data) - Poisson Pseudo-Maximum Likelihood Estimation

	(1)	(2)	(3)	(4)
Panel A: Full Sample				
Over-the-counter price	-0.151***	-0.062		
	(0.041)	(0.057)		
PMUY × Over-the-counter price	-1.473***	-1.462***		
	(0.178)	(0.183)		
Cash-back subsidy			-0.042***	-0.008
			(0.011)	(0.014)
PMUY × Cash-back subsidy			-0.426***	-0.426***
			(0.041)	(0.043)
Mean of Dependent Var.	0.578	0.578	0.578	0.578
Mean of Dependent Var. for PMUY	0.252	0.252	0.252	0.252
Mean of Dependent Var. for Non-PMUY	0.604	0.604	0.604	0.604
Observations	23,667,665	23,667,665	23,667,665	23,667,665
Panel B: Rural Sample				
Over-the-counter price	-0.161***	-0.064		
	(0.041)	(0.057)		
PMUY × Over-the-counter price	-1.552***	-1.540***		
	(0.140)	(0.147)		
Cash-back subsidy			-0.045***	-0.008
			(0.012)	(0.015)
PMUY × Cash-back subsidy			-0.436***	-0.437***
			(0.035)	(0.036)
Observations	13,505,577	13,505,577	13,505,577	13,505,577
Panel C: Urban Sample				
Over-the-counter price	-0.137***	-0.059		
	(0.041)	(0.058)		
PMUY × Over-the-counter price	-1.239***	-1.231***		
	(0.312)	(0.313)		
Cash-back subsidy			-0.038***	-0.008
			(0.011)	(0.014)
PMUY × Cash-back subsidy			-0.391***	-0.391***
			(0.070)	(0.071)
Observations	10,089,228	10,089,228	10,089,228	10,089,228
Month FE	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes
Household FE	Yes	Yes	Yes	Yes

Notes: This table shows the impact on monthly refills of changes in log of over-the-counter price and log of cash-back subsidy estimated using Poisson Pseudo Maximum Likelihood Estimation. Panel A shows the estimates for the full OMC administrative sample, Panel B shows the estimates for rural sub-sample, and Panel C shows the estimates for the urban sub-sample. "Over-the-counter price" is the log of the price paid upfront per kg of LPG. "Cash-back subsidy" is the log of the subsidy per kg of LPG that the consumers get back after purchase. The dependent variable is refills, which is the total monthly refills of a 14.2 kg LPG cylinder. Unit of observation is consumer-month-year, leading to a total of 23.69 million observations, corresponding to monthly refills for 26 months of the 911,454 unique consumers. Refill is coded zero if the consumer does not have a gas connection or did not purchase in a given month. PMUY is a dummy which equals 1 if the consumer has a PMUY connection, 0 if it's a regular gas connection. Standard errors, clustered at the market-month-year level, reported in parentheses. Significant at * 10%, ** 5% and ***1% level.

Table A11: Birth and Post-Birth Child Health Outcomes

	Obs	Mean	SD	Minimum	Maximum
Birth Weight	16,801	2.784	0.568	0.500	9.000
Cough	223,764	0.129	0.335	0.000	1.000
Rapid Breathing	223,862	0.065	0.246	0.000	1.000

Notes: This table summarizes the birth and post-birth child health outcomes from June 2018 to May 2021. All health outcomes are from the DHS Round 5, 2019-21 (previous 12 months is the reference period for interviews conducted during June 2019 to May 2021). DHS data used in the analysis is for all India (rural and urban) sample. 'Birth Weight' is weight at birth measured in kilograms. The sample is restricted to births whose conception was within a year prior to the DHS survey (pregnancies conceived from June 2018 to Dec 2020). 'Cough' is a dummy that equals 1 if the child (under 5 years of age) has been ill with cough in last two weeks and 'Rapid breathing' equals 1 if the child (under 5 years of age) suffered from rapid breathing in last two weeks.

