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Curbing leakage in public programs

Evidence from India's direct benefit transfer policy

Prabhat Barnwal

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Curbing Leakage in Public Programs: Evidence from India's Direct Benefit Transfer Policy

Prabhat Barnwal*

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Abstract

Pervasive corruption and evasion often undermine the provision of public programs. I study a major policy change in fuel subsidy administration in India, which enabled a direct bank transfer of benefits to verified beneficiaries. This study exploits two quasi-experiments – a phase-wise policy roll-out and its unexpected termination under a universal fuel subsidy program, and a unique dataset combining 23 million transactions and black-market fuel prices. Increased enforcement decreased subsidized-fuel purchase, indicating a significant reduction in subsidy leakage. Reduced diversion of subsidized fuel further changed equilibrium black-market fuel prices, resulting in lower fuel tax evasion. This study illustrates how states can improve welfare delivery systems.

JEL Codes: H26, O17, I38
Keywords: *Subsidy diversion, Tax evasion, Black market, Fuel Subsidy*

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1 Introduction

In developing countries, pervasive corruption and evasion often characterize inefficiency in public programs, whereas the presence of an underground economy further undermines the state's ability to collect taxes and provide welfare. Notwithstanding its central importance – when inefficient tax and transfer systems directly affect the availability of public funds for economic development (Acemoglu, 2005; Besley and Persson, 2013), there is little empirical research on investment in state capacity to enforce tax and transfer policies (Besley et al., 2013). This paper illustrates how investing in a technology-driven enforcement system can improve a state's ability to administer transfers under public programs. Using a rich context of a large in-kind transfer program, this study further shows the effect of increased enforcement on equilibrium prices in the black market, and its resulting impact on commodity tax evasion.

In this article, I study a major change in the welfare delivery design in India – *Direct Benefit Transfer (DBT)* policy, which replaces the traditional welfare delivery with a *direct bank transfer of benefits to verified beneficiaries*. My focus is on a universal cooking fuel subsidy program for households, where Liquified Petroleum Gas (LPG) is provided at a subsidized price to households for domestic cooking use, while commercial usage of the same fuel is taxed. This leads to dual pricing which in turn incentivizes a black market for illegally diverted subsidized fuel.

Fig. 1 (p. 2) motivates this study by illustrating a key puzzle commonly observed in many developing countries – the actual number of beneficiaries that received subsidy benefits in a large cooking fuel subsidy program in India is about 50% higher (i.e. about 40 million additional beneficiaries in 2010-11) than the reported estimates shown by the 2011 Census as well as the National Sample Survey. This subsidy gap has significant fiscal implication, given the cooking fuel subsidy program provided USD 8 billion in LPG subsidies to about 165 million household beneficiaries in 2013-14.[1] This context reflects a

[1] At an exchange rate of USD 1 = INR 60.

typical agency problem, when information asymmetries between the government and the intermediary agents overseeing subsidy disbursement – where the former has little means of authenticating the identity of beneficiaries, and the latter have perverse incentives to misreport – manifest in *subsidy diversion* or *leakage* under the rubric of "ghost" beneficiaries. This term *ghost beneficiary* represents an existing or non-existing person, under whose name benefits are illegally drawn. Diversion of public funds using ghost accounts is a general problem observed in many developing countries.[2], and policymakers often recognize the significant fiscal burden of subsidy diversion.[3] Yet caught between the incentives and constraints that are shaped by a weak institutional environment, states have little means to improve welfare delivery systems.

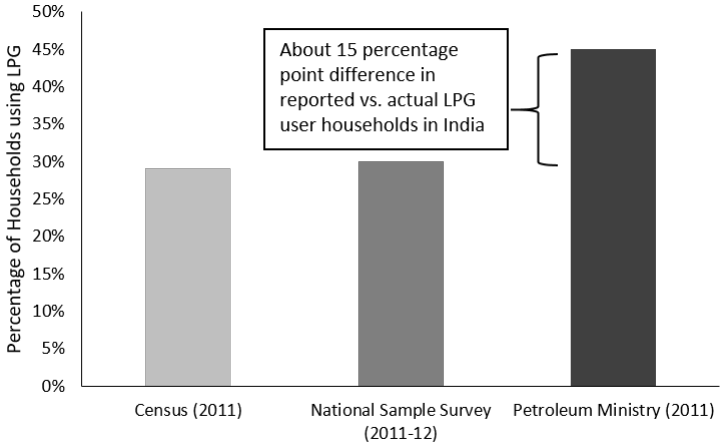

Figure 1: Subsidy gap: Reported vs. Actual beneficiaries in LPG subsidy program

Replacement of in-kind subsidies with a direct bank transfer to verified beneficiaries, may minimize the role of local officials in disbursing subsidies and increase the cost of carrying out transfers in the name of ghost and duplicate beneficiaries. The requirement of having a verified beneficiary bank account may enhance enforcement in welfare delivery,

[2]E.g., 1.5 million ghost voters in Ghana (Smith, 2002); ghost farmers in Malawi (Eggen, 2012); ghost soldiers in Uganda (Tangri and Mwenda, 2008); the 40% figure for ghost workers in Zimbabwe (Parliament of Zimbabwe, 2012); and officials gaming the traditional ID system in China (Kaiman, 2013).

[3]For example, India's then finance minister stated in 2012 that he was *"losing sleep over subsidy leakage, not [the] subsidy itself."*, underscoring the importance of subsidy administration over subsidy policy. This statement resonates well with Milka Casanegra de Jantscher's famous observation on developing countries: *"Tax administration is tax policy."*

where transfers leave information trail behind each transaction. In order to ensure de-duplication of the beneficiary list[4], DBT takes support of a biometrics-based unique ID system.[5] Covering about 300 million households across 74 different programs by 2016, DBT is frequently termed by policy-makers as a "game-changer" for improving subsidy administration (IANS, 2015).

On the other hand, any attempt to strengthen enforcement of tax and transfer rules has its own share of uncertainty. More enforcement is generally associated with concerns about exclusion induced by the increased complexity, the ex-ante uncertainty about the returns to investment in technology-based governance reforms, and any potential displacement in fraud and corruption. Ex-ante, the actual implication of any large investment in enforcement capacity, such as DBT policy, is far from being clear.

Using the context of the first major policy application of DBT in India[6] – Direct Benefit Transfer for LPG subsidies (DBTL), this paper studies the impact of increased enforcement on subsidy leakage in public programs. It further investigates the general equilibrium effect of increasing enforcement by estimating how formal sectors and black markets respond to reduction in leakage. Under this universal public program for fuel subsidies, Liquified Petroleum Gas (LPG) for households' domestic cooking use is universally subsidized, while commercial LPG fuel purchases are taxed.[7]. Such differential pricing gives rise to an illegal informal economy, where diverted subsidized domestic fuel refills change hands in the black market and eventually, are used for commercial purposes.

In my analysis, I first lay down a simple framework to understand how the policy-induced reduction in leakage affects the fuel markets. An enforcement policy, if effective, would enhance the state's ability to eliminate transfers to ghost beneficiaries in the subsi-

[4] *De-duplication* is the process to remove instances of multiple enrollments in public programs by the same individuals who use a fictitious or ineligible person's name to withdraw benefits.

[5] India has invested heavily in the ambitious *Aadhaar* program, which has provided the biometrics-based Unique Identification (UID) number to more than one billion residents by 2016.

[6] Out of about 321 million beneficiaries receiving benefits through DBT in 2016, more than half (about 54%) are enrolled under LPG fuel subsidy program (Sahu, 2016).

[7] Even though this seems inefficient, similar public programs exist in developed countries as well. For example, in the US, commercial use of diesel fuel is taxed, but residential use for heating purposes is not.

dized domestic fuel sector (i.e., fuel for household domestic cooking use). This would, in turn, restrict the supply of subsidized fuel in the black market, increasing the black market equilibrium prices. Subsequently, higher black market prices would induce firms in the commercial sector to exit the black market and increase fuel purchases through formal channels. Overall, increasing enforcement with the DBT policy and any resulting reduction in subsidy leakage in the subsidized domestic fuel sector would affect the fuel volume purchased in domestic and commercial fuel sectors, and a resulting supply shock will change equilibrium prices in the black market.

Next, I test these predictions empirically. My empirical strategy is based on two quasi-experiments: (1) the phasing-in of the policy across districts, and (2) its unexpected termination, and I employ difference-in-differences method. First, the DBTL policy was introduced in about 300 districts between June 2013 and January 2014 in six phases. Secondly, this policy was unexpectedly terminated during the run up to the general elections in early 2014.[8]

My analysis used a combination of two unusual and attractive datasets. First, I tap into a novel transaction-level rich administrative database on cooking fuel purchases. LPG is the most preferred cooking fuel in urban areas and is primarily used by middle and upper-class households. More than 3 million LPG refills are purchased every day, resulting in about one billion transactions a year. I use a representative sample of 23.2 million transactions that are carried out by about 4 million households in 509 districts. In addition, I use LPG distributor-level monthly data from more than 3,000 distributors that covers fuel sales in the domestic and commercial sectors.

Secondly, I directly address a perennial problem faced by researchers studying the underground economy: detecting black-market transactions. Black-market activities are difficult to measure, by definition. Previous studies on black markets and tax evasion have generally employed a methodology to compare information from different sources (similar to the

[8]Post-elections, the DBTL policy was reintroduced by the new government.

reporting gap as shown in Figure 1) (Pissarides and Weber, 1989; Fisman and Wei, 2001, 2009).[9][10] My approach involves an audit survey with agents in the black market conducted by enumerators acting as simulated customers, which, to my knowledge, is unique in this literature. The idea behind this audit survey comes from the realization that in this setting, the solicitation of black market prices is possible, since LPG delivery men (popularly known as *Gas hawkers*) – who perform doorstep deliveries to both households and commercial customers – play an important role in the black market for fuel. Further, to complement the 'supply side' black market price data, I also collect prices from the demand side (i.e. small businesses) in local markets to construct a firm-level panel data. Using a systematic data-collection strategy, I organized a team to carry out the field work in 89 districts in 11 states specifically covering the period before and after policy termination. The approach used in my fieldwork leverages the fact that the fuel price information is readily revealed by the unsuspecting agents in the local black markets, in part, because cooking fuel is a ubiquitous commodity.

My main results suggest about an 11% to 14% reduction in fuel purchases in the domestic sector when the DBT policy is enforced. Second, exploiting the policy termination for identification, I find that domestic fuel sales in the treated districts converge to fuel sales in the control districts when the DBT policy is terminated, which suggests that leakage increased when an effective enforcement is removed. Third, the analysis of the firm level panel data suggests about a 13% to 19% decrease in black market prices in treated districts. Black market supply side price data further confirms this. This is consistent with the prediction that when enforcement is removed a positive supply shock in the black market is expected. Fourth, I show that in response to the lower prices in the black market, commercial firms reduce their fuel purchase in the formal sector by up to 9%, which suggests

[9]For recent papers on the estimation of tax evasion and informal economy, see (Slemrod and Weber, 2012). Buehn and Schneider (2013) survey methods used to estimate the underground economy at macro level.

[10]See Merriman (2010) for an interesting application of indirect audits to estimate cross-border tax evasion.

that the removal of enforcement increased supply in the black market and turned it more attractive to firms. Taken together, the empirical evidence from formal and black markets for fuel show that investment in enforcement capacity can significantly strengthen the state's ability to tax and transfer.

I further address two important aspects regarding the enforcement in public programs. First, it is a valid concern that implementation issues in large scale technology-based enforcement programs may lead to an exclusion of genuine beneficiaries. In Section 5.3 and 5.4, I explore the purchase behavior of late complier and non-complier households. A complier household is the one who has submitted the UID and bank a/c details as required under the DBT policy. I find that the beneficiaries who drew more subsidies in the pre-enforcement period, are less likely to comply. Secondly, an increase in enforcement leading to an effective curb on corruption and fraud raises concerns about displacement (Yang, 2008), i.e., a reduction in corruption by the ghost beneficiaries may have to contend with a potential increase in subsidy diversion by genuine households. I find that increased fuel purchases by genuine households do not come close to outweighing the impact of increased enforcement.

This paper contributes to the literature on improving the design of public programs in developing countries. First, I present evidence on high level of leakage in a major public program in India, which is in line with previous research (Reinikka and Svensson, 2001; Niehaus and Sukhtankar, 2013a). Secondly, public programs may have significant pecuniary effects (Currie and Gahvari, 2008). Cunha et al. (2011) show experimental evidence on local price effect of in-kind transfers in rural Mexico, though they also note that the observed price effects are driven almost entirely by remote villages with limited market connectivity. In contrast, the price effect of PDS measured in this study come from local markets in dense urban areas in India. Thirdly, the case for increasing enforcement in public programs in developing countries becomes much stronger when such programs have significant indirect effects. However, empirical evidence on how enforcement in public programs may affect

market outcomes is relatively scant. This paper is one of the first to study the market effects of increasing enforcement in an in-kind transfer program. The evidence presented here complements recent studies on the wage effect of rural employment guarantee program in India (Muralidharan et al., 2016b; Deininger and Liu, 2013; Imbert and Papp, 2015).

Secondly, this study contributes to the literature on corruption in developing countries (Reinikka and Svensson, 2001; Olken, 2006; Niehaus and Sukhtankar, 2013b,a).[11]. Complementing previous theoretical work on controlling corruption using a task-focused approach (Banerjee et al., 2012), this paper shows that a relatively simple e-governance reform, which shifts the authentication and monitoring tasks away from the intermediating agents can be effective in containing fraud and corruption. This paper directly relates to a recent but growing literature on the effectiveness of payments and authentication infrastructure in developing countries.[12] In the context of India's national rural employment guarantee program, Muralidharan et al. (2016a) show that a biometric smart card-based payments infrastructure reduces over-reporting of transfers and is preferred by beneficiaries. aBanerjee et al. (2014) study the impact of e-governance reform in the fund-flow system on leakage in the same public program in India. Relatedly, in the modern tax literature, strengthening enforcement with more information is discussed as the key to increasing tax compliance (Kopczuk and Slemrod, 2006; Gordon and Li, 2009; Kleven et al., 2009).[13] By highlighting the importance of beneficiary information, my paper illustrates that the prevalence of identity fraud may partly explain the high level of evasion in tax and transfer programs in developing countries.

[11]For a review of the empirical literature on corruption in developing countries, see Olken and Pande (2012).

[12]E.g., recent studies provide empirical evidence on the effectiveness of mobile money transfer programs in Africa (Mbiti and Weil, 2011; Jack and Suri, 2014; Aker et al., 2014). Giné et al. (2012) show that fingerprinting borrowers leads to a higher payment rate in credit markets.

[13]Recent papers have highlighted the information-based approaches, as seen with the information trail (Gordon and Li, 2009; Kumler et al., 2013; Pomeranz, 2013), third party reporting (Alm et al., 2009; Kleven et al., 2011; Carrillo et al., 2014), and enforcement technology (Marion and Muehlegger, 2008; Casaburi and Troiano, 2016). See (Slemrod and Yitzhaki, 2002; Slemrod, 2007; Saez et al., 2012) for a review on the tax evasion literature, and Bird and Zolt (2008) for a review of technology's application in tax administration in developing countries.

Finally, this paper highlights the inefficiency in fuel subsidy distribution in developing countries. Fuel subsidies are costly and distorting, especially when they are cornered by non-intended beneficiaries (McLure Jr, 2013; Arze del Granado et al., 2012). When subsidy diversion and fuel black markets are also taken into account, the standard economic guidance to eliminate fuel subsidies in developing countries is likely to have a different impact.[14] Notwithstanding its importance, fuel subsidy diversion in developing countries remains relatively unexplored in the empirical literature.[15]

The rest of the paper is structured as follows. Section 2 discusses institutional context. Section 3 details a simple framework. Data and empirical strategy are discussed in Section 4. Results are reported in Section 5, and Section 6 concludes.

