Fueling the engines of liberation with cleaner cooking fuel: Evidence from Indonesia. *

Tushar Bharati † Yiwei Qian ‡ Jeonghwan Yun §

September 7, 2019

Abstract

Using the staggered roll out of the Indonesian "Conversion to Liquefied Petroleum Gas (LPG) Program", we show that a switch to the labor- and time-saving technology of cooking with LPG increased the labor force participation of exposed women. The program was associated with an increase in household expenditure on food and education and the subjective well being of women. We also show that the policy improves the decision-making power of women in the household, especially in financial matters. A back-of-the-envelope calculation suggests that saving in households expenditure on fuel far outweighed the cost of the conversion incurred by the government. To the extent that intra-household externalities and gender differences in preferences are a reason for the lack of adoption of such cost-effective technology, the results highlight that temporary subsidies that empower women can encourage the adoption and sustained use of such technology.

PRELIMINARY DRAFT: DO NOT CITE OR CIRCULATE WITHOUT PERMISSION

*We are grateful to Rakesh Banerjee, Dan Bennett, Rajeev Dehejia, Peter Drysdale, Dawoon Jung, Jeffery Nugent, Mari Pangestu, Juan Saavedra, John Strauss, participants at the 92nd Annual Western Economic Association International (WEAI) Conference (San Diego, 2017), Bank of Italy-World Bank joint conference on "Human Capital for 21st Century Job" (Rome, 2018), the Energy Innovation Academy (Florence, 2019), Population Association of American (PAA) Conference (Austin, 2019), University of Southern California (Los Angeles, 2019), and the Pacific Trade and Development (PAFTAD) Conference (Bangkok, 2019) for their valuable feedback. All errors are our own.

†University of Western Australia Business School. email: tushar.bharati@uwa.edu.au

‡Department of Economics, University of Southern California. email: yiweiqia@usc.edu

§Department of Economics, University of Southern California. email: jeonghwy@usc.edu

1 Introduction

Women held back from participating in productive market activities is human capital wasted. It is now well-established that the difference in rates of female labor force participation (FLFP) is an important explanation behind the persistent differences in GDP per capita across countries (Bloom et al. (2009)). Despite this, females form a little more than a third of the formal labor force of the world with their participation rates ranging from as low as 6% in Yemen to as high as 84% in Rwanda and Madagascar (World Bank Indicators, 2018). What explains these large differences in FLFP across countries?

Previous research has suggested several factors, including the desirability of the jobs available, medical and production technology, discrimination, availability of childcare, and cultural attitudes, affect FLFP.[1] While it is likely that a combination of factors are driving these differences, one potential explanation that not received enough attention in the context of developing countries is that of "engines of liberation" Greenwood et al. (2005). The emergence of cheap, time-saving household technology has often been credited with liberating women from the burden of household responsibilities and facilitating their integration into the labor force (Cutler et al. (2003); Goldin (2006); Aguiar and Hurst (2007); de V. Cavalcanti and Tavares (2008)). But there is only limited evidence on the liberating effect of such technology in developing countries and household responsibilities are still one of the biggest impediment to female labor force participation (Schaner and Das (2016)).

Against this backdrop, we study the potential role of household cooking technology in determining female labor force participation in Indonesia. Indonesia, like many other low- and middle-income countries, has grown steadily over the last few decades. While the welfare gains from this phase of rapid growth in Indonesia have been shared equally between males and females in domains like education (Figure 1), the female labor force participation in Indonesia has remained below the world average.[2] An opportunity to examine the role of household cooking technology in determining FLFP presented itself when, in 2007, Indonesia implemented the national "Conversion to Liquefied Petroleum Gas (LPG) Program".

The Conversion to LPG program, also known as the "No-Kero" or "Zero-Kero" program, subsidized the use of LPG. Studies from Indonesia have found that LPG is a labor- and time-saving cooking technology (ASTAE (2015); Thoday et al. (2018)). Using the exogenous staggered roll-out of the program, we show that a switch to LPG increased the labor force participation of exposed women. We also find that the policy was associated with an increase in household expenditure on food and education and the subjective well being of women. We explore two possible mechanisms through which the switch to LPG might have affected the

[1] See, among others, Goldin et al. (1992), Galor and Weil (1996), Costa (2000), Goldin and Katz (2002), Attanasio et al. (2008), Albanesi and Olivetti (2009), and Fernández (2013).

[2] In comparison, the labor force participation of Indonesian men has stayed well above the world average and relatively stable in the last three decades. See figure 2.

labor force participation of women - better health and time savings. Consistent with previous research on the topic, we do not find major effects on the health of the exposed women (Smith-Sivertsen et al. (2009); Duflo et al. (2012); Thoday et al. (2018)). While we do not have information on the time use of the exposed women, building on information from related studies and some suggestive evidence, we postulate that time saved due to the technology is an important pathway through which the switch to LPG affected labor force participation of women.

A back-of-the-envelope calculation suggests that saving in households expenditure on fuel far outweighed the cost of the conversion incurred by the government. We conjecture that households fail to switch to LPG despite the unambiguous net gains because of intra-household externalities and gender differences in preferences - the benefits from switching to a cleaner fuel are greatest for the woman in the household but the monetary price is most-often paid by the earning male (Miller and Mobarak (2013); Pitt et al. (2006)). We also show that the policy improves the decision-making power of women in the household, especially in financial matters. Given the role of intra-household externalities and gender differences in preferences in the setting, this has important implications for the sustained use of LPG even after the subsidy is withdrawn.

Our paper makes three main contributions. It is the first paper to evaluate the impact of the "Conversion to Liquefied Petroleum Gas (LPG) Program" on the labor force participation of those exposed. The results show that the benefits of the policy went far beyond the saved subsidy expenditure, the main motivation behind the program. Second, the findings suggest that switching to faster cooking methods, like cooking with LPG, can liberate women to join the labor force in developing countries. This is especially important for countries like Indonesia that does not fair too well on gender equality indices, where the working status of women is an important correlate of women's decision-making power within the household and attitudes towards domestic violence (Schaner and Das (2016)). Third, our findings are also related to the strand of literature that investigates the seemingly low rates of adoption of simple, relatively inexpensive, highly effective technologies in developing countries that hold promises of improving the quality of life through their impacts on health and productivity.[3] To the extent that intra-household externalities and gender differences in preferences drive the lack of adoption (Miller and Mobarak (2013)), the impact of the policy on the decision-making power of the women provides insights into how temporary subsidies that mitigate such externalities and empower women can encourage adoption and sustained use of such technology.

We have organized the rest of the paper as follows. Section 2 describes the program. Section 3 talks about the data and identification strategy. Section 4 describes the empirical specification used. Section 5 presents the results and section 6 concludes.

[3] See, for example, Foster and Rosenzweig (1995), Miguel and Kremer (2004), Bandiera and Rasul (2006), Duflo et al. (2008), Ashraf et al. (2010), Cohen and Dupas (2010), Conley and Udry (2010) and Foster and Rosenzweig (2010).

2 Background

At the turn of this millennium, kerosene was the main fuel used by Indonesian households for their cooking requirements. In 2004, 48 out of the 52 million Indonesian households depended on kerosene, mostly for their daily cooking requirement and as lighting fuel (Budya and Arofat (2011)). The government had provided large subsidies on kerosene for decades and the subsidy payouts were turning out to be a huge burden on the state, sometimes as high as 18 percent of the state's total expenditures.[4] In its attempt to reduce the subsidy burden, in 2007, the Indonesian government launched the "Conversion to LPG Program" to promote the use of Liquefied Petroleum Gas (LPG) in Indonesian households.