Table A12: Impact of Over-the-counter Price and Cash-back Subsidy on Birth and Post-birth Child Health Outcomes (with Sampling Weights)

	Birth Weight		Cough		Rapid Breathing	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Full Sample						
Over-the-counter price	-0.370		0.055		0.055**	
	(0.334)		(0.043)		(0.020)	
Cash-back subsidy		-0.005		-0.002		0.019***
		(0.026)		(0.016)		(0.005)
Mean of Dependent Var.	2.784	2.784	0.129	0.129	0.065	0.065
Observations	16,801	16,801	223,764	223,764	223,862	223,862
FDR-adjusted p-value	[0.226]	[1]	[0.226]	[1]	[0.039]	[0.006]
Panel B: Rural Sample						
Over-the-counter price	-0.510		0.044		0.079**	
	(0.308)		(0.043)		(0.035)	
Cash-back subsidy		-0.017		0.003		0.018*
		(0.027)		(0.014)		(0.010)
Mean of Dependent Var.	2.780	2.780	0.130	0.130	0.066	0.066
Observations	13,566	13,566	177,951	177,951	178,035	178,035
FDR-adjusted p-value	[0.127]	[1]	[0.195]	[1]	[0.127]	[0.272]
Panel C: Urban Sample						
Over-the-counter price	0.067		0.035		0.049	
	(0.591)		(0.095)		(0.031)	
Cash-back subsidy		0.047		-0.040		0.025
		(0.041)		(0.041)		(0.020)
Mean of Dependent Var.	2.800	2.800	0.124	0.124	0.059	0.059
Observations	3,235	3,235	45,813	45,813	45,827	45,827
FDR-adjusted p-value	[1]	[0.513]	[1]	[0.513]	[0.745]	[0.513]
Mother and Child Controls	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State × Month-Year Trend	Yes	Yes	Yes	Yes	Yes	Yes

Notes: As shown in Table 6 in the main paper. Observations in the regressions are weighted using the DHS household sampling weights.

Table A13: Effect of Over-the-counter Price and Cash-back Subsidy on Post-birth Child Health Outcomes

	Cough		Rapid Breathing	
	(1)	(2)	(3)	(4)
Panel A: Full Sample				
Over-the-counter price	0.089*		0.106***	
	[0.081]		[0.006]	
Cash-back subsidy		0.005		0.029**
		[0.593]		[0.011]
Mean of Dependent Var.	0.129	0.129	0.065	0.065
Observations	223,764	223,764	223,862	223,862
Panel B: Rural Sample				
Over-the-counter price	0.085		0.135***	
	[0.200]		[0.003]	
Cash-back subsidy		0.005		0.030*
		[0.674]		[0.053]
Mean of Dependent Var.	0.130	0.130	0.066	0.066
Observations	177,951	177,951	178,035	178,035
Panel C: Urban Sample				
Over-the-counter price	0.083		0.081	
	[0.422]		[0.202]	
Cash-back subsidy		-0.003		0.054
		[0.915]		[0.292]
Mean of Dependent Var.	0.124	0.124	0.059	0.059
Observations	45,813	45,813	45,827	45,827
Mother and Child Controls	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
State × Month-Year Trend	Yes	Yes	Yes	Yes

Note: This table is analogous to Table 6 (columns 3 to 6) in the main paper. Standard errors are bootstrapped at Month-Year of interview, and significance corresponds to bootstrapped p-values reported in square brackets. Significant at * 10%, ** 5% and ***1% level.

Table A14: Effect of Over-the-counter Price and Cash-back Subsidy on Child Anthropometric Outcomes

	Height for Age Z-Score		Weight for Age Z-Score	
	(1)	(2)	(3)	(4)
Over-the-counter price	0.017		-0.041	
	[0.932]		[0.800]	
Cash-back subsidy		0.015		-0.150
		[0.891]		[0.120]
Mean of Dependent Var.	-1.312	-1.312	-1.395	-1.395
Observations	206,025	206,025	210,524	210,524
Mother and Child Controls	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
State × Month-Year Trend	Yes	Yes	Yes	Yes

Notes: Log of over-the-counter LPG price and cash-back subsidy are obtained from the administrative dataset for BPCL Indore, while the health outcomes are from the DHS Round 5, 2019-21 (June 2019 to May 2021). DHS data used in the analysis is for all India (rural and urban) sample. Ht for Age and Wt for Age Z-scores are calculated using the new Child Growth Standards released by WHO in 2006, to develop a new international standard for assessing the physical growth nutrition status and motor development in all children from birth to age five. All time controls correspond to interview month-year of household. Standard errors are bootstrapped at Month-Year of interview, and significance corresponds to bootstrapped p-values reported in square brackets. Child controls include sex of child, if child is part of a multiple birth and birth order of the child in the household, age of child (and age squared). Mother controls include mother's age at birth (including age squared), mother's education level, if household is located in rural/urban area, religion, caste and wealth index. State x Year-Month Trend is 'i.state x c.month-year' of interview. Significant at * 10%, ** 5% and ***1% level.