2 The Institutional Context and Policy Experiment

2.1 LPG Sales, Subsidy, and Black Market

Oil Marketing Companies (OMCs) controlled by the government of India, sell LPG to households (for domestic cooking purpose) and to the commercial sector (i.e. businesses, industrial and transport sectors).[16] Households use LPG for domestic cooking and are commonly called "domestic sector", whereas all remaining fuel users are classified under "commercial sector". [17] A total of 13,896 distributors – a local franchisee of OMCs – deliver domestic and commercial LPG refills in 2013 (Ministry of Petroleum and Natural Gas, India, 2014). Without considering any diversion, the domestic sector consumes about 88% LPG fuel, with the remaining being consumed by the commercial, industrial and transport sectors. LPG is primarily an urban fuel with respectively 65.0% and 11.4% adoption in

[14]Particularly, from the climate change mitigation perspective, (Burke et al., 2016) highlight that "...appropriateness of policies may differ in countries with heavily subsidized fossil fuels, high rates of tax evasion, and large informal and state-owned sectors."

[15](Marion and Muehlegger, 2008; Kopczuk et al., 2013) discuss fuel tax evasion in the USA.

[16]India is one of the top five global LPG consumer.

[17]Three different public sector Oil Marketing Companies (OMCs) primarily supply LPG across the country. These OMCs are controlled by the Ministry of Petroleum and Natural Gas. Private LPG suppliers are allowed but their presence is limited to commercial fuel and the piped domestic supply in a few cities only. A heavy subsidy makes it difficult for the private companies to enter the domestic cooking LPG sector.

urban and rural areas (Registrar General of India, 2011). Primarily, middle to upper class households living in urban areas use LPG (Lahoti et al., 2012). Households are supplied with LPG in 14kg cylinders[18], whereas commercial customers receive the same fuel in larger size cylinders. An LPG refill transaction involves the exchange of an empty cylinder for an LPG-filled cylinder. Empty domestic-use cylinders are also rationed and are only supplied by the government appointed distributors[19], which limits the capacity to store LPG.

Fuel Subsidy and Taxation

LPG is subsidized for domestic cooking use and is taxed when used for commercial purposes.[20] There is no free market, and *regulated price* is determined and revised by the government regularly according to the LPG price in international markets. The general LPG pricing structure is as follows. Households receive fuel by paying a subsidized fuel price of $p - s$, whereas firms purchase fuel at a tax-inclusive price of $p + t$. The *regulated price* is p. Domestic subsidy and commercial tax are s and t, respectively. Fig. 2 (Panel (a)) illustrates LPG pricing structure with January 2014 prices, showing about 66% subsidy on domestic fuel and 33% additional taxes on commercial fuel. There is an annual cap on household refill purchase, and beyond that beneficiary households have to pay the regulated price. Annual cap is sufficiently relaxed and the current annual cap is not binding for more than 95% beneficiary households.

Enforcement of Dual Pricing

Since the same commodity is provided in two different sectors (domestic and commercial) at different prices, enforcement is needed to ensure market segmentation. Traditional enforcement of differential LPG pricing hinges on two main factors. First, the domestic LPG cylinder (i.e., LPG refills sold for domestic cooking use) is made to look different from the LPG cylinder meant for commercial consumption. Such visual differentiation in color, shape and size of LPG cylinders helps in reducing enforcement cost, similar to how red dye

[18]In other countries, LPG steel cylinder is also known as "bottle" or "canister".

[19]Of course, one can buy empty cylinder in the black market as well.

[20]Mostly excise tax and VAT. In a few states, domestic refills are also subjected to VAT, but overall there is substantial additional tax on commercial fuel.

in untaxed diesel decreases enforcement cost in the USA (Marion and Muehlegger (2008)). However, this is not a foolproof strategy when monitoring itself is poor. Secondly, the dual pricing is legally binding. *LPG Regulation of Supply Distribution Order 2000* makes it illegal to sell, transport or re-refill LPG by unauthorized persons. Hoarding multiple LPG connections within a household is also illegal.[21] In practice, the audit and penalty policies are not very effective in curbing evasion, when enforcement is costly and requires greater coordination among agencies.[22] After-sales enforcement may also be susceptible to local-level corruption and side payments.

Subsidy Leakage and the Black Market

Resulting price gap due to domestic fuel subsidy and the commercial fuel tax drives the incentive to trade LPG on the black market. Audits reveal that the number of fraudulently created LPG subsidy beneficiaries may run into millions (Sastry, 2012). Further, the role of the delivery man (more commonly known as – the *gas hawker*) becomes pivotal in the black market. In general, the same delivery team is employed by the LPG distributorship to carry out regular doorstep deliveries to the households as well as to commercial customers. Thus, the delivery men hold permits to carry cylinders of both types at the same time. Even though it is difficult to track who actually holds ghost accounts, delivery men become the de facto supply side in the black market. While severe legal provisions are applicable to the independent agents and cartels active in the black market, it is often difficult to punish the distributor or the delivery men even in cases where they have played an obvious role. For any critical irregularity carried out by an LPG distributor, the stipulated penalty terms are significantly less severe than the general penalty for operating in the black market (Ministry of Petroleum and Natural Gas, 2014).[23] LPG distributors have strong national- and state-

[21] As per the LPG Order 2000, "No person other than a Government Oil Company, a parallel marketeer or a distributor shall be engaged in the business of selling LPG to the consumer." Similar restrictions are also present for transportation and storage. Further, using LPG cylinders meant for domestic sector in any other way is a non-bailable offence under the Essential Commodities Act, 1955.

[22] E.g. Food Supplies, Weight and Measurement departments and the Police. Media often reports raids on cartels (PTI, 2014).

[23] Distributors also enjoy a certain level of accounting autonomy. For example, *"Dealers find it terrible*

level unions, and they regularly threaten to strike when reforms aimed at curtailing the subsidy diversion are announced.[24]

Further, diversion of subsidized fuel by households themselves can't be ruled out, and this also raises concerns about further increase in such diversion by households in response to an increase in incentives to sell subsidized fuel on the black market (e.g., higher black market prices). On the other hand, it would be more costly for a household to resell subsidized fuel for two reasons. First, there is a cap on how much subsidized fuel a household can buy, which leaves only a limited post-consumption margin to make profit. Secondly, potential risk of getting detected during as well as time and search cost for black market transactions would be higher for households when compared with delivery men.

2.2 Direct Benefit Transfer policy

The Indian government introduced Direct Benefit Transfer for LPG (DBTL) in June 2013. Under DBTL, benefits are transferred directly into the bank account of verified households beneficiaries, conditional on fuel purchase. After an initial transition period of three months, DBTL was fully enforced, which means only compliant households would receive the subsidy in their bank account once they purchase LPG refill. Irrespective of compliance to DBTL, the non-subsidized LPG (i.e., at regulated price p) remains available to all beneficiaries in the domestic fuel sector.

Generally, identity fraud in public programs is feasible for two main reasons. First, welfare schemes accept documentary proof from multiple and isolated sources[25], which are usually not costly to counterfeit. This makes de-duplication of accounts and verification of frequent transfers very costly. Secondly, intermediary agents (e.g., distributors) can them-

that sale of more than 50 'unaccounted' cylinders is regarded as a 'critical irregularity' [...They] want the limit to be increased to 300 cylinders." (Jai, 2013).

[24]In 2013, delivery men threatened the government with strikes when the UID requirement was introduced (TNN, 2013). In 2012, LPG distributors went on strike when an annual cap on subsidized LPG refills per household was introduced (Kumar, 2012).

[25]For instance, an LPG subsidy beneficiary application provides the option to submit one of the 12 types of documents as proof of identity.

selves over-report (acting independently or in collusion with others) when the responsibility to authenticate and monitor lies with them. Continuous de-duplication with audits is very expensive and infeasible policy option, particularly when the ghost beneficiaries immediately respond to new opportunities to divert subsidies.[26] The rollout of DBTL follows a multi-year preparation by the government of India for providing biometrics based Unique ID (UID) and increasing the coverage of bank accounts. De-duplication is a central feature of the UID program[27]. With the biometric data (i.e., fingerprints and an iris scan) and key demographic data collected during enrollment, an automated system carries out a match for each new record against the database of existing records, thus minimizing the possibility of any duplicity.

India is the first major country to roll out a national biometrics ID program in 2009, where every individual is allocated a unique 12-digit ID (UID) (Fig. A.12). Similar to the Social Security Number system in the USA, registration under the UID program is not yet mandatory, but key government schemes, welfare transfers as well as personal income tax collection (e.g., pensions, scholarships, rural employment guarantee program and other public distribution systems) are gradually being tied to it, thus assigning it a default status of national identification number.[28] Szreter (2007) argue that a national system of identity registration in 16^{th} century England contributed to the country's economic development by facilitating a functioning welfare system. Similarly, India's investment in UID is motivated with the potential efficiency gains in welfare programs and governance.[29] As of March 2014, around 600 million UIDs have been provided, in line with the target of providing the UID to

[26]A recent example is India's Food Security Act (FSA) 2013 which observed a quick flood of fictitious PDS applications. For instance, Bihar recently found more than half a million fake PDS cardholders with one year of the FSA 2013 (Singh, 2014).

[27]The UID program mentions in its mission statement – *"...that can be verified and authenticated in an online, cost-effective manner, which is robust enough to eliminate duplicate and fake identities"*.

[28]UID is also known as *Aadhaar*. More details are available at `http://www.uidai.gov.in`. Gelb and Clark (2013) provide a description of the UID program.

[29]On the other hand, there are privacy concerns associated with biometrics identification systems. The UK repealed its biometrics-based national identification card program (The Identity Cards Act 2006 (c 15)) in 2011. Developing countries may need to opt for second best institutions depending upon the constraints they face (Rodrik, 2008).

each resident – "nothing remotely similar in scale has ever been attempted" (Breckenridge, 2014).

If there are barriers to banking access, it may affect the take up leading to type-I error where genuine beneficiaries may get excluded. Due to greater emphasize on financial inclusion in recent years, banking access has significantly expanded since 2011. Moreover, LPG is primarily a fuel used by middle- to higher-income households and mainly in urban and semi-urban areas, which makes it even less prone to concerns about banking access. According to 2011 census, bank account ownership in India dominates LPG penetration, in both urban and rural areas (Fig. A.15).

DBT utilizes a centralized secured payments infrastructure – *Aadhaar Payment Bridge*, especially set up for transfers to authenticated bank accounts of beneficiaries. Further, when households' bank accounts and their fuel subsidy accounts are seeded with the UID, continuous verification in transactions is no longer needed. As UIDs are gradually linked to various welfare programs, benefits are transferred directly to the bank accounts of the beneficiaries.[30][31] Nevertheless, replacing over the counter subsidies with a direct bank transfer can itself increase enforcement irrespective of a mandatory UID requirement. The real advantage the DBTL policy may offer, is that it does not require frequent verification for each subsidy transfer, and thus, it takes the regular subsidy disbursement and monitoring responsibility away from the LPG distributor.[32]

Phase-wise roll-out and selection of districts

The DBTL policy was implemented in phases. In Phase 1, the government of India introduced it in 20 districts (for timeline, see Fig. 3).[33] In Phase 2, the policy was introduced in 34 new districts in September 2013 and it was fully enforced in January 2014.[34] One-time

[30]While registering for a UID, the application asks for the individual's bank details and provides an option to open a new bank account. Bank accounts can also be linked separately.

[31]The DBT has been criticized for the high cost of UID and potentially low benefits on various grounds including exclusion errors (Khera, 2011).

[32]Direct transfers may also reduce corruption in service provision (e.g., asking for bribe at the time of purchase).

[33]District names are listed in Fig. A.14.

[34]In Phase 1, two districts Mysore and Mandi had delayed implementation because of by-elections. In

compliance requires LPG beneficiary households to provide their bank account and UID number. Compliant households receive a subsidy amount in their bank account following each LPG refill purchase. In the transition period, households that had already complied receive transfers directly in their bank account, whereas non-compliant households kept availing LPG at the subsidized price. Once the policy was fully enforced in a district, all domestic fuel was sold at the regulated price p, and LPG subsidy was transferred only to the compliant households. Late complier households start receiving transfers once they comply and as I show it later, the timing of compliance may be dependent up on the need for next LPG refill.

In total, the DBTL policy was introduced in 291 districts from Phase 1 to Phase 6 by January 2014, out of which 42 districts (from nine states) had it fully enforced by January 2014. Selection of the districts in six phases was made on the basis of initial UID penetration in early 2013. The actual enforcement date was also subjected to a pre-determined cutoff to ensure wider UID take up before making the compliance mandatory for subsidy transfer. Most of the non-policy districts are not included in the program for a reason not related to the LPG subsidy program, which held up the biometrics collection in some states.[35]

2.3 Policy Termination

On January 31, 2014, the Cabinet Committee on Political Affairs unexpectedly decided to terminate the DBTL policy. About 40 days after the surprising political announcement, the government terminated the policy and the household LPG subsidy transfer system was restored to the old system on March 10, 2014 (Nambiar (2014)).[36] About 17 million

Phase 2, twelve districts in Kerala were not included in the mandatory implementation in January 2014.

[35]In January 2012, a cabinet committee divided biometric collection tasks between the Planning Commission (i.e., the UID program) and the Home Ministry (i.e., the National Population Register), which ultimately left a group of states with little UID coverage. Most of the 360 non-policy districts fall in these states – Bihar, Chhattisgarh, Jammu & Kashmir, Orissa, Tamil Nadu, Uttarakhand, Uttar Pradesh and northeastern states.

[36] Later in November 2014, the DBTL policy was re-launched by the new government. The eligibility was slightly modified by additional reliance on an LPG consumer UID and making biometric-based UID voluntary in order to quickly roll out the program across the country (i.e. this re-launch schedule covered whole country in two phases over two months, in contrast to the DBTL implementation schedule by the

households already complying with the program were also moved back to the old regime.[37] While implementation related issues were cited for the decision in a closed door meeting, it does not fit with the Petroleum Minister's assertion few days back that the policy was a success.[38] I look at the impact of delay in compliance due to any implementation-related issues in the results section. Having completed about six months of enforcement in Phase 1 districts, it seems the outright policy termination transpired after continued political lobbying in the run-up to the general elections. High global prices in early 2014 may have also further encouraged lobbying efforts through higher profit expectations in fuel black market transactions. Around election time, special interests group may try harder to obstruct policy reforms in order to ensure the survival of the traditional rent-seeking structure.[39] This may get further reinforcement by politicians who have their own special interests in LPG distributorships.[40] The expected electoral costs of reduced rents may affect the timing of the adoption of enforcement technologies that improve transparency (Bussell, 2010). An incumbent government may also strive to reduce bias in the media, if teething problems with a new policy are selectively highlighted. Moreover, fuel subsidy reforms are generally susceptible to political business cycles in developing countries.[41]

previous government which planned six phases over a duration of more than six months earlier to cover less than half of total number of districts.), minimizing concerns about exclusion errors in new DBT districts where UID enrollment is not yet complete. However, the mandatory UID requirement is reinstated in 2016.

[37]The policy termination also accompanied an increase in the annual refill cap from 9 to 11 in 2013–2014 in all the districts.

[38]The constitutional status of UID was also challenged in the Supreme Court (TNN, 2014), but this was not cited as the reason by the government at the time of sudden termination.

[39]On policy manipulation by politicians seeking re-election (Nordhaus, 1975; Alesina, 1997). Some related contexts of corruption are discussed in (Cole, 2009; Kapur and Vaishnav, 2011; Burgess et al., 2012; Sukhtankar, 2012; Foremny and Riedel, 2014)

[40]A former minister in Karnataka state, himself an LPG distributor, explains – *"As a politician, I am telling you that 90% of the LPG dealers and black-marketeers in the state are either politicians, bureaucrats, or their kin."* This news story was about 2.4 million fake LPG beneficiaries who were uncovered in Karnataka state (Aji, 2012).

[41]E.g., in Indonesia – *"Parliamentary and presidential elections in 2014 mean that there is likely to be little appetite for further subsidy reforms in the first two thirds of 2014."* (IISD, 2014).