LPG was the replacement choice for a variety of reasons. First, it was estimated that LPG would greatly reduce the subsidy cost per unit of end-use calorific value of energy delivered for cooking and subsidy per unit of fuel. Based on calculations by a team from the University of Trinity in Jakarta and the State Ministry for Women's Empowerment that included laboratory experiments under various cooking conditions in Indonesia, it was found that one liter of kerosene was equivalent to 0.39 kg LPG in terms of its end-use energy value (Budya and Arofat (2011)).[5] According to Budya and Arofat (2011), based on the 2006 calculations alone, this would have saved the state 2.17 billion USD. Second, LPG was a cleaner substitute with lower indoor pollution, which directly affected the health of the users, and lower levels of greenhouse-related pollutants compared to solid fuels.[6] Third, the infrastructure required to implement the transition to a cleaner fuel was more developed for LPG than for other alternatives like electricity. Successful implementation of subsidized LPG programs in neighboring countries of Malaysia and Thailand provided additional motivation.

Depending on the readiness of the the LPG procurement, storage, and distributional infrastructure in the region, the program was rolled out at different times in different regions. Urban regions often got the program earlier (Budya and Arofat (2011)). By 2008, entire of Jakarta, Bali, Yogyakarta, Banten, and parts of West, Central, and East Java had been covered. By 2009, the entire of Java and Bali, parts of Lampung, South Sulawesi, East and West Kalimatan, South and North Sumatra, and Riau had received the program. By 2011, the program covered the entire of Aceh, North Sumatra, Riau, Jambi, Bengkulu, Lampung, entire of Kalimatan except central Kalimatan, and entire of Sulawesi except central and Southeast Sulawesi. By 2013, West Sumatra, West Nusu Tenggara, Bangka Belitung, and the remaining regions of Kalimatan and Sulawesi were covered. Some regions, like East Nusu Tenggara, Malaku, North

[4]The situation was worsened by the reduction of subsidies for industrial fuels (diesel, industrial diesel oil, and marine fuel oil) in the early 2005, pricing them at international prices. The price disparity between the fuel prices for industries and households led to a substitution of kerosene for industrial fuels wherever possible and, as a result, an arbitrage opportunity. This subsequent smuggling caused large leakages in the subsidy increasing the cost even further.

[5]This does not take into account the possible misuse of kerosene for industrial purposes, which would further tilt the scale in favor of LPG. See Budya and Arofat (2011) for a detailed calculation, accounting for such leakages.

[6]See Lam et al. (2012) and WHO (2014) for a review.

Malaku, and Irani Jaya were not covered by the program. As is clear, there was a substantial level of variation in the roll-out date across provinces. Figure 3 depicts the variation in roll-out of the program.

Under the program, all eligible citizens were to receive a free 'initial pack' comprising a 3-kg LPG cylinder with the gas, a one-burner stove, a hose, and a regulator. A few trials runs were conducted before the launch of the program to gauge the society's perception and acceptance of LPG as a cooking fuel. The first test was carried out in Cempaka Baru Village, Kemayoran District, Central Jakarta, on August 1, 2006. 500 families were given the 'initial pack' and their responses and behaviors of the users were noted through surveys and observational methods. A second test was carried out with 18,800 households in Kemayoran District, Central Jakarta, and 6700 families in Karawaci District, Tangerang, Banten in December 2006. This test was not accompanied by a survey, and evaluations were based on observations of people's reaction. The general picture from these market tests was that households were willing to switch to LPG under the subsidy (See Budya and Arofat (2011) for details). A third test was carried out in February 2007 when the Ministry of State-Owned Enterprises, under the State-Owned Enterprises Care program to help flood victims in Jakarta, distributed 10,000 LPG cylinders in Kampung Makassar, East Jakarta. Here too the results were in favor of scaling up the program.

The program had a significant impact on the use of LPG as cooking fuel in Indonesia (Andadari et al. (2014)). The share of LPG in household consumption expenditure increased from 1.9 percent in 2005 to 13.5 percent in 2013, while the share of kerosene dropped considerably from 18 percent in 2005 to 1.8 percent in 2013. (Toft et al. (2016)). Besides the savings in subsidy cost for the government, switching from Kerosene to LPG might have had implication on community-level pollution and depletion of natural resources like forests, on food habits, budget allocations, resources distribution and bargaining within the household, and on health, education, time use, and labor force participation of individuals from the exposed household. A cost-benefit analysis in terms of subsidy cost-savings alone is likely to understate the net benefits of the program. However, there have hardly been any systematic evaluations of the impact on the program, especially on factors affecting the health and economic well being of those covered by the program.[7]

3 Data and Identification

For our main analysis, we use the information from a geographically stratified systematic 10% sample of the 2010 Indonesian Population Census. The census interviews the entire population

[7] Andadari et al. (2014) look at the impact of the program on energy poverty. They find that the programs led to increased stacking of fuels, increasing consumption of both electricity and traditional biomass. It failed to reduce the overall number of energy-poor people although it was somewhat effective at reducing extreme energy poverty. Permadi et al. (2017) find that the program led to significant reductions in emissions of greenhouse gases and air pollutants

of Indonesia, Indonesian and foreign, residing in the territorial area of Indonesia, regardless of residence status and includes homeless, refugees, ship crews, and people in inaccessible areas. Diplomats and their families residing in Indonesia are excluded. The census collected information on a wide range of variables including the district and province of current residence and the primary fuel used by responding households, the educational attainment, employment status, age and gender of the individual respondents. Wherever required, we use earlier waves of the Population Censuses and Intercensal Population Survey of Indonesia to examine time trends in the independent and dependent variables of interest.

Using information from these censuses, we first examine the impact of the program on the household's primary fuel of choice and the educational attainment and the employment status of individual respondents. While the large sample size of these censuses allow us to estimate the impact of the program on these variables with great precision, they lack additional details about the households and the individuals respondents preventing further analysis of the program. To get around this problem, we then use the information the third, fourth and fifth wave of the Indonesian Family Life Survey (IFLS). IFLS is a on-going longitudinal household survey representative of about 83 % of Indonesian population living in 13 of the 27 provinces in the country (Strauss et al. (2016)). The first wave was administered in 1993 to over 22,000 individuals living in 7,224 households. The follow-up waves 1997, 2000, 2007, and 2014, sought to follow the original respondents and their off-springs in the same or split-off household. In IFLS 5, 50,148 individuals living in 16,204 households were interviewed. The survey is remarkable for its low levels of attrition, with the recontact rate of original IFLS 1 dynasties (any part of the original IFLS 1 household) in IFLS 5 as high as 92%. We make use of waves 4 and 5 of the survey for our analysis.The survey contains information on a wide variety of topics at the individual, the household and the community level. At the individual-level, we make use of information on health, education, employment, migration, etc., of respondents. At the household level, we utilize the information on the main cooking fuel of the household and whether the household's kitchen is inside the house. Here, we first show that the impact of the program on LPG usage, education, and employment are robust across the two data sets. Then, we examine the impact of the program on a wide range of outcomes, including health and decision-making within the household.