Table A15: Impact of Over-the-counter Price on Monthly Refills: Heterogeneity by Asset Ownership (Survey Data)

	(1)	(2)
Over-the-counter price	-0.220***	-0.274***
	(0.040)	(0.050)
Asset Above median × Over-the-counter price	0.077**	
	(0.037)	
Asset Quartile 2 × Over-the-counter price		0.108**
		(0.054)
Asset Quartile 3 × Over-the-counter price		0.140**
		(0.055)
Asset Quartile 4 × Over-the-counter price		0.122**
		(0.056)
Constant	1.064***	1.064***
	(0.125)	(0.125)
Mean of Dependent Var.	0.411	0.411
Observations	54,366	54,366
Month FE	Yes	Yes
Year FE	Yes	Yes
Household FE	Yes	Yes

Notes: This table shows the impact on monthly refills of changes in log of over-the-counter price interacted with median asset and asset quartiles for the survey data. "Over-the-counter price" is the log of the price paid upfront per kg of LPG. The dependent variable is refills, which is the total monthly refills of a 14.2 kg LPG cylinder. Households are divided into 2 and 4 groups based on their baseline asset index. Asset Half 1 and Asset Quartile 1 (lowest) are the omitted categories. Unit of observation is household-month-year, leading to a total of 54,366 observations, corresponding to monthly refills for 26 months of the 2091 unique consumers. Refill is coded zero if the consumer does not have a gas connection or did not purchase in a given month. All specifications include month, year and household fixed effects. PMUY is a dummy which equals 1 if the consumer has a PMUY connection, 0 if it's a regular gas connection. Standard errors, clustered at the market-month-year level, reported in parentheses. Significant at * 10%, ** 5% and ***1% level.

Table A16: Correlation of Consumer Price Index with Nominal Over-the-counter Price of LPG

	(1) Food & Beverage	(2) Pan, Tobacco & Intoxicants	(3) Clothing & Footwear	(4) Fuel & Light	(5) All
Over the counter LPG price	-0.175	-0.227	-0.001	0.164*	-0.098
(Nominal terms)	(0.139)	(0.158)	(0.046)	(0.081)	(0.086)
Constant	150.658***	172.076***	150.104***	137.670***	109.858***
	(7.303)	(8.300)	(2.429)	(4.256)	(4.502)
Observations	26	26	26	26	26

Notes: This table regresses the monthly rural Consumer Price Index (CPI) on the (nominal) average monthly Over-the counter LPG price (per kg) between November 2017 - December 2019 (26 months). In Column 1 the dependent variable is the food and beverages CPI, in Column 2 it is pan, tobacco and intoxicants CPI, in Column 3 it is clothing and footwear CPI, and Column 4 is fuel and light CPI. Column 5 is a combination of all the four CPIs using on the following weights 0.54, 0.074, 0.0326, and 0.079, respectively as per Goyal et al. (2021). Standard errors reported in parentheses. Significant at * 10%, ** 5% and ***1% level.

Table A17: Impact of Over-the-counter Price on Monthly Refills: Heterogeneity by Knowledge About Subsidy (Survey Data)

	(1)	(2)	(3)	(4)	(5)
Over-the-counter price	-0.102*	-0.110**	-0.083*	-0.090	0.002
	(0.058)	(0.056)	(0.049)	(0.058)	(0.048)
PMUY × Over-the-counter price	-0.211***	-0.244***	-0.286***	-0.230***	-0.335***
	(0.069)	(0.082)	(0.062)	(0.068)	(0.071)
Govt. Deposits Subsidy × Over-the-counter price	0.024				
	(0.060)				
PMUY × Govt. Deposits Subsidy × Over-the-counter price	-0.066				
	(0.083)				
Subsidy Amt. Same × Over-the-counter price		0.038			
		(0.056)			
PMUY × Subsidy Amt. Same × Over-the-counter price		-0.014			
		(0.082)			
Out-of-Pocket<Paid × Over-the-counter price			-0.001		
			(0.056)		
PMUY × Out-of-Pocket<Paid × Over-the-counter price			0.067		
			(0.077)		
Subsidy SMS Alert × Over-the-counter price				0.009	
				(0.058)	
PMUY × Subsidy SMS Alert × Over-the-counter price				-0.037	
				(0.082)	
Subsidy only for PMUY × Over-the-counter price					-0.124***
					(0.045)
PMUY × Subsidy only for PMUY × Over-the-counter price					0.118
					(0.075)
Mean of Dependent Var.	0.412	0.412	0.412	0.412	0.412
Observations	53,534	53,534	53,534	53,534	53,534
Month FE	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the total number of monthly refills of a 14.2 kg LPG cylinder consumed by a household in the survey data. LPG subsidy knowledge equals 1 if the household correctly agreed/disagreed with each of the five statements: (1) 'govt. deposits subsidy' to your bank account (2) deposited 'subsidy amount remains same' every time (3) 'out-of-pocket expense' on LPG cylinder is less than the market price paid (4) govt. sends an 'SMS alert' about subsidy once deposited (5) LPG refill 'subsidy is only for PMUY' customers. Unit of observation is consumer-financial month- financial year. Refill is missing if consumer does not have a gas connection, and refills are non-missing once the consumer avails the connection (hence, the panel is unbalanced). Standard errors, clustered at the market-month-year level, reported in parentheses. Significant at * 10%, ** 5% and ***1% level.