3 Conceptual Framework

In this setup, LPG fuel is subsidized exclusively for household cooking usage (i.e., the domestic sector), whereas it is taxed in the commercial sector. Market segmentation creates an opportunity to make profit. Tax evasion and subsidy diversion are complementary here – to evade the fuel tax, a firm has to purchase diverted subsidized fuel from the black market. An entrepreneurial agent can make a profit by obtaining fake or multiple beneficiary accounts. This ghost beneficiary then purchases subsidized fuel and sells it to a firm on the black market. I consider agents on both sides of the black market to be risk neutral and their decision to deal in the black market is a choice under certainty. p is the *market price* (i.e. the government regulated price based on LPG prices in the international market), s is the subsidy in the domestic sector and t is tax in the commercial sector. Before the DBTL policy, all domestic fuel is sold at subsidized price $p - s$[42], and the commercial fuel is available at $p + t$. Total LPG sales (D_{Total}) will consist of cooking fuel demand of genuine households ($D_{household}$), the ghost beneficiaries (D_{ghost}) and the commercial firms (D_{firm}). Ghost beneficiaries purchase fuel in the domestic sector and sell it to the firms.

$$D_{Total} = \underbrace{D_{household} + D_{ghost}}_{Domestic\ fuel\ sector} + \underbrace{D_{firm} - D_{ghost}}_{Commercial\ fuel\ Sector} \tag{1}$$

The black market supply and demand is conditional on the level of enforcement C. Say, C_{ghost} and C_{firm} denote the net expected cost to the supply and demand side respectively,[43]. The equilibrium black-market price P is determined by the supply (S_{bm}) and demand (D_{bm}) in the black market:

$$S_{bm}(P - C_{ghost}) = D_{bm}(P + C_{firm}) \tag{2}$$

Thus, the black-market price is increasing in C_{ghost}. The DBTL policy makes it prohibitively

[42]Annual cap on subsidized fuel is ignored here, which was not binding for more than 95% of the beneficiaries in 2013-14.

[43]Here firm level heterogeneity in C_{firm} is ignored. In a richer model, there may be different categories of firms depending upon their preference for buying from the black market – (1) firms buying all the fuel in black market only; (2) firms buying fuel partially from the black market, and the rest through the formal channels; and (3) firms purchasing fuel only through formal channels.

expensive for the ghost beneficiaries to receive a fuel subsidy (i.e. C_{ghost} increases significantly), and so, the black-market price increases. Further, firms have an outside option available for purchasing the fuel legally at a tax-inclusive price $(p + t)$:

$$D_{firm} : D_f[min(p + t, P + C_{firm})] \tag{3}$$

When $P \geq p + t - C_{firm}$, firms may decide to leave the black market and purchase fuel in the formal sector. Firms may even switch to a new fuel.

However, in our setup, a ghost beneficiary can still continue to obtain non-subsidized fuel (i.e., at price p) without complying to DBTL policy. Before the DBTL policy, the ceiling and floor in the black market is determined by the subsidy diversion opportunities available to the ghost, tax level and existing enforcement on either side of the black market, $P \in (p - s + C_{ghost}, p + t - C_{firm})$. When the DBTL policy in enforced, the price floor shifts up because the increased enforcement eliminates subsidies to the ghost beneficiaries: $P_{DBTL} \in (p + C_{ghost}, p + t - C_{firm})$ (Fig. 2).

To sum, we have following predictions on the impact of the DBTL policy:

Prediction 1. Domestic Sector: Decrease in fuel purchase

Prediction 2. Commercial Sector: Increase in fuel purchase

Prediction 3. Black Market: Increase in price

Similarly, an opposite impact is expected when the policy is terminated.

Finally, increasing enforcement on corruption may encourage micro-level evasion by the households. A household may choose to divert unused fuel under its quota when the annual cap is not binding to its expected total fuel consumption. A household's decision to engage in the black market would depend on the expected cost and benefit. Increased enforcement on the ghost beneficiaries leads to a higher black-market price, which in turn, may tilt the decision in favor of diversion. Since household level subsidy diversion is still illegal, this increase in micro-level evasion is similar in spirit to the displacement in corruption, perhaps with redistribution consequences. Fig. A.13 illustrates the expected effects in the black

market.

4 Data and Identification

4.1 Data

4.1.1 Beneficiary Level Data

I use a transaction-level data from 3.79 million fuel subsidy beneficiaries. This sub-sample consists of 10% randomly selected beneficiaries from the HPCL (Hindustan Petroleum Corporation Limited) database of about 40 million beneficiaries.[44] This leads to a sample size of 23.2 million transactions in 509 districts in 25 states (Table 1). This dataset covers a 12 month period from April 2013 to March 2014 (i.e. one financial year) and includes complete LPG refill history for all the beneficiary accounts in the sample. The median household purchases seven LPG refills in a year ($\simeq$ 100kg LPG per year). The transaction-level data is rich in information. It provides the number of refills, the LPG refill order date, the LPG refill delivery date and information on compliance with the DBTL program. I consolidate the data into a household-month level panel.

4.1.2 Distributor-level Data

Distributor-month level LPG sales data covers 3,341 distributors in 504 districts (Table 1). The data segregates monthly LPG sales by sector, i.e., domestic fuel (14kg refills) and commercial fuel (19kg refills). On average, an LPG distributor sales around 6670 domestic fuel refills and 460 commercial-fuel refills in a month. The sample used in this study is from April 2013 to April 2014 (total 13 months). Note that 19kg LPG refills sales does not represent all of the commercial sector LPG demand. Small businesses and industries can buy LPG either in 19kg, 35kg, 47.5kg refills or in bulk. LPG is also distributed as transport fuel. Thus, I have commercial fuel sales information only from a subset of commercial sector (i.e. all 19kg LPG refill sales). The non-domestic sector sales is about 12% of the total

[44]HPCL is one of the three OMCs under the Ministry of Petroleum and Natural Gas and owns about 25% LPG market share. It is uniformly present in about 80% of the country.

LPG consumption in India in 2013-14.

4.1.3 Survey in the Black Market for LPG Fuel

I conducted fieldwork between December 2013 and March 2014 to collect black-market price information. Using two different survey instruments, data was gathered from: (1) the supply side, i.e., LPG delivery men, and (2) the demand side, i.e., small businesses. The survey instrument was designed with pilot surveys and an understanding of the LPG black market in urban areas. These districts are randomly selected from the different phases. There are 10 districts in Phases 1 and 2 (i.e., treated districts), 50 districts in Phases 3 through 6 (i.e., transition districts), and 29 districts in the non-policy group. Until the date of termination, the DBTL policy was fully enforced only in Phase 1 and 2 districts. Non-policy districts were never introduced to the policy. As it rightly appears, Phase 3 through 6 and non-policy districts are over-sampled. This is because policy-termination was not at all anticipated before the beginning of the field work. The initial fieldwork design was planned with a forward looking design to compare the pre- and post-treatment prices in the districts where the policy had not yet enforced. So, initial power calculations were based on a relatively mild and gradual impact expected on the black market fuel prices. Districts in Phase 1 and 2 were included right after the political announcement of policy termination, but about a month before the actual termination. Further, to ensure against any concerns about lag in surveying the treatment districts, an additional four control districts were surveyed simultaneously with Phase 1 and 2 districts.[45] In this study, data is used from the two survey rounds covering the period before and after the policy-termination (Table 2). As an advantage to this paper, the unexpected termination of the DBTL policy made it possible to observe the sudden and much higher impact on prices.

[45]The fieldwork in 14 additional districts (i.e., 10 districts in Phases 1 and 2, and 4 districts in non-policy group) began within five days of the regular round 1 survey in other districts. The difference in the mean black-market prices collected from the control districts surveyed in these two batches of the same wave is statistically insignificant. In the post-policy termination round, all the districts in the sample are surveyed simultaneously.

Demand Side: Survey of the Small Businesses

In each round of survey, about 15 small businesses were surveyed per district, leading to a total of 1452 small businesses from 89 districts. For sampling, first an area roster was created after listing the main market areas, and up to three local areas were randomly selected. Next, small businesses in these local markets were listed and sampled. Due attention was given to ensure the inclusion of small businesses with a similar production function, such as snack counters and restaurants.[46] For example, more than 60% of the sampled small-businesses sell Samosa (a popular North-Indian snack) and chai (hot tea). About 20% attrition was observed in the post-termination round and replacement firms were surveyed from the same local markets. With a number of questions on LPG prices asked in different ways, the survey instrument was carefully designed to collect LPG refill price information without confronting the business-owner about his dealings in the black market. The survey collects data on ongoing black market prices as well as on LPG refill history.

Supply side: audit survey with LPG delivery men

Up to seven LPG delivery men were surveyed in each district in an audit format.[47] The same local market areas were surveyed as in the small business survey and on the same day. The enumerator approached every alternate delivery man. A delivery man, as part of his regular job, carries empty and filled LPG cylinders of both types (domestic 14kg and commercial 19kg), so he can be recognized easily. The enumerator asked for a quote for a 14kg LPG refill to be delivered on the same day. Specifically, as per the script provided, the enumerator told the delivery men that she did not have an LPG beneficiary card and wants to buy an LPG refill today *in black*.[48] One round of bargaining was also embedded in the script to elicit the true offer price for a black market LPG refill.

[46]Metal-cutting shops, other small industrial firms and commercial taxi drivers may be other potential buyers on the black market.

[47]Enumerators could not find enough number of delivery men in all the areas.

[48]Inquiry to purchase an LPG cylinder "in black" or "without a beneficiary card" is readily interpreted for a potential black market transaction. In the pre- and post-termination rounds, the percentage of delivery men who refused to entertain a black market transaction inquiry was 18.2% and 4.2% respectively.

4.2 Empirical strategy

Using a difference-in-differences method, I exploit the phase-wise roll-out of the DBTL policy and its unexpected termination in order to test the predictions developed in Section 3. The phase-wise roll out-provides a treatment variation in time and districts. Selection of districts in earlier phases is on the basis of initial UID penetration in these districts, which is assumed to be uncorrelated with subsidized fuel diversion. I also use multiple control groups to conduct robustness checks. Next, I exploit unexpected decision to terminate the policy in early 2014 to estimate causal effect of DBTL policy termination. Post-termination, LPG subsidy transfer system was restored as it was before the introduction of DBTL policy. The assumption that the selection of districts into initial phases is not correlated to subsidy diversion, equally applies here. Equation 4 shows the main empirical specification.

$$Y_{idm}=\alpha + \beta.Post_m * DBTL_d + \mu_i + \pi_m + \epsilon_{idm} \tag{4}$$

where i in district d in given month m. $Post_m$ is defined as the dummy for treatment period taking value 1 after DBTL is enforced and 0 otherwise, $DBTL_d$ is dummy for the districts reflecting treatment status: districts in treated group has $DBTL_d = 1$ and 0 otherwise. μ_i is the dummy for each household controlling for household specific time invariant factors such as family size, education, wealth, eating preferences etc. ; π_m denotes month dummies controlling for month specific effects. ϵ_{idm} is household specific error term. With household-month level data, Y_{idm} is total number of LPG refills purchased by the household. The difference-in-differences coefficient β on $Post * DBTL_{dm}$ (i.e. an interaction of $DBTL_d$ and $Post_m$), provides average treatment effect of DBTL policy on domestic sector fuel purchase. OLS is used for estimation with standard errors clustered at the district level. In the preferred specification, Phase 1 districts are in the treated group, and are compared with the upcoming phases (where DBTL policy was introduced but not yet enforced) and non-policy districts (where DBTL policy was not yet introduced). This enables the longest treatment period of six months to reassure against any short term time-substitution in fuel

purchases and delay in compliance. Impact of policy termination is estimated in a similar way by replacing $Post_m$ with $Post - termination_m$.

In order to show dynamic response in domestic sector fuel purchase, I estimate month-wise treatment effect in treated districts with the following specification.

$$Y_{idm}=\alpha + \beta.DBTL_d * \theta_m + \theta_m + \mu_i + \epsilon_{idm} \tag{5}$$

where β provides month-wise marginal effect on recorded domestic sector LPG refills. I present the results with month-wise estimated coefficient plot. These plots also enable comparison of pre-treatment and post policy termination trends in pre-treatment and post-termination period. Further, I employ similar specification with distributor-month level panel. The outcome variable in *log(total LPG refills sales)* and I look at domestic and commercial fuel sales separately. Distributor fixed effects are included to control for distributor-level time invariant factors. Using the survey data, I estimate the impact of policy termination on black market fuel prices using similar specification (Equation 4). In the preferred specification, the outcome variable is *log(black-market price)*. With the supply side (delivery man survey) analysis, district level fixed effects are used, and with the demand side (firm-level survey) analysis, firm fixed effects are included.

5 Results

5.1 Impact of DBTL Policy Roll-out

5.1.1 Domestic Fuel Sector

Fig. 5 reports the estimated month-wise treatment effect of the DBTL policy on fuel purchases in the domestic sector (Equation 5). Regarding the pre-treatment trends, this plot shows that beneficiary fuel purchase trends in treated and control districts are similar in the five months prior to the enforcement of the DBT policy.

These estimates suggest the DBTL policy enforcement caused a significant drop in the fuel purchase in the domestic sector, indicating a reduction in leakage. Table 3 shows the

estimated average treatment effect using the same sub-sample as in Fig. 5. After controlling for household and month fixed effects, the estimated effect is an 11.2% to 13.8% decrease in domestic fuel purchase. The coefficient on the interaction term in Col (1) suggests a decrease of 0.0664 in monthly household LPG refills, which is about 11.8% of average LPG refills per household per month.[49] The estimates are robust to using different control districts. Col (2) and (3) show estimates of the effect of policy separately with transition (Phases 3 through 6) and non-policy districts in the control group. In all the regressions, the treatment group includes districts from Phase 1.[50]

Further, I confirm these estimates using the distributor-level panel dataset. In Fig. 6, the estimated coefficients suggest a similar impact of the DBTL policy on fuel sales in the domestic sector. Difference-in-differences estimates show that the enforcement of DBTL policy reduces fuel demand in domestic sector by 13% to 17% (Table 4). These estimates are slightly on the higher side, but are very close to the ones shown with the beneficiary-level panel above (Table 3).

Overall, the results show that the DBTL policy reduced the purchase of fuel in the domestic sector. This is in line with the first prediction and indicates that fuel purchase by the ghost beneficiaries decreased with the policy's enforcement. Note that in all of these regressions, our outcome variable includes all domestic LPG refills irrespective of the subsidy transfer, because excluding domestic fuel purchases by the households who did not comply or complied late may lead to an over estimation of the impact. A large effect in the first month indicates a delay in compliance and timing to purchase the fuel, likely by the households that were late to comply.[51] I discuss the policy effect on late complier and

[49]Mean of number of monthly refills per household is provided in the Table 3.

[50]Phase 2 districts are not included here because the DBTL policy was enforced in Phase 2 districts during the treatment period for Phase 1. Results with Phase 2 districts are presented in the appendix (Table A.11).

[51]Genuine exclusion, effect of subsidy-salience on fuel consumption, and fuel switching can also explain a part of the effect. However, it won't be a concern if the non-complier or late-complier household buys non-subsidized domestic LPG refill through the distributor or in the black market, since all domestic refills sales is included in the outcome variable. A beneficiary can switch to kerosene, but that will require surrendering their LPG beneficiary card. Potential concerns may be about switching to coal or firewood temporarily, which cannot be completely ruled out.

non-complier households in Section 5.3 and 5.4.

5.1.2 Commercial Fuel Sector

A reduction in sales of the domestic fuel should accompany an increase in the commercial-fuel demand. However, the estimated effect of DBTL on fuel sales in the commercial sector is not significant (Table A.13). Although this is surprising, several potential explanations are possible. First, the program enforcement date was known for a long time and firms as well as agents active in the black market may have anticipated the effect well in advance. Fuel switching and up to certain extent, fuel stock-piling because of anticipated black market price changes can also be not ruled out. Second, as already mentioned in the data section, the commercial LPG sales data do not cover all non-household LPG sales. The data used in this study includes 19kg LPG refills only, whereas commercial supply is also provided in 35kg, 47.5kg, in bulk and also as transport fuel.

5.2 Policy Termination

5.2.1 Domestic Fuel Sector

Policy termination provides another opportunity to identify the impact of the DBTL. The policy termination has already been shown with the coefficient plots (Fig. 5 and Fig. 6). With the distributor-level sales data, the covered time period includes one additional month (April 2014), providing a longer post-termination period. Note that Fig. 6 confirms that post-termination trends are similar in the treated and control districts. In addition, domestic sector fuel sales in treated districts revert to the level in the control districts, i.e., the difference between treated and control districts in terms of domestic fuel sales is insignificant after the enforcement is removed.