The information on the variation in program roll-out across regions is obtained from Budya and Arofat (2011) and Thoday et al. (2018). As described above, in certain cases only a part of a province was covered in a given year. The rest of the province was covered in the following years. Unfortunately, we do not have precise data on variation in roll-out at a finer level (district/village/communities). Instead, we define a province to have received the program only if the entire province was covered. This induces some degree measurement error that will bias the estimates downwards. The variation in roll out of the program across the communities in the IFLS dataset is presented in figure 4 and tables 1 and 2 reports the summary statistics for the two data sets we use.

4 Empirical Specification

By the time of the 2010 census, some provinces in Indonesia had received the LPG program while others had not. If the program had been randomly assigned to the provinces, we could have have attributed the differences in the outcome variables of interest across the provinces that had received the program (hereon, exposed provinces) and the provinces that had not (hereon, control provinces) as the causal impact of the program. But as we point out in Section 2, the rollout of the program was not random. The regions that had ready-infrastructure for LPG procurement, storage, and distribution had received the program. It is likely that the exposed provinces were different from the control provinces along a number of dimensions including our outcome variables of interest or the factors that drive these outcomes. To account for this, we use a difference-difference strategy. We compare the changes in our outcome variables of interest between 2005 and 2010 for provinces that had received the program by 2010 with provinces that had not received the program by 2010. Accounting for pre-existing differences across the provinces, we expect that the household in provinces that had received the program by 2010 must have increased their LPG usage more than those in control provinces.

The identifying assumption here is that in the absence of the program, the change in these outcome variables of interest should have been the same in the exposed and control provinces. Said differently, the trend in a variable of interest over time in the exposed provinces in the absence of the program is assumed to have been the same as the trend in the variable in the control provinces (hereon, the parallel trends assumption). We first provide support in favor of the parallel trend assumption by showing that the variables of interest trended parallel in exposed and control provinces before 2005. Then, we estimate the following equation:

$$Y_{idpt} = \alpha + \beta \times Post_t \times Treat_{dp} + \tau_t + \delta_d p + \varepsilon_{idpt} \tag{1}$$

where Y_{idpt} is the outcome variable of interest for household or individual i living in district (kabupaten in Indonesia) d of province p in year t. At the household level, the outcomes of interest are whether or not the household used LPG as the primary cooking fuel. At the individual level, we are most interested in the impact of the program on the labor force participation of those exposed to the program, especially that of females. $Post_t$ denotes the pre- and post-rollout period. It takes value '0' for year 2005 and '1' for 2010. $Treat_d p$ is an indicator variable that takes value '1' for all districts in all the provinces that had received the program by 2010, '0' otherwise. τ_t controls for time-varying factors that were common to exposed and control province and could have affected the outcome of interest. $\delta_d p$ controls for time-invariant differences across districts that could have affected the outcome.[8] To maintain consistency with the specifications that follow, we cluster the standard errors at the level of the district. Clustering them at the level of the province does not affect the statistical significance of the results.

However, provinces in Indonesia are considerably different. Not only in their population (ranging from a few hundred thousands to well over 40 millions) and their geographical area (from a little over 250 square miles to over 120000 square miles) but also in their distance from the government's seat in Jakarta or other bigger urban commercial centers in the country. As a result, it is possible that even though the time trends in variables of interest for the exposed and control provinces are parallel on an average, there are time-varying unobservable differences across provinces that might bias our results. For example, consider a scenario where some provincial administrations in-charge of the LPG program bundled the LPG program with other programs that affected the outcomes of interest while other did not. If so, if we estimate the model in (1), we will attribute any affect of these other programs on the outcome to the LPG program.

To get around this problem, we use a modified version of the shift-share instrument - we interact $Post_t * Treat_{dp}$ with the proportion of household in district d of province p that used kerosene as their primary cooking fuel in 2005.[9] The proportion of households in different districts within the provinces in Indonesia that used kerosene as their primary cooking fuel was vastly different. For the 258 districts included in the IPC and SUPAS, it ranges from as low was 0.03 % to as high as 94% in 2005. In the IFLS survey, out of the 311 communities, none of the households in nine communities and all of the households in 3 communities used kerosene in 2000. The LPG program was a national-level policy intervention and, therefore, should be exogenous to the variation in kerosene usage within the province.[10] Therefore, while the timing and nature of the program could have differed across provinces (shift), it is unlikely that it was associated with the differences across districts within a province and the districts with a higher proportion of kerosene users before the program within a province would have benefited more from the program (share). [11]

[8]Replacing district fixed effects with province fixed effects does not change our results.

[9]The shift-share instrument, often referred to as the Bartik instrument (Bartik (1991)), is used extensively in the migration literature. Some early applications of the instrument include Altonji and Card (1989), Card (2001), and Card (2009). It leverages the observation that a national policy will have differential impact across different regions of the country depending on the size of the population in each region affected by the policy.

[10]"National specification of targeted localities for conversion would be done centrally under control of the conversion team established by Pertamina." - (Budya and Arofat (2011))

[11]Our strategy is similar to Bleakley (2007) who combines the introduction of the hookworm eradication campaign in the American South in the 1910s with the variations in the hookworm infection rates prior to the campaign across regions to identify the impacts of hookworm eradication on later-life outcomes. The author points out that different areas of the US had distinct incidences of the hookworm disease and, therefore, stood to gain differentially from the campaign. The innovations in treatment of hookworm were not related to or in anticipation of the future growth prospects of the affected areas.

There are two reasons for why the districts with a higher incidence of kerosene usage stood to benefit more from the program. One, the LPG subsidy was rolled out to replace the kerosene subsidy. As a result, there was a high correlation between the phase in of the LPG subsidy and the phase out of the kerosene subsidy. This meant that while the cost of LPG decreased for all household in the regions that received the LPG subsidy, the relative price of kerosene went up even more for household that used kerosene before. Second, before the LPG program, kerosene was a highly subsidized fuel. Households that chose not to use kerosene even with the high subsidy must have had a relatively inelastic demand for the fuel they used instead.[12] It is likely that a reduction in LPG prices might have been equally unsuccessful in getting these households to switch from their fuel of choice. Therefore, one can think of the variation in pre-program kerosene usage across districts as a variation in the magnitude of the subsidy or the extent of its coverage. We estimate the following specification:

$$Y_{idpt} = \alpha + \beta_1 \times Post_t \times Treat_{dp} \times Kero_{dp,2005} + \beta_2 \times Post_t \times Treat_{dp} + \tau_t \times Kero_{dp,2005} + \gamma_{tp} + \delta_{dp} + \varepsilon_{idpt} \quad (2)$$

where the terms common with (1) are defined as before. $Kero_{dp,2005}$ is the percentage of households in district d of province p who used kerosene as their primary cooking fuel in 2005. β_2 captures the impact of the program in districts where no one used kerosene as the primary cooking fuel in 2005. β_1 measures the increase in the impact of the program with increase in the pre-program usage rate of kerosene. Following Acemoglu et al. (2004), Hoynes and Schanzenbach (2009) and Hoynes et al. (2016), we also include interactions of the year fixed effects with the pre-program proportion of kerosene users in the districts to control for possible differences in trends across districts with different levels of kerosene users. In addition, we include province-year fixed effects γ_{tp} to account for time-varying difference across provinces and δ_{dp} to account for time-invariant differences across districts. Even if the some provinces rolled out the program in combination with other programs, the province-year fixed effects will control for such differences. Since there is no variation in $Treat$, $Kero_{dp,2005}$, and $Treat \times Kero_{dp,2005}$ within a district, their effects are absorbed in the district fixed effect δ_{dp}. The effects of $Post_t$ and $Post_t \times Kero_{dp,2005}$ are absorbed in the $\tau_t \times Kero_{dp,2005}$ and γ_{tp}