Table A18: Impact of Over-the-counter Price on Monthly Refills: Heterogeneity by Trust in ASHA Worker (Survey Data)

	(1)
Over-the-counter price	-0.073
	(0.081)
PMUY × Over-the-counter Price	-0.250**
	(0.103)
Trust info from ASHA × Over-the-counter Price	-0.010
	(0.085)
PMUY × Trust info from ASHA × Over-the-counter Price	-0.004
	(0.108)
Mean of Dependent Var.	0.411
Observations	54,366
Month FE	Yes
Household FE	Yes
Year FE	Yes

Notes: The dependent variable is the total monthly refills of a 14.2 kg LPG cylinder consumed by a household in the survey data. ASHA is an acronym for 'Accredited Social Health Activist', a community health worker. "Trust info from ASHA" is the response to the survey question "Does your household trust information given by ASHA worker in your village", which equals 1 if the household reports saying they do trust the information from ASHA worker, and 0 otherwise. "Over-the-counter price" is the log of the price paid upfront per kg of LPG. Unit of observation is household-month-year, leading to a total of 54,366 observations, corresponding to monthly refills for 26 months of the 2091 unique consumers. Refill is coded zero if the consumer does not have a gas connection or did not purchase in a given month. All specifications include month, year and household fixed effects. PMUY is a dummy which equals 1 if the consumer has a PMUY connection, 0 if it's a regular gas connection. Standard errors, clustered at the market-month-year level, reported in parentheses. Significant at * 10%, ** 5% and ***1% level.

Table A19: Impact of Over-the-counter Price and Cash-back Subsidy on Monthly Refills
(Administrative Data)
(Sample Restricted to experienced LPG Users)

	(1)	(2)	(3)	(4)
Panel A: Full Sample				
Over-the-counter price	-0.001	-0.073**		
	(0.029)	(0.035)		
PMUY × Over-the-counter price	-0.312***	-0.312***		
	(0.043)	(0.040)		
Cash-back subsidy			0.003	-0.017*
			(0.007)	(0.009)
PMUY × Cash-back subsidy			-0.087***	-0.087***
			(0.012)	(0.011)
Mean of Dependent Var.	0.641	0.641	0.641	0.641
Observations	18,541,172	18,541,172	18,541,172	18,541,172
Panel B: Rural Sample				
Over-the-counter price	-0.010	-0.080**		
	(0.028)	(0.036)		
PMUY × Over-the-counter price	-0.327***	-0.327***		
	(0.042)	(0.040)		
Cash-back subsidy			0.001	-0.019*
			(0.007)	(0.010)
PMUY × Cash-back subsidy			-0.091***	-0.091***
			(0.012)	(0.012)
Mean of Dependent Var.	0.642	0.642	0.642	0.642
Observations	10,463,582	10,463,582	10,463,582	10,463,582
Panel C: Urban Sample				
Over-the-counter price	0.010	-0.063*		
	(0.031)	(0.035)		
PMUY × Over-the-counter price	-0.216***	-0.216***		
	(0.055)	(0.053)		
Cash-back subsidy			0.006	-0.015*
			(0.007)	(0.009)
PMUY × Cash-back subsidy			-0.062***	-0.062***
			(0.014)	(0.014)
Mean of Dependent Var.	0.640	0.640	0.640	0.640
Observations	8,014,064	8,014,064	8,014,064	8,014,064
Month FE	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes
Household FE	Yes	Yes	Yes	Yes