Table A.14 (Col (1) and (2)) reports about a 6 to 7.5% increase in the domestic fuel purchase due to the reversal in the DBTL policy. The estimate in Col (3), where the control group consists of districts not yet planned for policy roll-out, is positive but not significant.[52]

[52]This is likely because the post-termination dummy (termination occurred on March 10, 2014) does not

Similarly, with the distributor-level sales data, estimated coefficients suggest the symmetric impact of policy termination, when compared with the effect of policy enforcement (Table 5). About a 6% to 13% increase in distributor-level fuel sales in the domestic sector is observed when the DBTL policy was reverted. Taken together with the estimated effect of DBTL roll-out, we see the opposite impact on the fuel sales in domestic sector.

5.2.2 Commercial Fuel Sector

The termination of the DBTL policy lowered fuel sales in the commercial sector by 6% to 9% (Table 6). Together with the results on fuel sales in the domestic sector, we see that the DBTL policy termination, which was meant for the domestic sector only, affects fuel sales in the domestic as well as the commercial sector. While confirming prediction (2), this result indicates that the relaxation in enforcement in the domestic sector led to an increase in the diversion of subsidized fuel to the black market and fuel tax evasion in the commercial sector. Note that, in terms of levels, the impact on fuel sales in the commercial sector is lower than the increased amount of domestic fuel sales, but the direction of impact is in the same direction as predicted.

5.2.3 Black Market Price

***Supply Side*: Delivery Men Audit Survey**

Using black market LPG refill data from the pre- and post-termination periods, Table 7 (Panel A) reports the estimated coefficients for difference-in-differences specification. The DBTL policy termination reduced black-market price quotes from 13% to 16%. These estimates are also robust to more demanding time fixed effects as in Col(2). Since black market prices were higher during enforcement, it can be inferred that the impact on enforcement has had greater impact on pre-enforcement base prices. In other words, with respect to the pre-enforcement base price level, the impact of the DBTL will be even higher than these

fully align with the monthly structure of data, but I carry the same structure throughout this paper for consistency.

estimates.

Demand Side: Small Businesses Survey

Similarly, Table 7 (Panel B) presents estimates using the data reported by small businesses. This provides us with slightly higher, but still closely aligned, estimates. Col (3) and (4) show that the policy termination in treated districts caused about a 20% decrease in black-market price. This jump in black-market price indicates a positive supply shock on the backdrop of the termination of the DBTL policy. Note that the effect is slightly higher than the estimates with the supply side survey. A higher level of bargaining by long-time buyers after the sudden policy termination could be one potential explanation. Interestingly, the coefficients on the interaction and treatment terms sum up to zero, indicating that the policy termination led to a convergence in price levels in the treated and control districts. This is a significant result, considering that the treated and control districts had very similar trends in fuel sales in the pre-treatment period. Table A.15 in the Appendix provides additional results with the transition districts in the control group. It confirms that the policy termination unambiguously brought black market fuel prices down.

In above analysis, firm and location fixed effects help in controlling for any consistent misreporting. By design, each round of survey was completed in a tight time window, usually within a week, to counter concerns about any time variation in prices. Next, the audit survey (supply side) and the small businesses survey (demand side) provide similar estimates, that help in ruling out any strategic misreporting by the respondents. The demand-side survey also included questions about LPG refill history that provided retrospective data on the date and price of the last five LPG refills. This helps in creating an unbalanced daily panel of the black-market prices, which I use to estimate the impact of the policy. Using a range of different treatment and control districts, Table A.16 confirms that the estimated effect is robust to many different combinations of control and treatment districts. Unambiguously, the policy termination brought black-market prices down. However, effect size is smaller,

when the treatment group consists of transition districts only.[53]

The refill history data provides a price time line that allows testing for any discontinuity in black market prices on the date of the policy termination. Fig. 11 shows the results with a 40 day window around the policy termination date. Note that the discontinuity in black market prices only shows up in the treated districts, and price levels in the transition and non-policy districts are stable around the policy termination date. This offers additional support for the main estimates.

5.3 Slow Compliance and Implementation Issues

While the DBTL program has a significant effect on reducing subsidized fuel diversion into the black market, there are various factors that may affect the above estimates. First, implementation issues and delay in compliance may also affect the above estimates. This is a particular concern if some of the genuine beneficiaries, if they could not fulfill DBTL compliance requirement, are also eliminated. Compliance requires linking a bank account and UID with the LPG fuel account. Slow uptake may be attributed to bank accounts and UID coverage. However, by January 2014, UID penetration had covered 98.5% of the population in Phase 1 districts (Fig. A.14). The 2011 census shows that bank account ownership dominates LPG adoption by households (Fig. A.15). However, about 20% of households in the treated districts fulfilled the compliance requirement (i.e., submitting a UID and a bank account number) after Sep 2013 (Fig. A.16). A household is more likely to fulfill the compliance requirement the next time an LPG refill is needed. Note that more than 90% of households do not need to purchase an LPG refill every month, since the median household consumes seven LPG refills per year. Further, Fig. 10 provides a reasonable assurance against the concerns of implementation issues pertaining to compliant households (such as, delay in bank transfers or UID reporting affecting purchase behavior of compliant beneficiaries in the treated districts) since purchase behavior of genuine households in treated

[53]This is likely because even before the DBTL policy is enforced, black-market price starts increasing in the market.

districts is mostly parallel with the genuine households in Phase 6.

Second, the strategic timing of an LPG refill purchase can change pre- and post-treatment purchase. One possible channel is LPG storage. Households have limited, but some, storage capacity by design, since a 14kg LPG refill lasts almost two months for the median household.[54] Thus, the relatively large dip we observe in the first month of the DBTL enforcement period (as in Fig. 5) may be partially attributed to an inter-temporal substitution in purchase decisions. This attenuates the estimates for the impact on fuel sales in the domestic sector. However, given a total period of six months, this should not significantly affect the magnitude of the average effect.

There are several pieces of supporting evidence to suggest that late compliance does not drive our main results. First, Fig. 5 and particularly, Fig. 7 show that the post-enforcement gap between the treated and control group remains mostly constant (except for the first and last month during the enforcement period), despite more than 20% of households complying from September 2013 to February 2014. In other words, the relatively constant LPG refill purchase gap between the treated and control districts should have otherwise gradually reduced if the delay in compliance played a significant role in bringing down the amount of LPG purchased in the domestic sector. Second, I directly test it by comparing the purchase behavior of late complier households in the treated districts (Phase 1) with the fuel purchase by households in the control districts (Phase 3 through 6). Fig. 8 shows that households that complied late did reduce LPG refill purchases right after the enforcement, but they more than compensated for it in subsequent months. Since the post-enforcement period covers all six months, there should be little effect on the estimates. Overall, this indicates that households that could not comply before DBTL policy was enforced did not change their average fuel purchase behavior significantly during the enforcement period.

I compare the fuel purchases by early and late complier households in the treated districts. Fig. A.20 shows that the late complier households gradually increased their LPG refill

[54]Having more than two LPG cylinders per household is not allowed. The government controls the supply of empty LPG cylinders as well.

purchase. In fact, during the enforcement period, fuel purchase by late compliers reaches the fuel purchase level of early complier households, although in the pre-enforcement period average fuel purchase was lower in late complier sub-group. This suggests that, up to some extent, late complier households timed the decision to purchase fuel. Further, the decrease in fuel purchases contributed by late complier households is small (i.e., the area between the treated and control plots in Fig. A.20), when the proportion of late complier households is also take into account. At the most, it may explain a less than 4 percentage point decrease in LPG refill purchases, though additional robustness checks do not support this estimate.[55]

5.4 Non-Complier Households and Potential *Ghost Beneficiaries*

Less than 20% of beneficiaries in the treated districts did not comply by March 2014. With the descriptive data, Fig. 4, Panel (a) shows that beneficiaries who drew more refills in the pre-enforcement period are less likely to comply.[56] Fig. 4 further shows that the percentage compliance slows down at higher pre-treatment LPG refill counts. These non-compiler beneficiaries are also more likely to stop purchasing fuel. Fig. 9 reports that there was a huge drop in LPG refills purchased by non-compliant beneficiaries, when compared with complier households in Phase 3 through 6. On the other hand, we do not see such a drop in fuel purchases by late complier beneficiaries (households that complied after the program was enforced) in Fig. 8.

I further explore whether the count of beneficiaries purchasing zero refills responds to the introduction of the DBTL policy. Table 9 reports that the enforcement of the DBTL policy caused a 10% to 13% increase in the number of households that did not buy a single refill in a given month. This sample includes all the households, irrespective of their compliance status. Further investigating whether this effect is driven by low LPG refill purchases in the

[55] As an additional robustness check, I compare late complier households in Phase 1 districts with complier households in Phase 6 districts (Fig. A.21). Phase 6 provides an attractive control group for robustness check since it was introduced to the policy in the end.

[56] High-frequency beneficiaries are defined as the beneficiary who purchase five or more LPG refills, that is more than the prorated annual LPG refill cap at that time.

first enforcement month (or the last month before policy-termination), Fig. 7 reports that the treated districts observed more households that purchased no refills throughout during the enforcement period.

Exploring the take up rate in the treated districts, I plot monthly compliance conditional on pre-enforcement fuel purchase (Fig. A.17). The plot shows that compliance rate responds to the enforcement, but overall compliance stays much lower in high fuel purchase sub-group. Note that the steepest compliance rate is shown by the households which did not purchase a single refill in pre-enforcement period. This likely represents new enrollments in the LPG subsidy program.[57] This can also be explained by timing to comply only when the household needs next LPG refill.

These empirical patterns highlight a couple of important points. First, we see different pre-treatment purchase behavior of the households that failed to comply with the DBTL compliance requirement until the very end. Second, while late complier households do not show a significant reduction in LPG refills purchased during the DBTL enforcement period, non-complier beneficiaries significantly reduced their fuel purchase in this period. The number of households who purchased zero-refills during the enforcement period also suggests a pattern that is expected from the ghost beneficiaries, who may opt to exit the black market when the DBTL policy is enforced. Even though not all non-compliant beneficiary households can be categorized as ghost beneficiaries, it is likely that a good number of non-complier beneficiaries could not comply because they do not exist. However, using household level fuel purchase data, it is difficult to completely separate ghost beneficiaries from genuine non-compliant households.

5.5 Heterogeneous Effects

In order to see whether the DBTL policy affected various subgroups in different ways, I use pre-treatment purchase behavior and the compliance-status of the beneficiaries to

[57] Available data does not provide LPG subsidy beneficiary enrollment date.

analyze heterogeneous treatment effects. This endogenous analysis is obviously limited in the sense that I do not have socio-economic data on the households. It is possible that a large number of these LPG beneficiary cards were held by ghost beneficiaries, who drew a higher number of LPG refills in the pre-enforcement period.[58]

I explore the impact of DBTL on high and low LPG purchase frequency subgroups using a triple difference design. A prorated annual LPG cap cutoff (i.e., five or more than five refills) is used to divide households into two sub-groups as per their pre-treatment purchase behavior: (1) High-frequency beneficiary), and (2) Low-frequency beneficiary. Similarly, using the information on household compliance date, we have another division (1) Compliant beneficiaries, and (2) Non-compliant beneficiaries as per their status in the first month of enforcement. Results are shown in Fig. A.18. The triple difference coefficient shows more than 30% impact on the high-frequency non-compliant households, which is more than twice as large as the average treatment effect estimated in Section 5.1.1. It suggests that high-frequency non-compliant households are more likely to decrease their LPG purchase, once the DBTL policy was enforced (Table 8).

5.6 Diversion of Subsidized Fuel by Households

It is of policy interest to see whether the increase in enforcement on ghost beneficiaries causes an increase in subsidy diversion by genuine households. High black-market price (when the DBTL policy was enforced) and the non-binding annual LPG refill cap can provide lucrative incentives to trade on the black market. I empirically test whether the DBTL policy induces additional households to divert domestic fuel to the black market.

Fig. A.19 shows that there is indeed a steep jump in LPG purchases by early complier households, when DBTL is enforced. An early complier household is the one who complied by the time the policy is enforced. This single difference plot reports that early complier

[58] A genuine beneficiary who prefers not to comply (or, cannot comply) would likely try to use the entire fuel quota before the DBTL policy came into force, but households have limited capacity to store LPG because of the cap on empty cylinders.

households increased their fuel purchase substantially when DBTL policy was enforced. In order to elicit causal estimates, I further use compliant households in yet-to-be treated districts (Phase 3 through 6) as control. Table 10 shows the results. Enforcing the DBTL caused a 4% increase in LPG refill purchases by the genuine households in treated districts (Col (1)). While this is a positive effect, when compared to the overall impact of the DBTL policy on the supply in the black market, the size of this effect is small.

As a robustness check, to allay concerns about any effect of the DBTL policy introduction on the households in the control group, I test the same specification only with households in Phase 6 as control. Phase 6 districts entered the transition period in January 2014, thus the first four months in the Phase 1 treatment period (September to December 2013) are relatively less prone to any concern about changes in purchase behavior during the transition period. Fig. 10 provides little support in favor of an increase in the subsidy diversion by households, as reported in Col (2) in Table 10. There are two potential explanations. First, households may face a higher legal and logistic cost when they try to sell an LPG refill on the black market. Second, social norms may make it costly for a household to participate in the black market. Overall, household-level diversion does not seem to outweigh the reduction in household fuel sales after increased enforcement.

5.7 Comparison of Results with Predictions and Concerns about Estimates

To summarize, results show that the Direct Benefit Transfer policy reduced fuel purchases in the domestic sector. This confirms Prediction (1) and indicates a reduction in subsidy diversion through the ghost beneficiary accounts. Analysis of commercial fuel demand did not show a significant positive effect during the enforcement period, but the impact of unexpected policy termination confirms Prediction (2). Black-market price decreased when the DBTL policy was terminated, which is in line with Prediction (3).

I also investigated several other strands. First, it is evident that the beneficiaries who

bought more subsidized fuel in pre-enforcement period are less likely to comply with the requirement for DBTL. Evidence suggests these beneficiaries are also more likely to change their purchase behavior after the increased enforcement. This is consistent with the story of subsidy diversion through the ghost beneficiaries that are unable to procure a bank account and/or UID. Secondly, I show that results are not driven by late compliance or under-provision to compliant households. Finally, I test whether the increased enforcement increased diversion of subsidized fuel by compliant households in treated districts and, at least in the short run, it does not seem to be high enough to outweigh the reduction in subsidy diversion by the ghost beneficiaries.

The main estimate on reduction in fuel purchases (i.e., 11% to 14%) in the domestic sector is less than the *subsidy gap* shown in Fig. 1. However, it is not far from official audits. For example, Karnataka state carried out rigorous verification of the LPG subsidy beneficiary list in 2012 and found about 22% illegal LPG beneficiary cards (Sastry, 2012). Note that a certain degree of subsidy diversion could still continue under the DBTL policy, since a lower but significant margin to make profit remained available due to price difference between non-subsidized domestic fuel and commercial fuel. A part of the residual *subsidy gap* can also be explained with a pre-existing level of subsidy diversion by compliant households. Finally, genuine exclusion remains a potential concern in this paper, which could not be sufficiently addressed with the available data and is difficult to separate from voluntary non-compliance.

6 Policy Discussion and Conclusion

When reducing subsidy diversion and curtailing the black markets using traditional enforcement methods (e.g., audit and penalty) is not feasible, it may be more effective to invest in enforcement infrastructure such as a DBT platform. This paper presents an array of empirical evidences from formal and informal sectors to illustrate how developing countries can make welfare delivery systems more effective.

With a reduced subsidy burden, there are direct benefits in terms of more funds for other public programs and a reduction in taxes. Black-market activities are also a waste of resources, which could be put to more productive use. In addition, since reduced evasion changes the ultimate fuel price that firms face, an increase in fuel efficiency may also have its own environmental and macro-economic benefits. Moreover, there is an effect expected in terms of decreasing informality and cash in the underground economy. Gordon and Li (2009) discuss how, in developing countries, informal firms decide to stay in the cash economy by weighing the potential cost and benefits of using the financial sector. Fuel purchases in the black markets play a similar role by allowing firms to avoid leaving an information trail of their fuel consumption, which could otherwise be linked to the size of their businesses by tax inspectors.