Once we establish the impact of the program using data from the censuses and the intercensal surveys, we move to the IFLS to examine other outcomes and mechanism variables of interest. None of provinces had received the program by 2000 when the third wave of IFLS was fielded. By the time of the IFLS wave 4 in 2007 while the program had started, it was still in its initial stages and none of the provinces had been covered completely. By the time of the fifth wave of IFLS, all the provinces included in the IFLS surveys had been covered. As a result, in contrast to data from the IPC and SUPAS, we do not have distinct exposed and control

[12] Firewood was the second most important primary fuel of choice before the program.

provinces in IFLS and, therefore, cannot use $Post_t \times Treat_{dp}$ identification strategy laid out in (1). However, IFLS, besides the in-depth information on individuals and households, has one more advantage that helps the identification of the program impacts. IFLS provides geographical identifiers for communities that are smaller geographical units than districts. This allows us to use variations in pre-program kerosene usage at a finer level to identify the impact of the program. We begin by estimating the following specification:

$$Y_{icdpt} = \alpha + \beta_1 \times Post_t \times Kero_{cdp,2000} + \tau_t \times Kero_{cdp,2005} + \gamma_{tdp} + \delta_{cdp} + \varepsilon_{icdpt} \quad (3)$$

where c denotes the community recorded in the IFLS survey. $Kero_{cdp,2005}$ is the proportion of households in community c of sub-district (kecamatan) d of province p who used kerosene as the primary cooking fuel in 2000. Similar to (2), we include interaction of the time fixed effects with the pre-program rate of kerosene usage, sub-district-year fixed effects, and community fixed effects. We cluster the standard errors at the level of the community.

5 Results

5.1 Fuel of choice

Figure 5 reports the change in proportion of respondent households cooking with different kinds of fuel. The proportion of households using LPG increased substantially from below 10 % in 2005 to almost 50 % in 2010. We also observe a corresponding decline in the use of kerosene. Consistent with earlier findings, we find that there were no sharp trend breaks in the proportion of households using solid fuels between 2005 and 2010 but the number of solid-fuel users was declining throughout the 1995-2010 period (Thoday et al. (2018)). The LPG conversion program started in 2007-08. Therefore, it seems likely that the increase in LPG usage rate was a result of the program. To probe this further, in Figure 6, we break down the LPG usage rate by whether or not the district was exposed to the program by the time of the survey. There was an increase in the LPG usage rate in all districts between 2005 and 2010.[13] However, the increase in LPG usage in districts that had received the program was visibly greater than that in districts that had not received the program.

We verify these findings using a regression framework that controls for district-level differences and province-level changes over time. Table 3 presents the results. In column (1), we compare the differences the probability of a household using LPG across time in exposed

[13]Remember, according to our definition of exposure, districts in a province are not considered exposed until the entire province has been covered by the program. This means that we might categorize some districts that have already received the program as control districts. As explained in section 3, this will bias our coefficients downwards. This may also explain some of the increase in the LPG usage rate in control districts in Figure 6.

and control provinces. We find that households in regions that received the LPG program were more likely to use LPG by almost 40%. In columns (2) - (4), we show that this finding is not sensitive to the level of geography that we include fixed-effects and cluster the standard errors at. In column (5), using the strongest and our most-preferred specification from equation (2) that allows us to exploit finer geographical variation, we show that the impact of the program was much higher in districts with higher pre-program kerosene usage rate. As expected, the program had a bigger impact on the fuel of choice in districts with a high rate of pre-program kerosene usage. The difference between the change in LPG usage rate across two exposed districts, one where no one used kerosene before the program and the other where everyone used kerosene before the program, was almost 40 percentage points. The findings from table 3 are consistent with the broad trends presented in Figures 6 and 7 - the program had a causal affect on the LPG usage rate.

Next, we verify these findings using information from IFLS using community-level variations. We present the results in Table 4. According to column (1), controlling for differences across time and time-invariant differences across communities, communities where everyone used kerosene in 2000 were 40% more likely to be using LPG after the program in 2014 compared to communities where no one used kerosene in 2000. Controlling for household fixed effects and kecamatan-year fixed effects do not change the results. The impact magnitudes estimated using information from IFLS are strikingly close to those from IPC and SUPAS, suggesting that estimated impacts are robust across data-sets.

5.2 Labour supply

As discussed before, adoption of modern household technology can significant impacts on the labor force participation of household members. Figure 11 presents the unconditional trend in the labor force participation of men and women in the exposed and control provinces. The labor force participation appears to have followed a roughly parallel trend in the two groups until 2005. However, the labor force participation of both men and women in 2010 was significantly more in province exposed to the program. Table 5 presents the difference in the labor force participation status controlling for pre-program difference across regions. According to column (1), the labor force participation increased significantly in regions exposed to the program. In column (2), we find that though the labor force participation of status of both men and women increased over the period, the increase in labor force participation of women was far 26 percentage points higher than that for the males. In column (3), we examine the increase in labor force participation by pre-program kerosene usage rate. As expected, we find that individuals in regions where the program had a bigger impact on LPG usage see a higher increase in labor force participation. Finally, in column (4), we break down the impact on males and females in high and low pre-program usage rate. We find that the program had a negative effect on the labor force participation rate of males in districts with low rates of pre-program kerosene usage but this effect was more than offset by an increase in the female labor force participation in these districts. The effect was not significantly different for males in districts with high rates of pre-program kerosene usage. However, the increase in labor force participation of women in these regions was much higher. In summary, the findings suggest a change in intra-household allocation. Controlling for province-level time variation observable factors, we find that men might have decreased their labor force by a small amount and women increased their labor force participation in all districts, more so in districts more affected by the program. This is consistent with the findings from the OECD countries that modern household technology have led to an increase in female labor force participation (Greenwood et al. (2005); Goldin (2006); Aguiar and Hurst (2007); de V. Cavalcanti and Tavares (2008)).

Data from the IFLS allows us to examine the impact of the program on the type of work that men and women do. Table 6 presents the results. Women exposed to the program in regions that had a high pre-program usage rate of kerosene were much more likely to report working for pay as their primary activity in week prior to the survey. There is a corresponding decline in women reporting housekeeping as their primary activity in the previous week. In terms of all activities performed in the previous week, exposed women report having worked with or without pay and searched for jobs more often and to have done housekeeping less often. Interestingly enough, housekeeping activities for the men also seem to have gone down due to the program. This suggest that the change due to the program was not a mere reassignment of household and other responsibilities. The increase in labor force participation of the exposed women is also visible in the increase in their probability of having ever held a job in the years preceding the survey (Table 7).