Notes: This table reproduces Table 3 in the main paper to show the impact of changes in log of over-the-counter price and cash-back subsidy on monthly consumption of LPG refills. The sample is restricted to only those consumers who had an LPG account by the beginning of 2017. **Panel A** shows the estimates for the full OMC administrative sample, **Panel B** shows the estimates for rural sub-sample, and **Panel C** shows the estimates for the urban sub-sample. "Over-the-counter price" is the log of the price paid upfront per kg of LPG. "Cash-back subsidy" is the log of the subsidy per kg of LPG that the consumers get back after purchase. The dependent variable is refills, which is the total monthly refills of a 14.2 kg LPG cylinder. Unit of observation is consumer-month-year. Refill is coded zero if consumer did not purchase in a given month. PMUY is a dummy which equals 1 if the consumer has a PMUY connection, 0 if it's a regular gas connection. Standard errors, clustered at the market-month-year level, reported in parentheses. Significant at * 10%, ** 5% and ***1% level.

Table A20: Impact of Over-the-counter Price and Cash-back Subsidy on Monthly Refills (Administrative Data) including Unemployment as a Control

	(1)	(2)	(3)	(4)
Panel A: Full Sample				
Over-the-counter price	-0.049	-0.024		
	(0.032)	(0.033)		
Unemployment	0.015***	-0.010	0.015***	-0.015*
	(0.003)	(0.007)	(0.003)	(0.008)
PMUY × Over-the-counter price	-0.348***	-0.347***		
	(0.053)	(0.052)		
Cash-back subsidy			-0.011	-0.001
			(0.009)	(0.008)
PMUY × Cash-back subsidy			-0.110***	-0.110***
			(0.013)	(0.013)
Mean of Dependent Var.	0.578	0.578	0.578	0.578
Mean of Dependent Var. for PMUY	0.252	0.252	0.252	0.252
Mean of Dependent Var. for Non-PMUY	0.604	0.604	0.604	0.604
Observations	23,697,794	23,697,794	23,697,794	23,697,794
Panel B: Rural Sample				
Over-the-counter price	-0.071**	-0.018		
	(0.030)	(0.036)		
Unemployment (Rural)	0.020***	-0.014	0.020***	-0.019*
	(0.004)	(0.011)	(0.005)	(0.012)
PMUY × Over-the-counter price	-0.372***	-0.372***		
	(0.046)	(0.045)		
Cash-back subsidy			-0.017**	0.002
			(0.009)	(0.009)
PMUY × Cash-back subsidy			-0.115***	-0.115***
			(0.012)	(0.011)
Observations	13,522,165	13,522,165	13,522,165	13,522,165
Panel C: Urban Sample				
Over-the-counter price	-0.040	-0.028		
	(0.033)	(0.032)		
Unemployment (Urban)	0.012***	-0.007	0.012***	-0.009*
	(0.003)	(0.004)	(0.003)	(0.005)
PMUY × Over-the-counter price	-0.275***	-0.275***		
	(0.074)	(0.074)		
Cash-back subsidy			-0.008	-0.003
			(0.009)	(0.007)
PMUY × Cash-back subsidy			-0.094***	-0.093***
			(0.018)	(0.018)
Observations	10,102,717	10,102,717	10,102,717	10,102,717
Month FE	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes
Household FE	Yes	Yes	Yes	Yes

Notes: This table shows the impact on monthly refills of changes in log of over-the-counter price and log of cash-back subsidy using the OMC administrative data, controlling for the monthly unemployment rate. **Panel A** shows the estimates for the full OMC administrative sample, **Panel B** shows the estimates for rural sub-sample, and **Panel C** shows the estimates for the urban sub-sample. "Over-the-counter price" is the log of the price paid upfront per kg of LPG. "Cash-back subsidy" is the log of the subsidy per kg of LPG that the consumers get back after purchase. "Unemployment" is the monthly unemployment rate for all-India (Panel A) and rural (Panel B) and urban (Panel C) regions, calculated (from CMIE data) as the total number of men aged 15 and above who are unemployed and willing to work as a percentage of the labour force (men aged 15 and above who are employed or unemployed and willing to work). The dependent variable is refills, which is the total monthly refills of a 14.2 kg LPG cylinder. Unit of observation is consumer-month-year, leading to a total of 23.69 million observations, corresponding to monthly refills for 26 months of the 911,454 unique consumers. Refill is coded zero if the consumer does not have a gas connection or did not purchase in a given month. PMUY is a dummy that equals 1 if the consumer has a PMUY connection, 0 if it's a regular gas connection. Standard errors, clustered at the market-month-year level, reported in parentheses. Significant at * 10%, ** 5% and ***1% level.