A complete welfare analysis would require the analysis of general equilibrium effects, for which no attempt is made here. Increasing enforcement on fuel subsidies may increase the general price levels. There could also be a heterogeneous impact on firms who would then try further to find ways to manipulate the new system. Secondly, there are implications for redistribution if poor households are genuinely excluded or they loose benefits from diverting subsidized fuel. In the latter case, heterogeneity in household's ability to make profits on the black market would matter. Thirdly, any switching to dirtier fuels in response to higher LPG prices will have its own health and environmental implications.

Tax and transfer administration reforms are important for developing countries. Yet, the enormous investment required often makes it difficult for policymakers to commit to new enforcement systems. India's DBT policy rides on a heavy investment in technology and its cost and expected benefits are widely debated. Since the DBT program is also being implemented for other welfare programs, it is difficult to gauge its net benefits in this paper. However, at a recurring bank transfer cost fixed at 1% and the expected cost of USD 3 for each UID issued (Gelb and Clark, 2013), it is likely that, expected efficiency gains in tax and transfer programs over years will outweigh the cost of enforcement. For

example, DBT has been implemented in about 74 public programs in India till 2016, and recent government estimates suggest a fiscal savings of *"...USD 6 billion which used to be pilfered by middleman or fictitious persons"* (PTI, 2016).

On a broader level, reforms to combat corruption and evasion need much stronger political support and are susceptible to political business cycles. The unexpected DBTL policy also illustrates that as long as political acceptance remains insufficient, technology alone cannot help. Casaburi and Troiano (2016) show that incumbent politicians may enjoy higher likelihood of re-election because of wider approval with an anti-tax evasion policy. However, such potential gains may not be visible to the politicians themselves ex ante.

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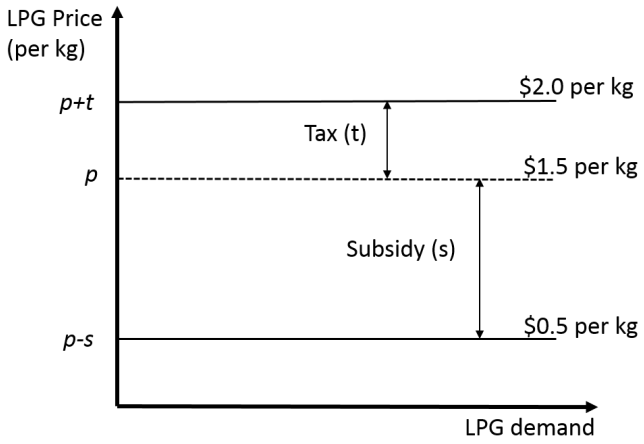
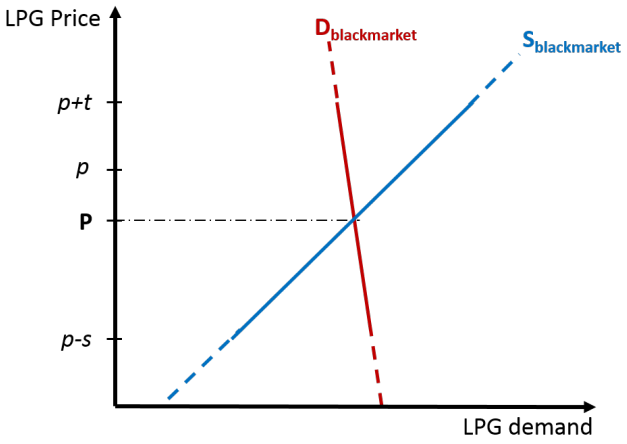
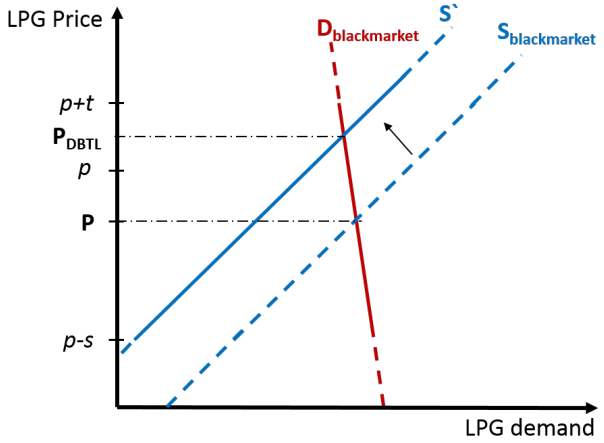
Figure 2: Impact of DBTL on fuel black market



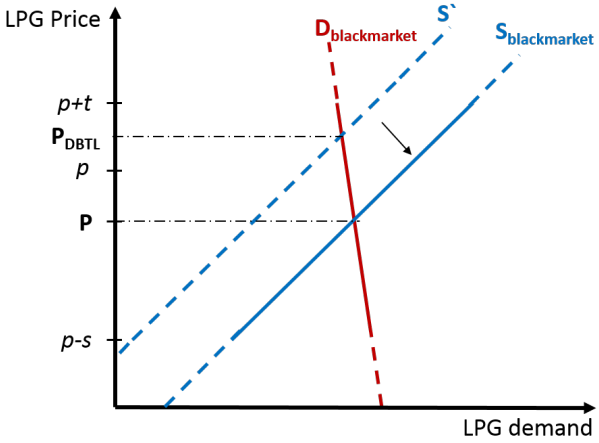
(a) LPG pricing



(b) Equilibrium price in fuel black market



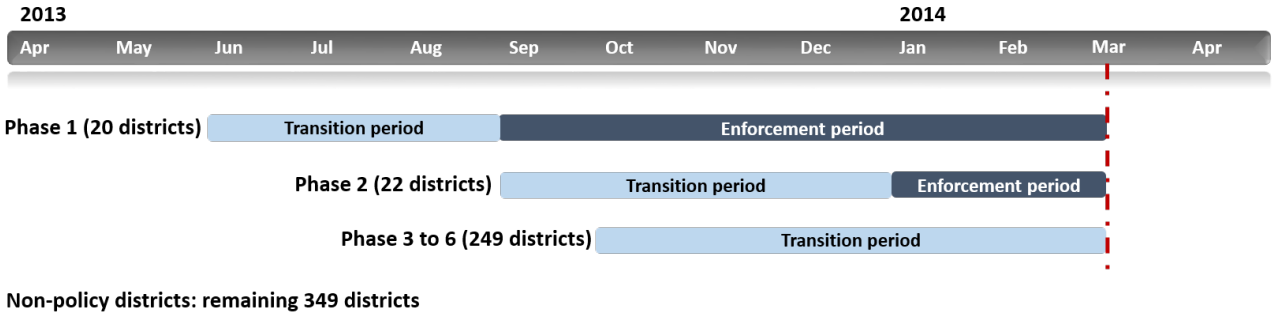
(c) DBTL: Negative supply shock



(d) DBTL terminated: Positive supply shock

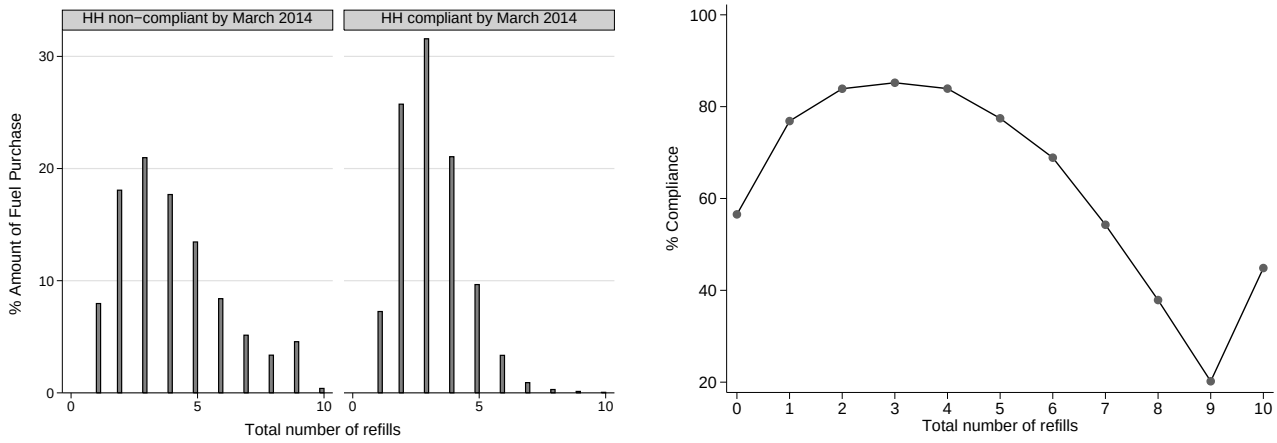
Note:
Panel (a) shows different price slabs as per the pricing structure regulated by the government. Households face subsidized fuel price $(p-s)$, whereas commercial firms purchase fuel at a tax inclusive price $(p+t)$. Households which exceed their annual cap on LPG refills, can buy LPG at non-subsidized prices (p), that is exogenously determined. January 2014 price levels are shown (approximate). Since supply is not constrained, $p-s$ and $p+t$ also represent formal sector supply curve for the domestic and commercial consumers.
Panel (b) presents the supply-demand and the equilibrium price in the fuel black market. The difference in prices provides arbitrage opportunity. Price floor and ceiling automatically become effective because of the market segmentation. Selling or purchasing LPG from non-authorized sources (i.e. non-PDS sources) is illegal, so these transactions take place in the black market.
Panel (c) shows impact of the DBTL enforcement on the black market supply. LPG subsidy s is transferred directly to households after they submit they become cash transfer compliant under DBTL. Thus, DBTL facilitates a de-duplication process where *ghost beneficiaries* do not receive fuel subsidy anymore. However, any LPG beneficiary (that includes late and non-compliant households as well as *ghost beneficiaries* can purchase LPG at the non-subsidized price p. Thus enforcement with the DBTL policy causes a supply shock in the black market.
Panel (d) explains the expected impact of policy termination. When the DBTL policy for subsidy transfer is terminated, old system is restored (as in Panel (b)). A positive supply-shock is expected in the fuel black market because now *ghost beneficiaries* can buy LPG at subsidized price $p-s$.

Figure 3: Timeline: The DBTL policy roll-out and termination



Note: **DBTL Roll-out:**Above timeline shows variation in the time of policy enforcement. Phase 1 districts were introduced with the policy in June 2013. In the transition period, a household who has fulfilled the compliance requirement of DBTL policy, received fuel subsidy directly in the bank account. A non-compliant household (as well as *ghost beneficiaries*) continue to purchase LPG refills at subsidy-inclusive price. Once transition period is over, the DBTL is fully enforced in Phase 1 districts starting from 1 September 2013. All households avail LPG only at the non-subsidized price now, whereas only compliant households get subsidy amount in their bank accounts. This policy was gradually introduced in five next phases covering almost half of country. By January 2014, the policy was introduced in 291 districts, and 42 districts had it fully enforced.
Policy Termination: A political announcement to terminate the DBTL policy was made on January 31, 2014, and the actual termination occurred after about 40 days. Policy termination effectively restored the subsidy delivery mechanism back to the old system.
Data Coverage: Administrative data on household-level fuel purchases covers whole 12 months period (Apr 13 – Mar 14). Month-wise distributor level sales data for domestic and commercia fuel covers 13 months period (Apr 13 – April 14). Black-market survey data collection was done before and after the policy termination.

Figure 4: Pre-treatment fuel purchase and household's compliance status

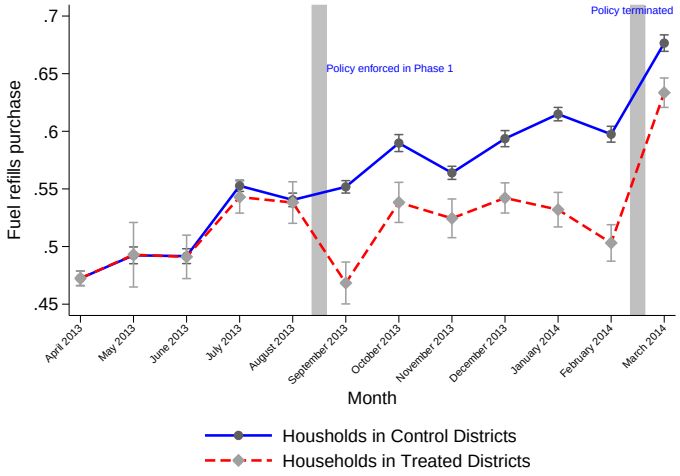


(a) Fuel purchase by compliance

(b) Compliance percentage by LPG Refills purchased

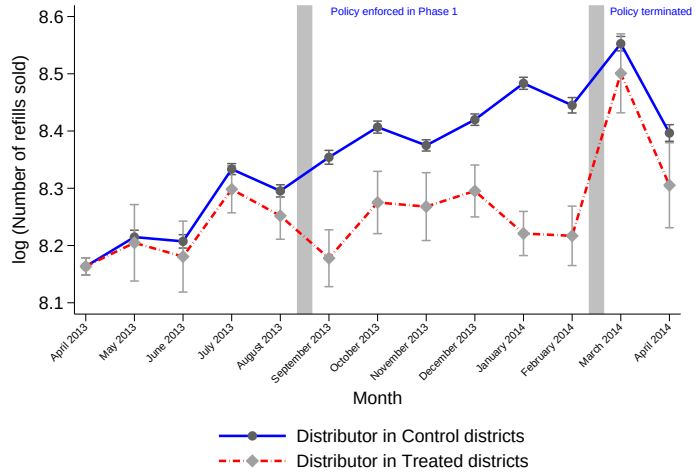
Note: The above plots show the distribution of pre-treatment LPG refill purchases and household compliance in the DBTL policy. Y-axis in the Subplot (a) reports volume of fuel bought by households in pre-treatment period. Subplot (b) shows % compliant households (at distributor level) over total number of LPG refills purchased during pre-treatment period in Phase 1 districts. It is evident in the histogram that the beneficiaries who purchased beyond their prorated annual LPG refill cap (i.e. 5 or more), are less likely to comply. In 2013, annual LPG refill cap was 9, which is clearly reflected on the curve in lower panel. Compliant households are defined considering their compliance status by March 2014. Note that higher number of LPG refills are bunched together at 10 in both subplots.

Figure 5: Impact of DBTL on domestic fuel purchase by beneficiaries



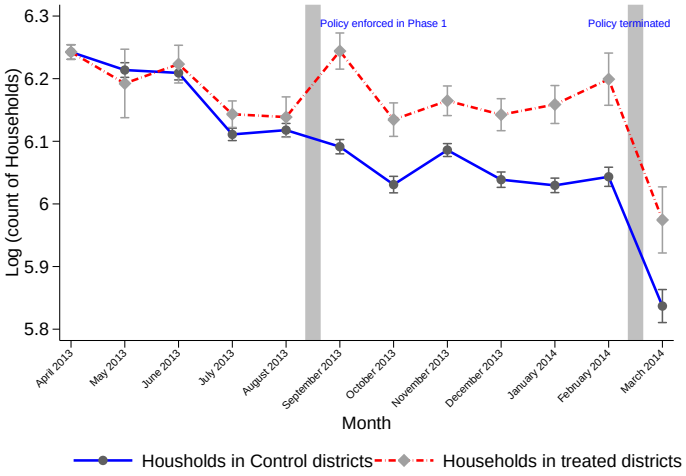
Note: The above plot shows the impact of DBTL policy on household LPG refill purchases using a household-month panel dataset. This plot reports month-wise treatment effect (Equation 5) after controlling for household fixed effects. Dependent variable is the number of 14kg domestic LPG refills (subsidized as well as non-subsidized) by a household in a given month. Domestic fuel purchase by beneficiaries drops down right after the policy is enforced and it increases again when the policy is terminated. LPG refills transaction data from 3,481,298 households is used covering Apr 2013 to Mar 2014. This is 10% randomly drawn sample from administrative records. There are total 16 Phase 1 districts in the treatment group and 473 districts in the control group (i.e. Phase 3 to Phase 6 and remaining non-policy districts). Policy was terminated on March 10, 2014. Phase 2 districts are excluded for clarity because the DBTL policy was enforced in January 2014.