There are two important differences between the estimated labor market impacts of the program in tables 5 and 6. First, the impacts are smaller for women when we use information from IFLS. This could be a result of the fact that IFLS is representative of only 83% of the Indonesian population living in 13 provinces on the main islands and misses out on the remoter areas of the country (Strauss et al. (2016)). It is conceivable that the program had a bigger impact on the labor force participation of women in these remoter areas. Comparing the labor force participation of women in across the summary statistic tables 1 and 2, it is clear that those areas not included in IFLS but included in IPC and SUPAS have a lower rate of female labor force participation. This, in turn, could have been a result of the differences in household cooking technology used across these regions. The IFLS regions had a higher rate of LPG usage than the IPC and SUPAS regions before the program. The program, therefore, might have liberated more women from the burden of household responsibilities in these remote regions. Second, there appears to be no negative impact of the program on male labor force participation of men when we use information from IFLS. This too could be due to the difference is the representativeness of the IFLS from that of IPC and SUPAS. Removal of kerosene subsidy negatively affected some cottage industries in the coastal areas. For example, the *Batik* textile production, a textile production technique indigenous to Indonesia, in coastal regions suffered when the kerosene subsidy was withdrawn as LPG could not be used in place of kerosene to melt the *Batik* wax.[14]

5.3 Time use

As is clean from table 6, while women exposed to the program were less likely to report having performed housekeeping activities in the week prior to the survey, there was no discernible increase in the housekeeping activities performed by men from the exposed households. This suggests that women must have found the time to do both - perform housekeeping activities and work for pay. Since it is unlikely that the program changed the list of housekeeping activities to be performed, women must have been able to perform their housekeeping activities in a smaller amount of time.

This is not unlikely. An advantage of cooking with LPG is the smaller amount of time required for cooking compared to cooking with kerosene or other solid-fuels. Igniting a solid-fuel or a kerosene stoves to full capacity is substantially more work than switching on the LPG stove by turning a knob. Unlike some other fuels, it also does require the women to spend time collecting the fuel and preparing it for usage. Since the cooking activities in most developing countries are predominantly carried out women, the benefits of a switch to LPG, especially in terms of time saved, are likely to be higher for women (Pitt et al. (2006); Miller and Mobarak (2013)). Unfortunately, we do not have time use data for exposed women to be able to examine this mechanism explicitly. However, earlier research on related topics provide suggestive evidence.

In their 2016 study of the Indonesian domestic biogas program of 2009, Gurung and Setyowati (2016) found that women save well over one hour per day when they switch to domestic bio-gas for their cooking needs. This time saving, they report, is net of activities like cleaning the stable, collecting dung, putting the dung into bio-digester, putting bio-slurry into the pit, etc., required to fuel a bio-gas plan that requires close to forty minutes. LPG stoves do not require these elaborate processes to keep it running. Therefore, the time saved from switching to LPG might have been higher. Gurung and Setyowati (2016) also find that most of the saved time is spent in productive activities. Similarly, an in-depth survey of cooking fuel consumption and cooking habits in peri-urban households outside Yogyakarta City, in central Java by the World Bank found that cooking with LPG was significantly faster than other methods (ASTAE (2015)). When examining preference for fuels and cooking stoves, the survey finds that households preferred technologies that saved time.

It is likely that the LPG program, since it was similar to the bio-gas program but only faster, had similar effects on the time use of the women in the household and on their labor

[14]We thank Mari Pangestu, erstwhile Minister of Trade, and Tourism and Creative Economy, for pointing this out.

force participation. Is the time-saving enough to generate impacts on labor force participation? Building on the findings from Gurung and Setyowati (2016), even if we use a conservative estimate of one hour saved everyday, it amounts to seven hours in a week. Aggregating time saved over a week is especially important in this case since some of the activities it replaces, like collection of firewood and chopping it into usable blocks, is done on a weekly basis and often performed collectively by female members of the households. With such activities no longer required, it is plausible that women might have had enough time to work for pay for at least one day during the week. Unfortunately, it is difficult to make claims about time use as a mechanism with certainty without data on time use and future research should aim to test with hypothesis explicitly.

5.4 Health outcomes

Time savings from switching to LPG might not be the only pathway through which the program might have affected labor supply. Cleaner cooking fuel generates less indoor air pollution. This could have improved the respiratory health of the household members. In fact, much of the motivation behind the large subsidies on cleaner cooking stoves and fuels comes from their potential positive impact on health, and in particular, the respiratory health of women and young children through reduction in indoor air pollution. And while better health is a desirable result in itself, it might also affect the labor supply of the household members.

However, despite the perceived potential benefits, there is a dearth of empirical evidence on the respiratory health benefits of using cleaner cooking fuels or technologies. Duflo et al. (2012) examine the impact of a randomized distribution of cleaner cooking stoves in rural Orissa in India on respiratory health of those who received the cook stove. They find reduction in the amount of smoke inhaled in the first year but no improvements in lung capacity or other measures of health. RESPIRE study, an experiment involving randomized distribution of concrete stoves in Guatemala, finds similar results - reduction in CO and pm2.5 exposure but no improvement in lung function and other respiratory symptoms like chronic cough, wheezing, tightness of chest, etc. (Smith-Sivertsen et al. (2009)).

Using information from IFLS waves 2, 3, and 4, Silwal and McKay (2015) find that individuals living in households that cook with firewood have 11.2 per cent lower lung capacity than others. But their instrument of choice for household's fuel choice, the availability of an all-whether road in the community, might have affected health via other channels like access to health care facilities. Gajate-Garrido (2013) uses a two-wave panel survey of Peruvian children and a household fixed effects specification to show that young boys in households cooking with firewood are more likely to report respiratory illnesses. The household fixed effects model does not account for household-level time varying factors that might affect the choice of cooking fuel and child health. Besides, it is not clear why the effect might be differential effects on girls, for whom she finds no impact, and boys.

Since IPC and SUPAS do not contain health measures for the respondents, we turn to the IFLS to examine the impact of the program on health. As a part of the IFLS survey, a professionally trained nurse collects an extensive array of biomarker measurements. In table 8, we examine the impact of the program on some of these measures. The program had no effect on the maximum lung capacity of those exposed to the program. Among other measured health biomarkers, we do not find any significant impact of the program on the probability of being underweight, grip strength, systolic or diastolic blood pressure of any one in the household. However, exposure to the program is associated with a significant increase in the proportion of overweight males and females. We also see a significant increase in the pulse rate of males. IFLS also collects self-reported information on doctor-diagnosed chronic conditions. Table 9 reports the impact of the program on the probability of having been diagnosed with certain chronic conditions. Consistent with our earlier findings on lung capacity in table 8, we find no effect of the program on respiratory conditions like asthma and other lung conditions.

Exposure to the program is associated with a small decrease in the incidence of hypertension in females. But taken together, the findings suggest that there were no major impact of the program on the health of those exposed to the program. Our findings, that are consistent with Smith-Sivertsen et al. (2009) and Duflo et al. (2012), appear to be driven by two factors. First, most of the households that changed their primary cooking fuel switched from kerosene to LPG. Studies find that kerosene is almost as clean as LPG in household cooking settings (Mehta and Shahpar (2004)). Second, there is a significant positive association between those who cook with solid fuels and those who have the kitchen outside their main housing building. This is consistent with the findings of Pitt et al. (2006) who find that households in Bangladesh understand the harmful effects of indoor air pollution generated due to cooking and invest in mitigation mechanisms. Similarly, Kan et al. (2011) find that households in Anhui, China tend to use griddle stoves with smoke removed by a hood or a chimney and cook in a separate room or building to mitigate the harmful effects of cooking with solid-fuels. If the Indonesian households choose the location of the kitchen strategically to mitigate the negative impact of indoor air pollution due to cooking, it seems plausible that these household also invest in other methods of mitigation, including better ventilation in the kitchen. The lack of any major significant effects on the respiratory health of those who received the program are, therefore, not surprising.

The programs impact on lifestyle diseases, chances of being overweight and suffering from hypertension are unlikely to be a result of reduction in indoor air pollution. While a reduction labor market activities could have been a possible explanation for increasing weight-related issues in men, we do not find a reduction in the labor market or household activities for males in the IFLS dataset that we use to evaluate the health effects of the program. In addition, change in labor market activities cannot explain the results for women who were working more often. A more plausible pathway is the income effect. An increase in labor force participation of women is likely to increase the household income. This additional income may have changed the composition of household's food consumption that lead to these effects. But these effects are too small to explain the magnitude of the effect on female labor force participation.