Table A21: Impact of Over-the-counter Price and Cash-back Subsidy on Solid Fuel Expenditure (Survey Data) (Adding Year FE)

	Explicit Expenditure		Implicit Expenditure		Total Expenditure	
	(1)	(2)	(3)	(4)	(5)	(6)
Over-the-counter price	-207.356		1,786.951		1,579.595	
	(708.855)		(1,562.332)		(1,762.133)	
PMUY × Over-the-counter price	179.255**		1,008.961***		1,188.216***	
	(86.475)		(138.637)		(182.887)	
Cash-back subsidy		-24.642		166.540		141.897
		(65.481)		(147.326)		(166.834)
PMUY × Cash-back subsidy		57.566**		328.092***		385.657***
		(28.266)		(45.690)		(60.065)
Mean of Dependent Var.	208.975	208.975	1,047.526	1,047.526	1,256.501	1,256.501
Observations	4,118	4,118	4,118	4,118	4,118	4,118
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Same as Table 5 in the main paper but with Year FE.

B Appendix: Reproduction of analyses in the main paper with LPG Refills recoded as missing until consumer obtains an LPG account during our study period (Nov 2017 - Dec 2019)

Table B1: LPG Consumer Characteristics (Administrative Data)

	Obs	Mean	SD	Minimum	Maximum
Panel A: Attributes					
PMUY	910,778	0.074	0.262	0.000	1.000
Female	910,423	0.320	0.466	0.000	1.000
Rural	907,975	0.572	0.495	0.000	1.000
Panel B: LPG Refills					
All	21,898,168	0.625	0.640	0.000	16.000
PMUY	1,299,503	0.340	0.549	0.000	12.000
Non-PMUY	20,598,665	0.643	0.642	0.000	16.000
Rural	12,468,102	0.624	0.646	0.000	16.000
PMUY	936,682	0.343	0.554	0.000	12.000
Non-PMUY	11,531,420	0.647	0.648	0.000	16.000
Urban	9,360,226	0.626	0.633	0.000	13.000
PMUY	361,737	0.332	0.535	0.000	11.000
Non-PMUY	8,998,489	0.637	0.634	0.000	13.000

Notes: as shown in Table 1 in the main paper.

Table B2: Household Characteristics (Survey Data)

	Obs	Mean	SD	Minimum	Maximum
	Panel A: Household Attributes (Baseline)				
PMUY	2,085	0.391	0.488	0.000	1.000
Asset Index	2,085	1.620	0.748	-0.150	3.965
General Caste	2,085	0.150	0.357	0.000	1.000
Salaried HH Head	2,085	0.106	0.309	0.000	1.000
Agri Self-Employed HH Head	2,085	0.305	0.461	0.000	1.000
Agri Casual Laborer HH Head	2,085	0.390	0.488	0.000	1.000
Land Owner	2,085	0.522	0.500	0.000	1.000
Land Owner/Leaser	2,085	0.536	0.499	0.000	1.000
HH Head Education	2,085	0.412	0.492	0.000	1.000
Latrine in HH	2,085	0.879	0.326	0.000	1.000
	Panel B: Household Solid Fuel				
Baseline & Endline					
Explicit firewood expenditure (Rs.)	4,150	56.791	282.530	0.000	6,000.000
Implicit firewood expenditure (Rs.)	4,150	543.258	833.181	0.000	4,480.000
Explicit dung expenditure (Rs.)	4,150	151.177	470.125	0.000	6,000.000
Implicit dung expenditure (Rs.)	4,150	503.106	626.538	0.000	9,800.000
	Panel C: Household Refills Matched to Admin Data				
All Refills	50,578	0.442	0.586	0.000	7.000
PMUY refills	18,335	0.331	0.530	0.000	7.000
Non-PMUY refills	32,243	0.505	0.606	0.000	6.000

Notes: as shown in Table 2 in the main paper.