Figure 6: Impact of DBTL on domestic fuel sales by distributors



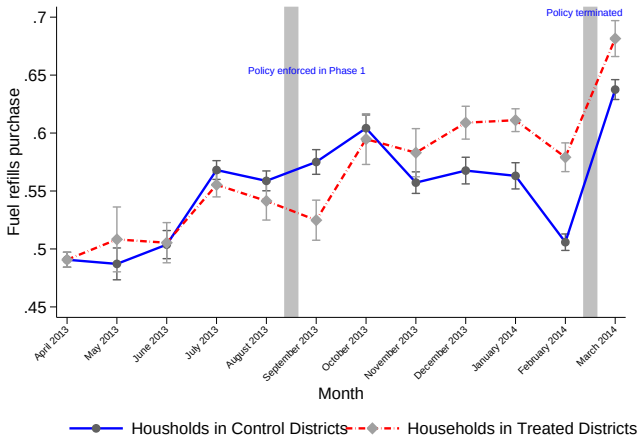
Note: The above plot shows the impact of DBTL policy on fuel sales in domestic sector using a distributor-month panel dataset. It confirms that the domestic fuel sales decreased during the enforcement period and reverted back when the policy is terminated. This plot reports month-wise treatment effect (Equation 5 after controlling for distributor fixed effects. Outcome variable is 'log of total number of 14kg domestic LPG refills'. This sample covers data from 3013 distributors in 485 districts. Treatment group consists of 15 districts from Phase 1, whereas control groups has all the districts from Phase 3-6 and non-policy districts. Phase 2 districts are excluded. Policy was terminated on March 10, 2014.

Figure 7: Impact of DBTL on number of beneficiaries with no fuel purchase



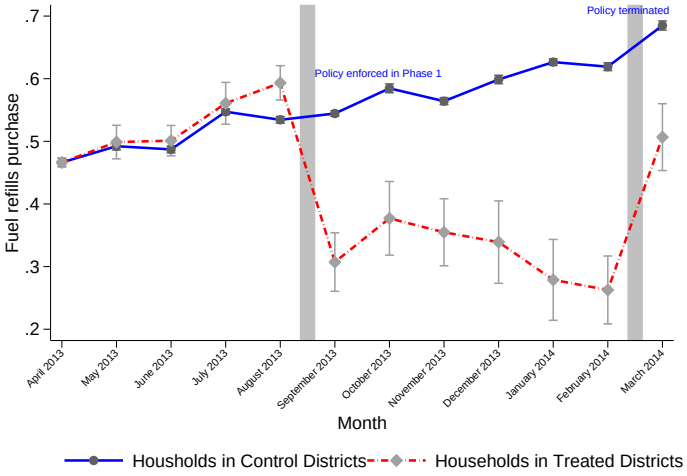
Note: This plot shows the impact of DBTL on the number of zero-refill beneficiaries using a distributor-month level panel dataset. Zero-refill beneficiary is defined as the beneficiary who does not purchase any LPG refill in a given month. Outcome variable is log(number of zero-refill households). Treated group includes distributors in Phase 1 districts, whereas control group includes distributors in Phase 3 to 6. The panel is created by collapsing household-month panel. Distributor fixed effects are included. This plot suggests significant increase in the number of households who bought no refills during the DBTL policy enforcement period.

Figure 8: Fuel purchase by late-complier beneficiary households



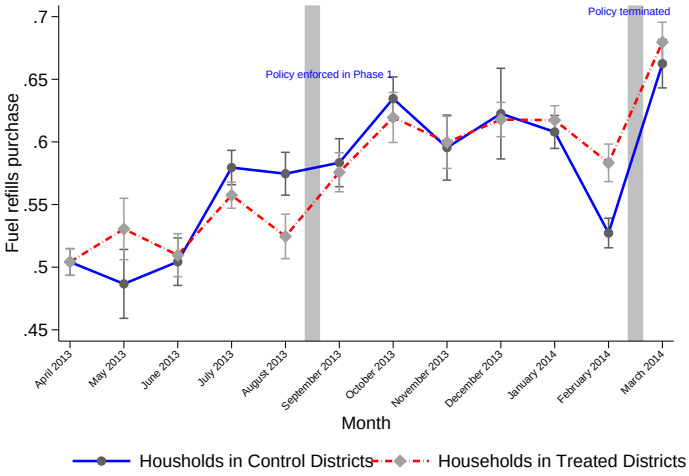
Note: This graph investigates the purchase behavior of late complier households in the treated districts with respect to complier households in upcoming phases. Estimated monthly coefficients show that the late complier households in Phase 1 districts increased their LPG purchases after first month in the enforcement period. This suggests delaying in the compliance may be governed by household's need for the next LPG refill. Also, relative size of coefficients, when averaged over the enforcement period, indicates that the late complier households did not change their purchase behavior much and so, late compliance does not seem to drive our main results. Note that complier households in districts in upcoming phases are included as control here. These households fulfill the compliance requirement, but the DBTL policy was not yet enforced.

Figure 9: Fuel purchase by non-compliant beneficiaries



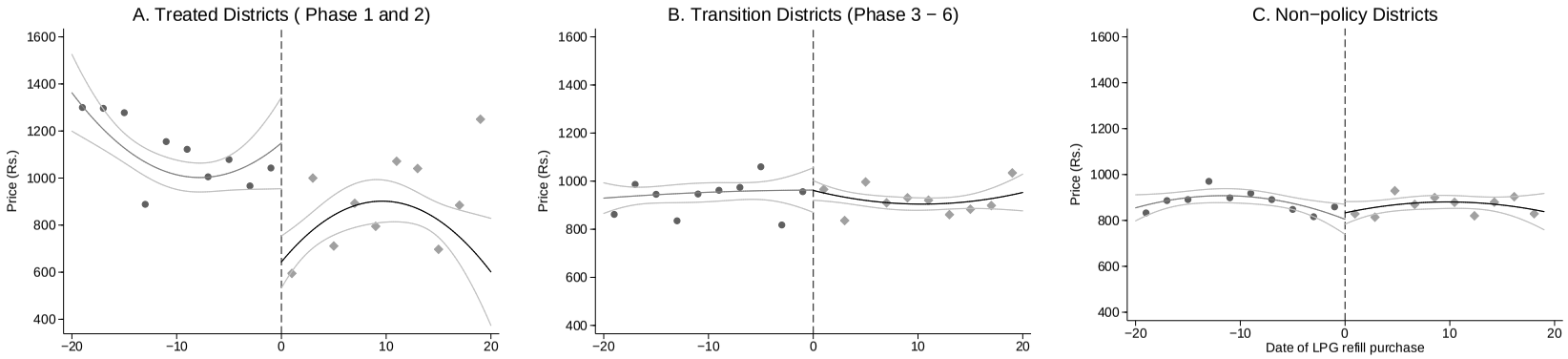
Note: Above plot shows the purchase behavior of non-compliant beneficiaries in treated districts when compared with compliant households in control districts. These beneficiaries did not comply with the requirements for DBTL till March 2014. Using monthly coefficients from an empirical specification similar to (Eq. 5), this plot reports monthwise treatment effect on the non-compliant beneficiaries. Household fixed effects are included. Above plot also shows evidence of bunching right before the enforcement of the DBTL policy.

Figure 10: Fuel purchase by compliant beneficiary households



Note: This plot shows the LPG refill purchase behavior of all compliant households in treated districts when compared with compliant households in Phase 6 districts. Since the policy was introduced in Phase 6 districts in January 2014, this control group is relatively free of any concerns about strategic refill timing by households during the transition period (specifically, between September to December). This graph provides a reasonable assurance against concerns about implementation issues pertaining to compliant households (such as, delay in bank transfers or UID reporting affecting purchase behaviors in treated districts) since purchase behavior of households is mostly comparable with households in control group. Next, this plot also shows that early complier households in treated districts do not cause any significant increase in fuel purchase. Note that Phase 6 compliant households are early complier households, since the policy was introduced (in January 2014) but was not yet enforced.

Figure 11: Policy termination: Impact on equilibrium prices in the fuel black market



(a) Treated districts (b) Transition districts (c) Non-policy districts

Note: This plot shows discontinuity in the reported black-market LPG refill prices right after enforcement policy is terminated in treated districts (Panel (a)). A 20-days window is used on either side of the termination date. A fitted quadratic curve is also shown with 95 % confidence interval. Treated districts observe significant decrease in prices right on the day of policy termination, whereas Control districts (Panel (b)) do not observe any significant change. Note that the political announcement to terminate the enforcement policy was made about 40 days before the actual termination, but the official notification to terminate the policy from March 10, 2014 (Monday) was sent out only on March 7, 2014 (Friday). Thus, a credible signal of termination date was absent till two days before the actual termination. This explains why the price response is immediate, when pre-enforcement system of subsidy disbursement is restored in March 10, 2015.

Table 1: Descriptive statistics: Administrative data

A. Household level LPG transactions data			
	Mean	Median	SD
Subsidized Refills	6.523	7	2.853
Total Refills	6.575	7	2.935
Monthly Refills	0.553	1	0.586
Households	3.79 million		
Distributors	3165		
Districts	509		
States	25		
Time period	12 months (Apr 2013 - Mar 2014)		
Transactions	23.17 million		

B. Distributor level LPG sales data			
	Mean	Median	SD
14kg refills (Domestic)	6,670	5,656	5,530
19kg refills (Commercial)	459.8	150	1,007
Distributors	3341		
Districts	504		
States	25		
Time period	13 months (Apr 2013 - Apr 2014)		
Monthly observations	43433		

Note: Details of beneficiary-level domestic LPG refills (14kg refills) transaction data are shown in Panel A. This sample represents about 2.5% of all household beneficiaries during 2013-14. Panel B shows LPG distributor-level sales data for domestic and commercial fuel. This data covers all LPG distributors under HPCL, which has about 25% of total LPG market share.

Table 2: Descriptive statistics: Supply- and Demand-side audit survey in the black market

Variable	N	Mean	SD	Min	Max
Demand side price	2369	1039.13	241.26	430	1600
Supply side price	1202	1062.49	233.41	550	1950
Firms	1452				
Delivery men	1202				
District	89				
State	11				

Note: The above table shows summary statistics of black market LPG refill prices collected from the supply and demand side in two rounds (before and after policy termination). Price values are in INR (USD 1 INR 60). Outlier values reported below the regulated price for subsidized fuel or above the regulated price for non-subsidized commercial fuel are removed. In demand side survey, about 20% of attrition in responding small-businesses is observed in the post-termination round.

Table 3: Impact of DBTL on domestic fuel purchase by beneficiary households

	(1)	(2)	(3)
Outcome variable: Household monthly LPG refill purchase			
DBTL X Post	-0.0664***	-0.0621***	-0.0769***
	(0.00375)	(0.00401)	(0.00466)
Constant	0.484***	0.485***	0.475***
	(0.00319)	(0.00378)	(0.00396)
Observations	37,408,250	27,389,714	13,064,788
Household	3,400,750	2,489,974	1,187,708
Mean of outcome var	0.561	0.556	0.556
Control group	Ph 3-6 & Non-policy	Ph 3-6	Non-policy
Household FE	Yes	Yes	Yes
Month FE	Yes	Yes	Yes

Note: This regression estimates the impact of DBTL policy on domestic fuel purchase using OLS. A household-month level panel is used. Difference-in-differences estimates suggest about 11% to 14% reduction in fuel purchase in domestic cooking sector (i.e. coefficient on the interaction term as the percentage of mean value). Outcome variable is – number of LPG refills purchased by a beneficiary in a given month. Household and month fixed effects are included. Treated group includes all Phase 1 districts in the sample (16 districts). Phase 2 districts are not included. Col (1) combines all upcoming phases and non-policy districts together in the control group. Col(2) and Col (3) present estimates from the same specification, but with two different sub-groups as control. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are in parentheses. Standard errors are clustered at the district level.

Table 4: Impact of DBTL on domestic fuel sales by distributors

	(1)	(2)	(3)
Outcome variable: log(Domestic LPG refills sales)			
DBTL X Post	-0.149***	-0.134***	-0.174***
	(0.0110)	(0.0118)	(0.0128)
Constant	8.178***	8.357***	7.975***
	(0.00716)	(0.00927)	(0.00953)
Observations	31,322	19,944	13,135
District	485	236	264
Distributor	3013	1909	1269
Control	Ph3-6 & Non-policy	Ph3-6	Non-policy
Distributor FE	Yes	Yes	Yes
Month FE	Yes	Yes	Yes

Note: This regression estimates the impact of DBTL program on domestic-use fuel sales using OLS. A distributor-month level panel is used. Difference-in-differences estimates suggest about 13% to 17% reduction in domestic-use LPG purchase. Outcome variable is – log(Total domestic-use LPG refills sold to households in a given month). Distributor and month fixed effects are included. Treated group includes all Phase 1 districts in the sample (16 districts). Phase 2 districts are not included. Col (1) combines all upcoming phases and non-policy districts together in the control group. Col(2) and Col (3) present estimates from same specification, but with two different control groups. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are in parentheses. Standard errors are clustered at the district level.

Table 5: Impact of DBTL policy termination on domestic fuel sales by distributors

	(1)	(2)	(3)
Outcome variable: log(Domestic LPG refill sales)			
DBTL X Post termination	0.101***	0.127***	0.0593**
	(0.0234)	(0.0235)	(0.0247)
Constant	8.303***	8.492***	8.069***
	(0.00678)	(0.00808)	(0.00812)
Observations	23,396	14,826	9,854
District	485	236	264
Distributor	3060	1932	1294
Control	Ph3-6 & Non-policy	Ph3-6	Non-policy
Distributor FE	Yes	Yes	Yes
Month FE	Yes	Yes	Yes

Note: This regression estimates the impact of the DBTL policy termination on fuel sales in the domestic sector. A distributor-month level panel is used. Above estimates suggest about 6% to 13% increase in fuel purchase in domestic sector. Outcome variable is – log(Total domestic-use LPG refills sold to households in a given month). Distributor and month fixed effects are included. Treated group includes all Phase 1 districts in the sample (16 districts). Phase 2 districts are not included. Col (1) combines all upcoming phases and non-policy districts together in the control group. Col(2) and Col (3) present estimates from the same specification, but with two different sub-groups as control. Post-termination period includes two months (March and April 2014). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are in parentheses. Standard errors are clustered at the district level.

Table 6: Impact of DBTL policy termination on commercial fuel sales

	(1)	(2)	(3)
Outcome variable: log(Commercial LPG refill sales)			
DBTL X Post termination	-0.0727**	-0.0637*	-0.0895**
	(0.0348)	(0.0353)	(0.0377)
Constant	5.124***	5.467***	4.636***
	(0.0106)	(0.0126)	(0.0186)
Observations	17,661	11,862	6,883
District	480	234	261
Distributor	2637	1727	1060
Control	Ph3-6 & Non-policy	Ph3-6	Non-policy
Distributor FE	Yes	Yes	Yes
Month FE	Yes	Yes	Yes

Note: This regression estimates the impact of the DBTL policy termination on commercial fuel sales. A distributor-month level panel is used. Estimates suggest about 6% to 9% reduction. Outcome variable is – log(Total commercial-use 19kg LPG refills sold to households in a given month). This does not include all commercial LPG sales. Distributor and month fixed effects are included. Treated group includes all Phase 1 districts in the sample (16 districts). Phase 2 districts are not included. Col (1) combines all upcoming phases and non-policy districts together in the control group. Col(2) and Col (3) present estimates from the same specification, but with two different sub-groups as control. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are in parentheses. Standard errors are clustered at the district level.