5.5 Other benefits

The increase in participation of women in work for pay activities, even though small, should imply an increase in household income and expenditures. We examine this by looking at the impact on different types of expenditure for the households. We report the results in table 10. For pre-program kerosene-user households exposed to the program, weekly expenditure on food items increased significantly after the program. While a increase of USD 3.61 might not look to high, it is important to compare it with the average food expenditure per week. In percentage terms, there was a 14% increase in food expenditure for the households affected by the program in the week prior to the survey. In table 11, we examine the impact of the program on food composition. We find that the program led to an increase in consumption of fruits, especially by women, but did not have significant effects on the consumption of protein-rich food items. But we must point out that the results in table 11 capture the impact of the program on the extensive margin of the food items reported and fail to capture any changes in the quantity and quality of the food items at the intensive margin. A key takeaway from table 11 is that the food consumption benefits accrue to both males and females in the family. That is, the increased food expenditure due to the program benefited both males and females in the household. The household sizes in IFLS3, 4, and 5 are 5.2, 4.5, ad 4.3, respectively.[per]

The change in non-food and education expenditures, in comparison, have a lot of variation to infer a clear impact of the program (columns (2)-(4) of table 10). The impact of the program on non-food expenditure is, *a priori*, theoretically ambiguous. While increased female labor force participation might have led to increase in household non-food expenditure, a reduction in price of fuel due to the program, a non-food commodity with a relatively inelastic demand, might have meant a reduction in non-food expenditure. In table 12, we separate out the impact of the program on fuel and other expenditure on other utilities. We find that fuel and expenditures on other utilities form a significantly smaller share of household non-food expenditure for the households affected by the program. Therefore, it is difficult to rule out the positive impact on non-food consumption even though we do not see a significant effect on the household's non-food expenditure. It is entirely possible that the money saved in fuel expenses was used to increase the consumption of other non-food items.

But though everyone in the household benefits from the program's impact on household expenditures, women were working more often. It is not clear by itself that the women preferred the arrangement where an increase in consumption expenditure came at the cost of them working more. It is possible that women would have preferred to enjoy their time savings as leisure but were pressurized by household members to work for pay instead. While there is no way to verify that with the data we have, we might expect such a situation to have negative effect on the subjective well being of women. Table 13 reports the impact of the program on the subjective well being of members of the exposed household. While there is no change in the subjective well being of men except for increased optimism about the future, women are significantly more optimistic about the future, less concerned about the situation of their standard of living and food consumption, and happier. this makes it unlikely that women were pressured into work against their wishes. In the next section, we provide further evidence on increased decision-making power of women that rules out the possibility of women being pressured into work further.

5.6 Cost-benefit analysis and female decision-making power

In 2007, the cost of LPG/kg (US$ 0.89) was marginally higher than the cost of a liter of kerosene (US$ 0.61). However, 1 liter of kerosene was equivalent to 0.39 kgs of LPG in terms of end use energy generated (Budya and Arofat (2011)). Even if we assume that the two fuels generated the same amount of energy per kg, and the average LPG requirement for one household to be between 4 to 5 kgs per household per week (Thoday et al. (2018)), the benefits of switching to LPG on household food expenditure alone outweighed the costs. The question that then arises is why did the household not switch to LPG themselves?

The lack of adoption cannot be explained as a supply side constraint. In 2007, the average rate of LPG usage across different IFLS communities was close to 20%. Out of the 312 communities, 237 had at least one household using LPG. But even among communities with at least one LPG user, the LPG usage rate was around 26%. Later, the single-most important reason for choosing LPG as the replacement fuel was that *" ... elements of the supply chain were already in place and it was the easiest fuel to distribute to rural and remote populations across a vast territory"* (Thoday et al. (2018)). This suggests that even in 2007, LPG was readily available. Since the difference between the expenditure on fuels would have been around five percent of the average household weekly food expenditure, it is unlike that credit constraints prevented around 80 percent of the Indonesian households from using LPG. Another often-cited reason is that the LPG cylinders before the program had a capacity of 12 kgs while the those distributed during the program were 3-kg cylinders and the 12 kg-cylinders were difficult to transport and store. We cannot rule this out as a possible explanation. But a 12-kg cylinder would have meant a single trip to the retailer in a month in comparison to multiple trips for those using kerosene. Storage at home is also unlikely to be a factor since the two types of cylinders were significantly different only in their height.

A more likely reason seems to be the one suggested by Miller and Mobarak (2013) and alluded to by Pitt et al. (2006) - intrahousehold externalities and gender differences in preferences. In Indonesia, mostly women are in charge of cooking activities. As a result, they bear the maximum brunt of the negative impact of the conventional cooking methods. However, expenditure decisions are often taken by the males in the family who might sometimes be somewhat reluctant to spend money on commodities that do not benefit them directly. That is, there might be intra-household externalities of the decision to switch fuels and there might be a difference in preferences across different genders within the household.

It is possible that if women had more say in financial decisions, there might have been a higher rate of adoption of cleaner cooking fuel. To examine this further, we examine the association between the woman's choice of cooking fuel and her decision-making power within the household. We use two measures of a woman's decision-making power within the household. IFLS surveys ask a respondent 18 questions about who among their household members makes decisions pertaining to different household matters. For example, one of the questions asked that pertains to financial decision-making is "In your household, who makes decisions about money for monthly savings?" The respondent can choose more than one person as the decision-maker. For our first measure, we count the respondent as having complete say in the matter if the respondent reports that he or she takes decisions in the matter alone. For the second measure, we count the individuals as having some say in the matter, if the respondent reports more than one person, including himself or herself, as the decision-makers. We use a count measure of the number of domains in which an individual has complete or some say in the matters. In addition to the general measure that aggregates our decision-making variable over all 18 questions, we also define similar measures of financial decision-making using eight questions related to financial matters. As reported in table 14, we find that the probability of a woman cooking with LPG (or solid fuels) before the program was significantly and positively (negatively) associated with the decision-making power of women.

Among other correlated, working status of a woman was also associated with a higher likelihood of cooking with LPG. Since the subsidy program increased female labor force participation., we might expect that the program to have increased the decision-making power of women in the exposed households. We examine the possibility in table 15. Women affected by the program report an increase in their decision-making power, especially in financial matters. This change in decision-making power is, quite possibly, a result of increased work-force participation of women. If the unwillingness of the husbands to pay for LPG was, in fact, a reason that explained low adoption of the fuel, the increase in labor force participation and decision-making power of women, especially in financial matters, might ensure that they buy the beneficial technology on their own even in the absence of the subsidy.

6 Conclusion

In an attempt to reduce the subsidy burden of kerosene, the Indonesian government sought to replace it with subsidized LPG. Cooking with LPG is less time consuming than cooking with kerosene or solid fuels. Previous research has found that modern time-saving household technologies have implication on female labor force participation. Consistent with this, we find large impacts on the female labor force participation of women exposed to the LPG subsidy program. The results reinforce the effectiveness of relatively inexpensive policy incentives for the adoption of modern household technology in ensuring greater integration of women in the labor force.