Table B3: Impact of Over-the-counter Price and Cash-back Subsidy on Monthly Refills (Administrative Data)

	(1)	(2)	(3)	(4)
Panel A: Full Sample				
Over-the-counter price	0.015	-0.060*		
	(0.029)	(0.035)		
PMUY × Over-the-counter price	-0.230***	-0.227***		
	(0.035)	(0.035)		
Cash-back subsidy			0.008	-0.013
			(0.007)	(0.009)
PMUY × Cash-back subsidy			-0.059***	-0.058***
			(0.010)	(0.010)
Mean of Dependent Var.	0.625	0.625	0.625	0.625
Mean of Dependent Var. for PMUY	0.340	0.340	0.340	0.340
Mean of Dependent Var. for Non-PMUY	0.643	0.643	0.643	0.643
Observations	21,894,452	21,894,452	21,894,452	21,894,452
Panel B: Rural Sample				
Over-the-counter price	0.008	-0.067*		
	(0.028)	(0.037)		
PMUY × Over-the-counter price	-0.259***	-0.256***		
	(0.034)	(0.033)		
Cash-back subsidy			0.006	-0.015
			(0.007)	(0.010)
PMUY × Cash-back subsidy			-0.067***	-0.065***
			(0.010)	(0.010)
Observations	12,466,067	12,466,067	12,466,067	12,466,067
Panel C: Urban Sample				
Over-the-counter price	0.025	-0.052		
	(0.031)	(0.034)		
PMUY × Over-the-counter price	-0.150***	-0.146***		
	(0.053)	(0.055)		
Cash-back subsidy			0.010	-0.011
			(0.007)	(0.008)
PMUY × Cash-back subsidy			-0.038**	-0.036**
			(0.016)	(0.016)
Observations	9,358,549	9,358,549	9,358,549	9,358,549
Month FE	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes
Household FE	Yes	Yes	Yes	Yes

Notes: as shown in Table 3 in the main paper.

Table B4: Impact of Over-the-counter Price and Cash-back Subsidy on Monthly Refills (Survey Data)

	(1)	(2)	(3)	(4)
Over-the-counter price	-0.143***	-0.146***		
	(0.034)	(0.042)		
PMUY × Over-the-counter price	-0.190***	-0.189***		
	(0.052)	(0.052)		
Cash-back subsidy			-0.037***	-0.035***
			(0.010)	(0.013)
PMUY × Cash-back subsidy			-0.054***	-0.053***
			(0.016)	(0.016)
Mean of Dependent Var.	0.442	0.442	0.442	0.442
Mean of Dependent Var. for PMUY	0.331	0.331	0.331	0.331
Mean of Dependent Var. for Non-PMUY	0.505	0.505	0.505	0.505
Observations	50,577	50,577	50,577	50,577
Month FE	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes
Household FE	Yes	Yes	Yes	Yes

Notes: as shown in Table 4 in the main paper.

Table B5: Impact of Over-the-counter Price on Monthly Refills: Heterogeneity by Household Attributes (Survey data)

	Z					
	Asset Index		General Caste		Casual Laborer	
	(1)	(2)	(3)	(4)	(5)	(6)
Over-the-counter price	-0.328***		-0.232***		-0.187***	
	(0.061)		(0.038)		(0.040)	
Over-the-counter price × Z	0.069**		0.108*		-0.075*	
	(0.028)		(0.060)		(0.040)	
Cash-back subsidy		-0.085***		-0.059***		-0.048***
		(0.018)		(0.012)		(0.013)
Cash-back subsidy × Z		0.019**		0.031*		-0.017
		(0.008)		(0.018)		(0.012)
Mean of Dependent Var.	0.442	0.442	0.442	0.442	0.442	0.442
Observations	50,577	50,577	50,577	50,577	50,577	50,577
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: as shown in Table 7 in the main paper.

Table B6: Impact of Cash on Hand (COH), Over-the-counter Price on Monthly Refills

	(1)	(2)	(3)	(4)	(5)
COH	0.096***	0.096***	0.096***	0.096***	0.096***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Over-the-counter price		-0.180***	-0.182***		
		(0.018)	(0.025)		
Over-the-counter price × COH			0.083*		
			(0.040)		
Cash-back subsidy				-0.048***	-0.048***
				(0.007)	(0.008)
Cash-back subsidy × COH					0.018
					(0.014)
Mean of Dependent Var.	0.455	0.455	0.455	0.455	0.455
Observations	416	416	416	416	416
Month FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Notes: as shown in Table 8 in the main paper.