Table 7: Impact of DBTL policy termination on black-market fuel prices

	(1)	(2)	(3)	(4)
	A. Supply Side		B. Demand Side	
Outcome variable: log (price)				
DBTL X Post termination	-0.127***	-0.159***	-0.175***	-0.192***
	(0.0417)	(0.0406)	(0.0610)	(0.0736)
Constant	7.058***	7.023***	6.973***	7.134***
	(0.0137)	(0.0234)	(0.0363)	(0.00787)
Observations	504	504	1,000	1,000
Treatment	Ph1&2	Ph1&2	Ph1&2	Ph1&2
Control	Non-policy	Non-policy	Non-policy	Non-policy
Firm			602	602
District	38	38	38	38
District FE	Yes	Yes		
Firm FE			Yes	Yes
Date FE		Yes		Yes

Note: This table presents difference-in-differences estimate of the impact of enforcement policy termination on the black market fuel prices. The outcome variable is log(price). The sample consists of the treated districts (Phase 1 and 2) and non-policy districts in the control group. These 38 districts are from 8 states. Panel A (Col (1) and (2)) shows the impact of policy termination on the quoted price by the supply side (delivery man). Coefficients on the interaction term suggest 13% to 16% decrease in the black-market prices in treated districts, when the DBTL policy is terminated. Note that the dummy on the treated group is included in the empirical specification, but the variation is absorbed by district fixed effects in Col(1) and (2). In Panel B, the outcome variable is the ongoing black-market price mentioned by small businesses. This panel shows about 18% to 19% decrease in the black-market price, when the policy is terminated. Districts, firms and interview date fixed effects are used where applicable. Additional robustness checks are provided in the Appendix. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are in parentheses. Standard errors are clustered at the district level.

Table 8: Heterogenous effect of DBTL on domestic fuel purchase

	(1)	(2)	(3)
Outcome variable: Household monthly LPG refill purchase			
Post	0.100***	0.0971***	0.140***
	(0.00771)	(0.00796)	(0.00926)
High frequency HH	0.548***		0.464***
	(0.00607)		(0.00348)
Post X High frequency HH	-0.345***		-0.249***
	(0.0273)		(0.0155)
HH not complied		-0.0233	-0.0789***
		(0.0147)	(0.00735)
Post X HH not complied		-0.131***	-0.0816***
		(0.0134)	(0.00792)
High frequency HH X HH not complied			0.154***
			(0.0119)
Post X High frequency HH X HH not complied			-0.154***
			(0.0345)
Constant	0.338***	0.461***	0.378***
	(0.00444)	(0.00694)	(0.00548)
Observations	3,095,114	3,095,114	3,095,114
Households	281,374	281,374	281,374
Month FE	Yes	Yes	Yes
District FE	Yes	Yes	Yes

Note: This table shows the heterogeneity in the impact of DBTL policy on different subgroups of beneficiaries in the treated districts. Beneficiaries are categorized in two groups based on their pre-treatment fuel purchases. Next, households compliant status is used to segregate the impact on compliant and non-compliant beneficiaries. With triple difference estimate, the coefficient on *"Post X High frequency HH X HH not complied"* shows that the DBTL policy had a much stronger impact on the high frequency beneficiaries who failed to comply. District fixed effects are used. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. Standard errors are clustered at the district level.

Table 9: Impact of DBTL on number of beneficiaries with no fuel purchase

	(1)	(2)	(3)
Outcome variable: log(count of households who purchased zero refills)			
DBTL X Post	0.107***	0.0993***	0.126***
	(0.00565)	(0.00644)	(0.00684)
Constant	6.827***	6.934***	6.704***
	(0.00454)	(0.00599)	(0.00489)
Observations	38,294,158	27,954,157	13,435,115
Control group	Ph 3-6 & non-policy	Ph 3-6	Non-policy
Mean of outcome var	1057	1159	990.3
Month FE	Yes	Yes	Yes
Distributor FE	Yes	Yes	Yes

Note: This table reports the impact of DBTL policy enforcement on the count of beneficiaries who did not purchase fuel in a given month. This includes the subsidized as well as non-subsidized fuel refill purchase. A distributor-month level panel is created by collapsing the household-month data. Outcome variable is in log. The estimated coefficients suggest about 10% to 13% increase in the number of beneficiaries who did not purchase a single LPG refill. Distributor and month fixed effects are included. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are in parentheses. Standard errors are clustered at the district level.

Table 10: Impact of DBTL on domestic fuel purchased by compliant households

	(1)	(2)
Outcome variable: Household monthly LPG refill purchase		
DBTL X Post	0.0215***	-0.00195
	(0.00476)	(0.00590)
Constant	0.479***	0.488***
	(0.00330)	(0.00564)
Observations	11,803,583	3,899,918
Control group	Ph 3-6	Ph 6
Mean of outcome var	0.537	0.551
Month FE	Yes	Yes
Household FE	Yes	Yes

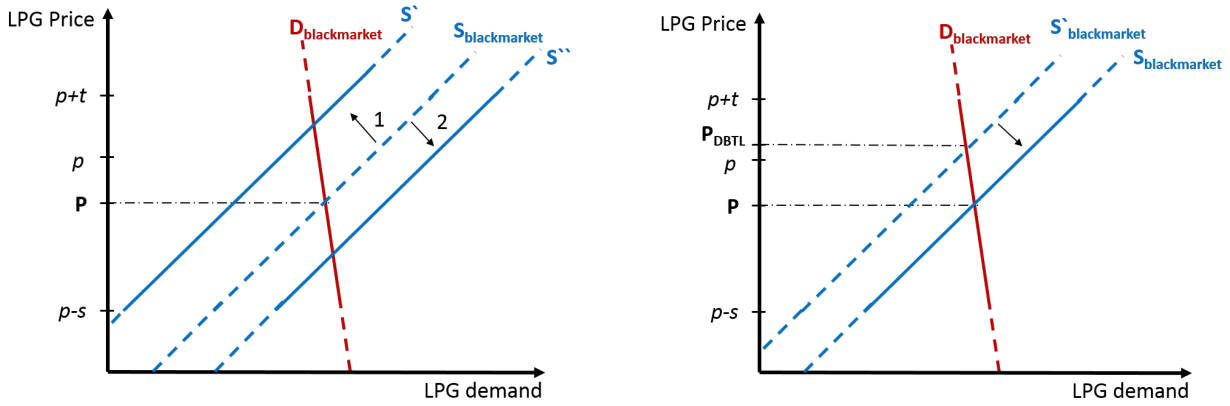
Note: This table reports the impact of the DBTL policy enforcement on any increase in LPG refill purchase by compliant households. All the households who complied by March 2014 are included. Col (1) suggests about 4% increase in LPG refill purchases by compliant households in the treated districts. Col (2) uses the Phase 6 districts as control and does not show any significant effect. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are in parentheses. Standard errors are clustered at the district level.

A APPENDIX - For Online Publication

Figure A.12: Sample Unique Identification (UID)

Note: UID number is communicated to the residents in above format. Also known as *Aadhaar* number, each 12 digit number is unique and is de-duplicated with already existing biometric database.(Source: `http://indane.co.in/images/aadhar-reg.jpg`

Figure A.13: Diversion of subsidized fuel by households under increased enforcement

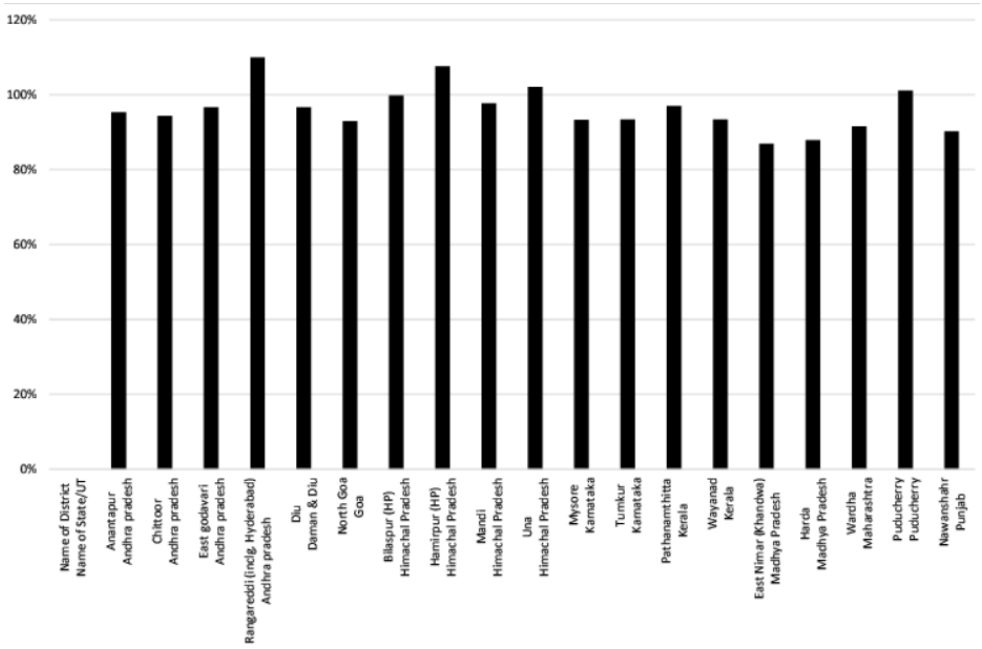


(a) DBTL and diversion by households

(b) DBTL termination and diversion by households

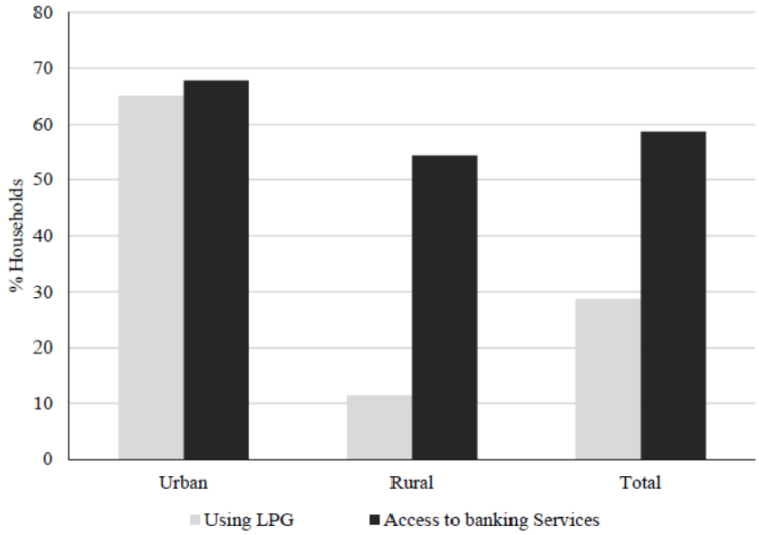
Note:**Panel(a)** illustrates two opposing effects of the DBTL policy. First, an elimination of *ghost beneficiaries* would cause a negative supply shock pushing the black-market price up (1). Next, since the payoff in the black market is higher now, households may in turn increase the supply of subsidized-fuel from their own quota. Thus figure represents the trade-off between two factors – reducing corruption Vs. increasing micro-level evasion, when enforcement is on the first factor only. The net effect on supply and equilibrium price in the black market will depend on their relative magnitude.
Panel(b) highlights the case when *ghost beneficiaries* are the dominant supply factor in the black market. The policy termination should move the black-market price down to the equilibrium level in control districts.

Figure A.14: UID penetration in Phase 1 districts



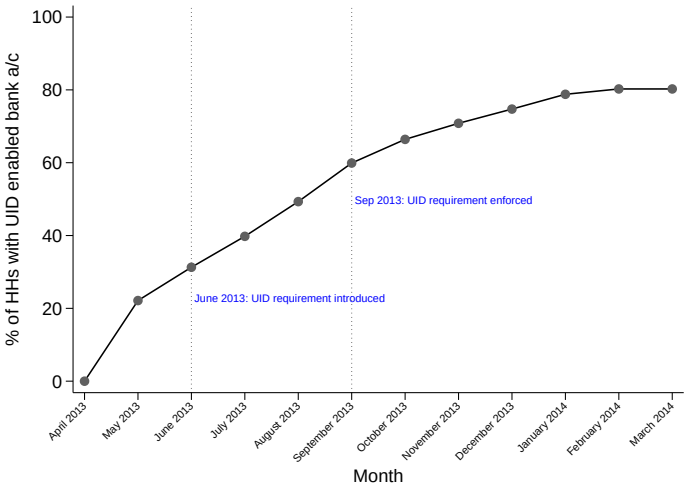
Note: This graphs shows UID coverage in Phase 1 districts in January 2014 (right before the policy termination), as per the data provided by the UID Authority of India. In these districts, 98.5% population (compared to the 2014 census) had received UID number. UID penetration in four districts exceeds their respective population, likely because of in-migration since 2011. Similarly, it is possible that some of the other districts could not reach 100% penetration because of an out-migration.

Figure A.15: Access to Banking Services and LPG adoption



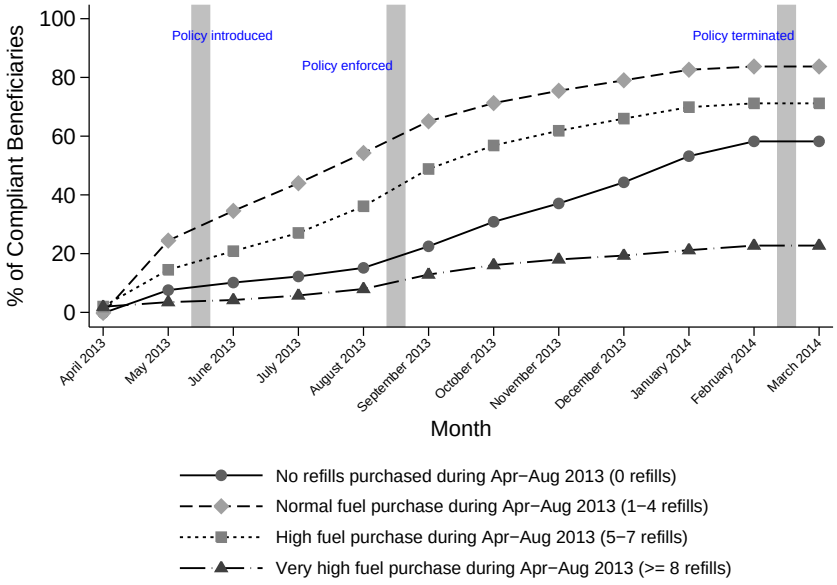
Note: 2011 Census collects information on "household having any type of bank account" (that does not include Self-help Groups, Agricultural Credit Societies etc.). Comparing data on LPG user households from the same source, the access to the banking services is more than the adoption of LPG for cooking purpose. This holds for urban as well as rural areas. Further, India carried out dedicated campaign to increase the financial inclusion since 2011.

Figure A.16: Household compliance with DBTL



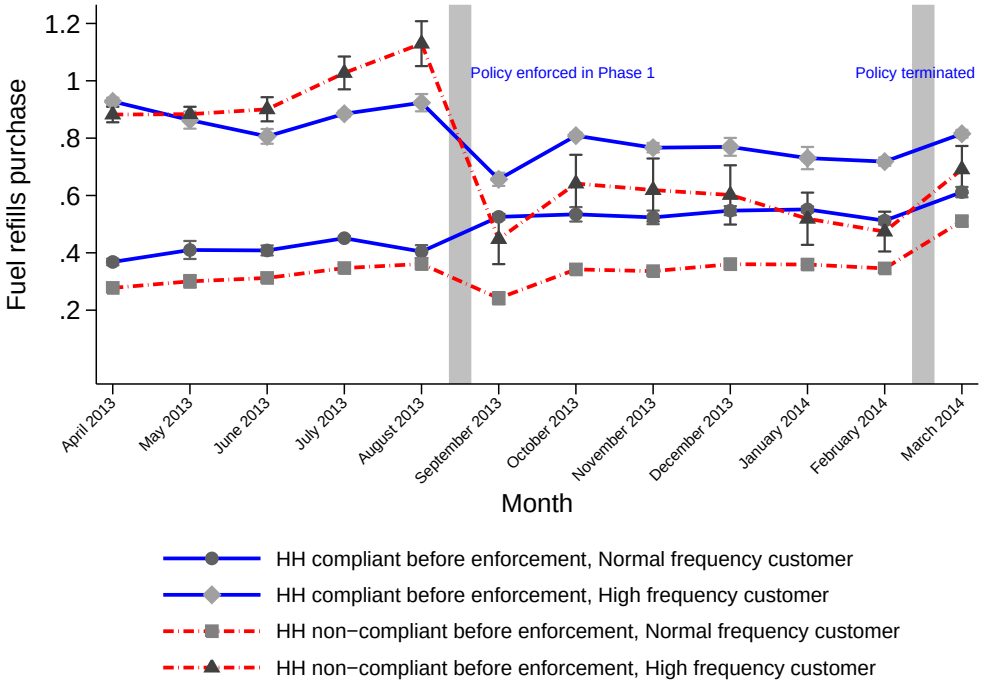
Note: This table shows household compliance in treated districts (Phase 1). Compliance requires households to submit their bank account and UID number. Right after the introduction of the DBTL policy, compliance increased steeply, and gradually the take up rate decreases. Households are not necessarily required to comply if they do not want subsidy transfer. When DBTL policy was enforced, a non-compliant beneficiary could continue to avail domestic fuel, but not the subsidy. It is likely that the timing of next refill would affect household's decision to comply. Overall more than 80% compliance was achieved during the six month enforcement period.