We explore two possible pathways through which a switch to LPG for cooking might have affected labor force participation of women - better health and time saving. We rule out the health mechanism but do not have adequate data to verify the time-saving mechanism. Based on previous research on the topic, we posit that the time-saving mechanism might have been operation. We leave a more rigorous examination of this mechanism to future research. We show that the program had benefits for the entire households, and not just for women. Household expenditure on food items increased significantly. Women were more optimistic, less worried, happier, and had more decision-making power within the household, especially in financial matters.

The results have important implications on the cost-benefit analysis of the programs of the kind. Focusing on the health alone might underestimate the benefits of such programs. The recent developments in consumer technologies have been impressive not only in their pace but also in the increasing number of feature they incorporate. A comprehensive analysis of the benefits of any such technology should examine the effects on a number of dimensions of well-being. Another important take away pertains to private incentives to adopt modern technology. Even in situations where the private benefits of adoption might surpass the cost for a household, intra-household externalities and differences in preferences within the household might hinder adoption. We must, therefore, revisit the question of low adoption of welfare-enhancing technology and evaluate the extent to which difference in preferences of the potential beneficiaries can explain the puzzle. Temporary subsidies that mitigate externalities might go a long way in solving the low-adoption problem in such contexts.

Our analysis leaves a lot to be desired. An direct examination of the causal analysis of the impact of the decision-making power with women on the adoption of modern technology is essential in the identification of possible virtuous cycle of greater adoption and welfare. Similarly, an understanding of the pathways through which technologies such as cooking with LPG affects labor force participation of women is of crucial importance for designing policies aimed at improving female labor force participation. Due to data limitation, we leave this to future research.

References

Acemoglu, D., Autor, D. H., and Lyle, D. (2004). Women, war, and wages: The effect of female labor supply on the wage structure at mid-century. *Journal of Political Economy*, 112(3):497–551.

Aguiar, M. and Hurst, E. (2007). Measuring trends in leisure: The allocation of time over five decades. *The Quarterly Journal of Economics*, 122(3):969–1006.

Albanesi, S. and Olivetti, C. (2009). Home production, market production and the gender wage gap: Incentives and expectations. *Review of Economic Dynamics*, 12(1):80–107.

Altonji, J. G. and Card, D. (1989). The effects of immigration on the labor market outcomes of natives. Technical report, National Bureau of Economic Research.

Andadari, R. K., Mulder, P., and Rietveld, P. (2014). Energy poverty reduction by fuel switching: Impact evaluation of the LPG conversion program in Indonesia. *Energy Policy*, 66:436–449.

Angst, F., Drerup, S., Werle, S., Herren, D. B., Simmen, B. R., and Goldhahn, J. (2010). Prediction of grip and key pinch strength in 978 healthy subjects. *BMC Musculoskeletal Disorders*, 11(1):94.

Ashraf, N., Berry, J., and Shapiro, J. M. (2010). Can higher prices stimulate product use? Evidence from a field experiment in Zambia. *American Economic Review*, 100(5):2383–2413.

ASTAE (2015). Clean biomass cookstoves in central Java, Indonesia: A quantitative market analysis. Technical report, Asia Sustainable and Alternative Energy Program, The World Bank Group.

Attanasio, O., Low, H., and Sánchez-Marcos, V. (2008). Explaining changes in female labor supply in a life-cycle model. *American Economic Review*, 98(4):1517–52.

Bandiera, O. and Rasul, I. (2006). Social networks and technology adoption in northern Mozambique. *Economic Journal*, 116(514):869–902.

Bartik, T. J. (1991). Who benefits from state and local economic development policies?

Bleakley, H. (2007). Disease and development: Evidence from hookworm eradication in the American South. *Quarterly Journal of Economics*, 122(1):73–117.

Bloom, D. E., Canning, D., Fink, G., and Finlay, J. E. (2009). Fertility, female labor force participation, and the demographic dividend. *Journal of Economic Growth*, 14(2):79–101.

Brunekreef, B., Janssen, N. A., de Hartog, J., Harssema, H., Knape, M., and van Vliet, P. (1997). Air pollution from truck traffic and lung function in children living near motorways. *Epidemiology*, pages 298–303.

Budya, H. and Arofat, M. Y. (2011). Providing cleaner energy access in Indonesia through the megaproject of kerosene conversion to LPG. *Energy Policy*, 39(12):7575–7586.

Card, D. (2001). Immigrant inflows, native outflows, and the local labor market impacts of higher immigration. *Journal of Labor Economics*, 19(1):22–64.

Card, D. (2009). Immigration and inequality. *American Economic Review*, 99(2):1–21.

Caselli, F. (2005). Accounting for cross-country income differences. *Handbook of Economic Growth*, 1:679–741.

Cohen, J. and Dupas, P. (2010). Free distribution or cost-sharing? Evidence from a randomized malaria prevention experiment. *The Quarterly Journal of Economics*, pages 1–45.

Conley, T. G. and Udry, C. R. (2010). Learning about a new technology: Pineapple in Ghana. *The American Economic Review*, 100(1):35–69.

Costa, D. L. (2000). From mill town to board room: The rise of women's paid labor. *Journal of Economic Perspectives*, 14(4):101–122.

Cubas, G. (2016). Distortions, infrastructure, and female labor supply in developing countries. *European Economic Review*, 87:194–215.

Cutler, D. M., Glaeser, E. L., and Shapiro, J. M. (2003). Why have Americans become more obese? *Journal of Economic Perspectives*, 17(3):93–118.

de V. Cavalcanti, T. V. and Tavares, J. (2008). Assessing the "engines of liberation": Home appliances and female labor force participation. *The Review of Economics and Statistics*, 90(1):81–88.

Duflo, E., Greenstone, M., and Hanna, R. (2012). Up in smoke: The influence of household behavior on the long-run impact of improved cooking stoves. *NBER Working Paper*, 18033.

Duflo, E., Kremer, M., and Robinson, J. (2008). How high are rates of return to fertilizer? Evidence from field experiments in Kenya. *The American economic review*, 98(2):482–488.

Fernández, R. (2013). Cultural change as learning: The evolution of female labor force participation over a century. *American Economic Review*, 103(1):472–500.

Foster, A. D. and Rosenzweig, M. R. (1995). Learning by doing and learning from others: Human capital and technical change in agriculture. *Journal of Political Economy*, 103(6):1176–1209.

Foster, A. D. and Rosenzweig, M. R. (2010). Microeconomics of technology adoption. *Annual Review of Economics*, 2(1):395–424.

Gagliardone, L. (2015). Women's allocation of time in India, Indonesia, and China.

Gajate-Garrido, G. (2013). The impact of indoor air pollution on the incidence of life threatening respiratory illnesses: Evidence from young children in Peru. *The Journal of Development Studies*, 49(4):500–515.

Galor, O. and Weil, D. N. (1996). The gender gap, fertility, and growth. *American Economic Review*, 86(3):374–387.

Gharaibeh, N. S. (1996). Effects of indoor air pollution on lung function of primary school children in Jordan. *Annals of Tropical Paediatrics*, 16(2):97–102.

Goldin, C. (2006). The quiet revolution that transformed women's employment, education, and family. *American Economic Review*, 96(2):1–21.

Goldin, C. et al. (1992). Understanding the gender gap: An economic history of american women. *OUP Catalogue*.

Goldin, C. and Katz, L. F. (2002). The power of the pill: Oral contraceptives and women's career and marriage decisions. *Journal of Political Economy*, 110(4):730–770.

Greenwood, J., Seshadri, A., and Yorukoglu, M. (2005). Engines of liberation. *Review of Economic Studies*, 72(1):109–133.