Figure A.17: Compliance and pre-enforcement fuel purchase



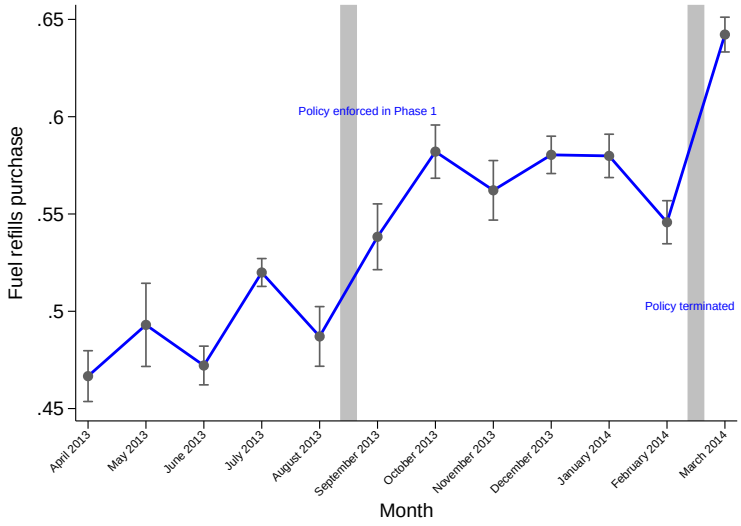
Note: The above plot shows how compliance levels vary with the number of LPG refills bought by a beneficiary households before the DBTL program was enforced (Apr-Aug 2013). Sample consists of data from Phase 1 districts. A "normal household" purchases 4 LPG refills as per the pro-rated annual cap basis. Higher purchase frequency households consistently show low compliance. Note that households who did not purchase a single refill in the pre-enforcement period, show a much higher compliance rate after the policy is enforced.

Figure A.18: Heterogeneous effect in treated districts



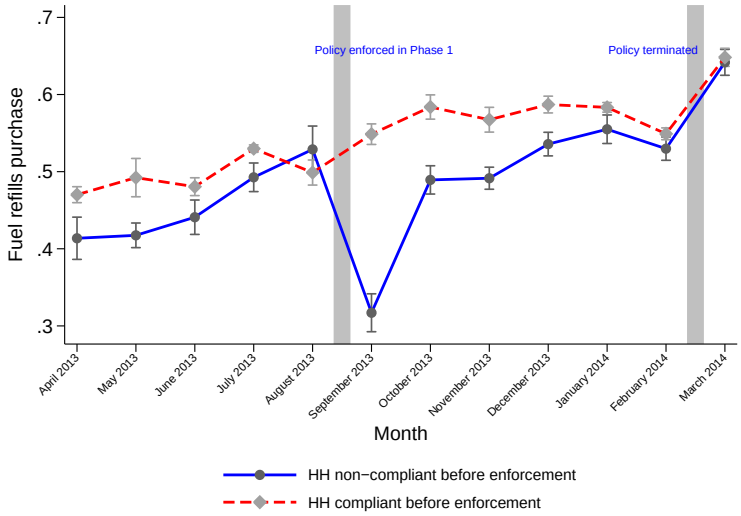
Note: This graph shows the impact of DBTL policy estimated with a triple difference empirical model for beneficiaries in Phase 1 districts. Non-complier beneficiaries who purchased higher number of LPG refills in pre-treatment period, exhibit higher impact of the enforcement. High and normal frequency beneficiaries are defined as per their fuel purchase in the pre-treatment period. 'Normal frequency customer' denotes the household who has bought LPG refills as per its prorated annual cap (i.e. up to 4 LPG refills) and 'High frequency customer' is the household which bought five or more. We see that pre-treatment high frequency customers, who failed to comply by the first month of enforcement, significantly reduce their LPG refills purchase. Bunching i.e. more LPG purchases in anticipation before the DBTL policy is enforced, is also observed. Triple difference estimates are presented in Table 8. District level fixed effects are used.

Figure A.19: Early complier households: Increase in fuel purchase



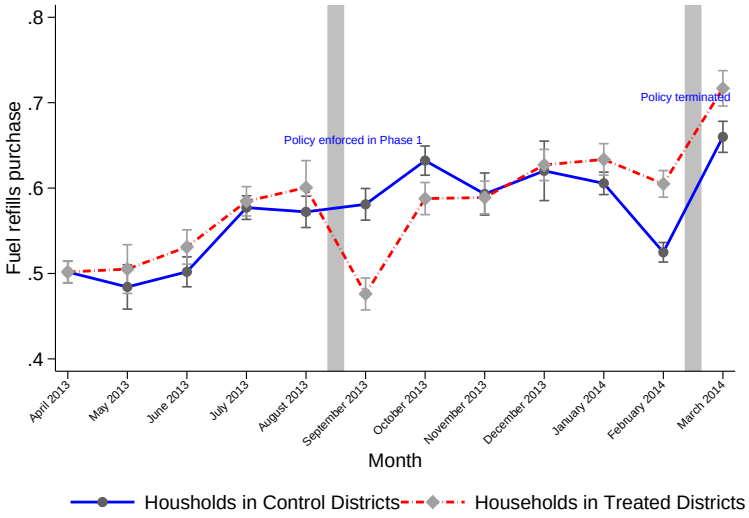
Note: The above plot shows the purchase behavior of early compliant households in Phase 1 districts. This plot reports monthwise coefficient on LPG refill purchase by the early complier households. Household fixed effects are included. Sub-sample includes households who fulfilled the compliant requirement before treatment (i.e. before Sep 2013). There is a steep increase in LPG refill purchase, when the DBTL policy is enforced in Sep 2013.

Figure A.20: Comparison of the early and late complier households in treated districts



Note: This coefficient plot shows comparison of late vs early compilers in the treated districts (all Phase 1 districts). It suggests late complier households decrease their LPG purchase in the first month of enforcement and then eventually catch up with the complier households. Note that the late complier households are about 20% of total number of households.

Figure A.21: Comparison of the late complier households in treated districts with complier households in control districts



Note: This plot shows LPG refill purchase behavior of all late compliant households in treated districts when compared with compliant households in Phase 6 districts. Since the policy was introduced in Phase 6 districts in January 2014, this control group is relatively free of any concerns about strategic refill timing by households during the transition period (specifically, between September to December). This graphs shows that late complier in treated districts, on average, did not buy lower fuel than the complier households in control districts. First two months in the enforcement period observe a decrease in the fuel purchase, but households increase their fuel purchase in subsequent months. Note that Phase 6 compliant households are early complier households, since the policy was introduced (in January 2014) but was not yet enforced.

Table A.11: Domestic fuel sales in Phase 2 (Household level data)

	(1)	(2)	(3)
Outcome variable: Household monthly LPG refill purchase			
DBTL X Post	-0.134***	-0.123***	-0.162***
	(0.00660)	(0.00693)	(0.00705)
Constant	0.481***	0.481***	0.466***
	(0.00321)	(0.00382)	(0.00412)
Observations	37,579,113	27,560,577	13,235,651
Household	3,416,283	2,505,507	1,203,241
Mean of outcome var	0.559	0.554	0.550
Control group	Ph 3-6 & Non-policy	Ph 3-6	Non-policy
Household FE	Yes	Yes	Yes
Month FE	Yes	Yes	Yes

This table reports estimates of the impact of DBTL program in Phase 2 districts. A household-month level panel is used. Outcome variable is – *number of LPG refills purchased in a month.* Estimates suggest about 22% to 29% reduction in domestic-use LPG purchase (i.e. coefficient on the interaction term as a percentage of mean value). Phase 2 districts had the DBTL policy enforced for a relatively short period, so these estimates include households' timing behavior. Phase 1 districts are not included. Note that control groups are different in three columns and provide a robustness check. Household and month fixed effects are included. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are in parentheses. Standard errors are clustered at the district level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are in parentheses.

Table A.12: Fuel purchase in domestic sector: Comparison of OLS and Poisson estimates

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	Poisson	OLS	Poisson	OLS	Poisson
Outcome variable: Household monthly LPG refill purchase						
DBTL X Post	-0.0643***	-0.112***	-0.0619***	-0.109***	-0.0701***	-0.119***
	(0.00562)	(0.0130)	(0.00596)	(0.0131)	(0.00666)	(0.0141)
Constant	0.481***		0.477***		0.481***	
	(0.00473)		(0.00578)		(0.00629)	
Observations	375,914	375,914	274,450	274,450	133,562	133,562
Districts	487	487	238	238	265	265
Distributors	2750	2750	1765	1765	1140	1140
Households	34174	34174	24950	24950	12142	12142
Mean of outcome var	0.561		0.554		0.561	
Control group	Ph 3-6 & Non-policy	Ph 3-6 & Non-policy	Ph 3-6	Ph 3-6	Non-policy	Non-policy
Household FE	Yes	Yes	Yes			
Month FE	Yes	Yes	Yes			

Note: This table presents a comparison of estimates from the OLS and Poisson models for robustness check. The outcome variable (i.e., number of LPG refills per household per month) has a structure similar to Poisson distribution. 1% sample is used. Poisson estimates of the causal impact of the DBTL policy are very close to OLS estimates. Month and household fixed effects are included. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are in parentheses.

Table A.13: Impact of DBTL policy on commercial fuel sales by distributors

	(1)	(2)	(3)
Outcome variable: log(Commercial LPG refills sales)			
DBTL X Post	0.0113	-0.000159	0.0326
	(0.0212)	(0.0217)	(0.0234)
Constant	5.119***	5.447***	4.672***
	(0.0110)	(0.0132)	(0.0182)
Observations	24,288	16,303	9,475
District	482	235	262
Distributor	2678	1745	1082
Control	Ph3-6 & Non-policy	Ph3-6	Non-policy
Distributor FE	Yes	Yes	Yes
Month FE	Yes	Yes	Yes

Note: This regression estimates impact of the DBTL program on commercial fuel sales using distributor-month level panel. Outcome variable is – log(Total commercial-use 19kg LPG refills sold to businesses in a given month). Estimates are not significant. Note that the data does not include all commercial LPG sales, since LPG is distributed with higher size cylinders, in bulk and as auto-fuel. Distributor and month fixed effects are included. Treated group includes all Phase 1 districts in the sample (16 districts). Phase 2 districts are not included. Col (1) combines all upcoming phases and non-policy districts together in the control group. Col(2) and Col (3) present estimates from the same specification, but with two different sub-groups as control. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are in parentheses. Standard errors are clustered at the district level.

Table A.14: Impact of DBTL policy termination on domestic fuel purchased by beneficiaries

	(1)	(2)	(3)
Outcome variable: Household monthly LPG refill purchase			
DBTL X Post termination	0.0343***	0.0444***	0.00963
	(0.00509)	(0.00519)	(0.00676)
Constant	0.560***	0.558***	0.538***
	(0.00314)	(0.00382)	(0.00279)
Observations	23,885,798	17,481,131	8,347,633
Mean of outcome var	0.605	0.597	0.603
Control group	Ph 3-6 & Non-policy	Ph 3-6	Non-policy
Month FE	Yes	Yes	Yes
Household FE	Yes	Yes	Yes

Note: This regression estimates the impact of DBTL policy termination on domestic fuel purchase by the beneficiaries. Outcome variable is – the number of LPG refills purchased by a beneficiary in a given month. A household-month level panel is used. Comparing the interaction coefficient with the mean value, estimates suggest about 7% increase in fuel purchase in domestic sector (i.e. coefficient on the interaction term as a percentage of the mean value). Household and month fixed effects are included. Treated group includes all Phase 1 districts in the sample (16 districts). Phase 2 districts are not included. Col (1) combines all upcoming phases and non-policy districts together in the control group. Col(2) and Col (3) present estimates from same specification, but with two different sub-groups as control. Note that the sample includes only one month (March 2014) in the post-termination period. Whole March month is considered as post-treatment period for consistency, though the exact date of policy termination is 10 March. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are in parentheses. Standard errors are clustered at the district level.

Table A.15: Robustness check: Impact of DBTL Policy Termination on Black market Price (Demand Side)

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome variable: log(price)						
Policy termination	-0.257***	-0.452***	-0.285***	-0.234**	-0.203***	-0.444***
	(0.0192)	(0.0481)	(0.0212)	(0.115)	(0.0360)	(0.0715)
DBTL	0.127***	0.193***	0.0956***	0.251**	0.188***	0.196***
	(0.0239)	(0.0551)	(0.0287)	(0.102)	(0.0371)	(0.0582)
DBTL X Policy termination	-0.122**	-0.210***	-0.0940*	-0.276**	-0.175***	-0.192***
	(0.0530)	(0.0731)	(0.0541)	(0.110)	(0.0610)	(0.0736)
Constant	7.035***	7.131***	7.066***	6.907***	6.973***	7.134***
	(0.0225)	(0.00833)	(0.0275)	(0.101)	(0.0363)	(0.00787)
Observations	2,369	2,369	1,622	1,622	1,000	1,000
Firm	1,406	1,406	955	955	602	602
District	89	89	61	61	38	38
Control	Ph3-6 & Non-policy	Ph3-6 & Non-policy	Ph3-6	Ph3-6	Non-policy	Non-policy
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Day FE		Yes		Yes		Yes

Note: This table shows the impact of policy termination on the ongoing black market prices as collected from the small businesses. Outcome variable is Log(black-market price). Even numbered columns include interview date fixed effect. Robustness is checked with different combinations of control groups. Col (5) and Col(6) present the preferred specification (already provided in the paper) and are provided here for a comparison. Firm FE are included. Standard errors are clustered at the district level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are in parentheses.

Table A.16: Robustness check: Impact of DBTL Policy Termination on Black market Price (Refill History Data)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Outcome variable: log(price)							
Policy termination	-0.131**	-0.127**	-0.127**	-0.191**	-0.00692	0.0627**	0.0658**
	(0.0642)	(0.0620)	(0.0621)	(0.0765)	(0.0263)	(0.0264)	(0.0257)
DBTL X Policy termination	-0.0902**	-0.0916**	-0.0915**	-0.0711**	-0.163**	-0.112**	-0.117***
	(0.0374)	(0.0383)	(0.0349)	(0.0345)	(0.0717)	(0.0451)	(0.0407)
Constant	6.861***	6.865***	6.866***	6.932***	6.799***	6.816***	6.820***
	(0.0201)	(0.0200)	(0.0200)	(0.0397)	(0.0223)	(0.0235)	(0.0236)
Observations	1,895	2,021	2,037	1,271	782	908	924
Firm	624	671	677	424	259	306	312
District	74	79	81	53	30	35	37
Treatment group	Ph 1	Ph 2	Ph 1 & 2	Ph 1 & 2	Ph 1	Ph 2	Ph 1 & 2
Control group		Ph 3-6 & Non-policy		Ph 3-6		Non-policy	
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Date FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: The above table shows the impact of policy termination on LPG refills prices using refill history data. In survey, each small business is asked for the date and price of last five LPG refills. Firm-date level panel is constructed with this data. Coefficient on the interaction term provide the impact of policy termination on the black market prices paid by the firms. Note that different control and treatment groups are used for robustness check. Firm and Refill date level FE are included. Standard errors are clustered at the district level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are in parentheses.

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