Gurung, B. and Setyowati, A. (2016). Measuring time savings generated by the Indonesia domestic biogas programme (IDBP).

Hoynes, H., Schanzenbach, D. W., and Almond, D. (2016). Long-run impacts of childhood access to the safety net. *American Economic Review*, 106(4):903–34.

Hoynes, H. W. and Schanzenbach, D. W. (2009). Consumption responses to in-kind transfers: Evidence from the introduction of the food stamp program. *American Economic Journal: Applied Economics*, 1(4):109–39.

James Gauderman, W., McConnell, R., Gilliland, F., London, S., Thomas, D., Avol, E., Vora, H., Berhane, K., Rappaport, E. B., Lurmann, F., et al. (2000). Association between air pollution and lung function growth in southern California children. *American Journal of Respiratory and Critical Care Medicine*, 162(4):1383–1390.

Kan, X., Chiang, C.-Y., Enarson, D. A., Chen, W., Yang, J., and Chen, G. (2011). Indoor solid fuel use and tuberculosis in China: A matched case-control study. *BMC Public Health*, 11(1):498.

Lam, N. L., Smith, K. R., Gauthier, A., and Bates, M. N. (2012). Kerosene: A review of household uses and their hazards in low-and middle-income countries. *Journal of Toxicology and Environmental Health, Part B*, 15(6):396–432.

Lin, H.-H., Ezzati, M., and Murray, M. (2007). Tobacco smoke, indoor air pollution and tuberculosis: A systematic review and meta-analysis. *PLoS Medicine*, 4(1):e20.

Martin, W. J., Glass, R. I., Balbus, J. M., and Collins, F. S. (2011). A major environmental cause of death. *Science*, 334(6053):180–181.

Mehta, S. and Shahpar, C. (2004). The health benefits of interventions to reduce indoor air pollution from solid fuel use: A cost-effectiveness analysis. *Energy for Sustainable Development*, 8(3):53–59.

Miguel, E. and Kremer, M. (2004). Worms: Identifying impacts on education and health in the presence of treatment externalities. *Econometrica*, 72(1):159–217.

Miller, G. and Mobarak, A. M. (2013). Gender differences in preferences, intra-household externalities, and low demand for improved cookstoves. Technical report, National Bureau of Economic Research.

Permadi, D. A., Sofyan, A., and Oanh, N. T. K. (2017). Assessment of emissions of greenhouse gases and air pollutants in indonesia and impacts of national policy for elimination of kerosene use in cooking. *Atmospheric Environment*, 154:82–94.

Pitt, M. M., Rosenzweig, M. R., and Hassan, M. N. (2006). Sharing the burden of disease: Gender, the household division of labor and the health effects of indoor air pollution in Bangladesh and India. In *Stanford Institute for Theoretical Economics Summer Workshop*, volume 202.

Schaner, S. and Das, S. (2016). Female labor force participation in Asia: Indonesia country study. *Asian Development Bank Economics Working Paper Series*, (474).

Silwal, A. R. and McKay, A. (2015). The impact of cooking with firewood on respiratory health: Evidence from Indonesia. *The Journal of Development Studies*, 51(12):1619–1633.

Slama, K., Chiang, C. Y., Hinderaker, S., Bruce, N., Vedal, S., and Enarson, D. (2010). Indoor solid fuel combustion and tuberculosis: Is there an association? *The International Journal of Tuberculosis and Lung Disease*, 14(1):6–14.

Smith, K. R. (2010). What's cooking? A brief update. *Energy for Sustainable Development*, 14(4):251–252.

Smith-Sivertsen, T., Diaz, E., Pope, D., Lie, R. T., Diaz, A., McCracken, J., Bakke, P., Arana, B., Smith, K. R., and Bruce, N. (2009). Effect of reducing indoor air pollution on women's respiratory symptoms and lung function: The RESPIRE randomized trial, Guatemala. *American Journal of Epidemiology*, 170(2):211–220.

Strauss, J., Witoelar, F., and Sikoki, B. (2016). The fifth wave of the Indonesia family life survey: Overview and field report.

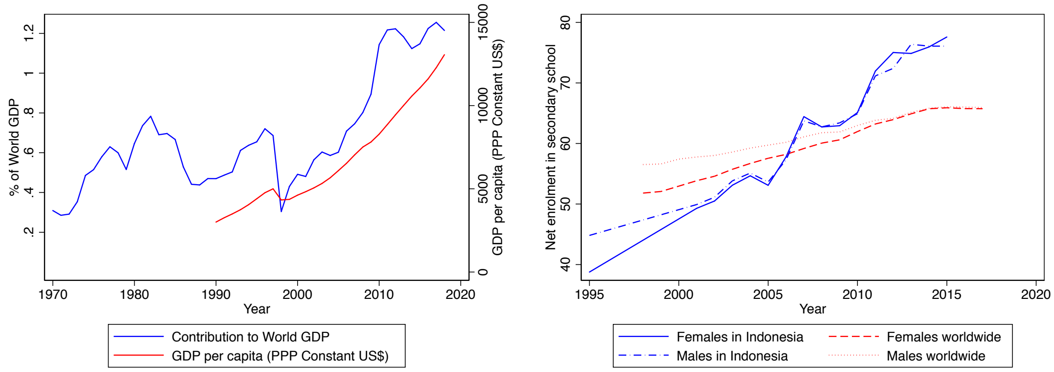
Sumpter, C. and Chandramohan, D. (2013). Systematic review and meta-analysis of the associations between indoor air pollution and tuberculosis. *Tropical Medicine & International Health*, 18(1):101–108.

Thoday, K., Benjamin, P., Gan, M., and Puzzolo, E. (2018). The mega conversion program from kerosene to lpg in Indonesia: Lessons learned and recommendations for future clean cooking energy expansion. *Energy for Sustainable Development*, 46:71–81.

Toft, L., Beaton, C., and Lontoh, L. (2016). *International experiences with LPG subsidy reform*. International Institute for Sustainable Development.

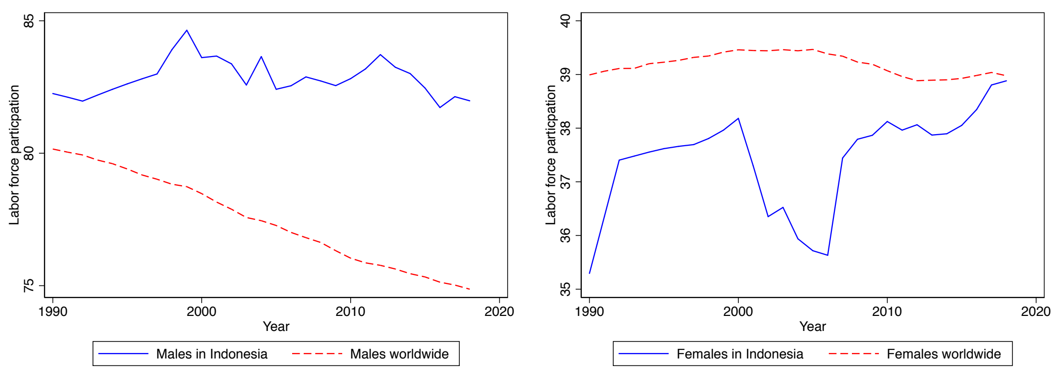
WHO (2014). Who indoor air quality guidelines: Household fuel combustion.

Figure 1: Trends in GDP and education in Indonesia



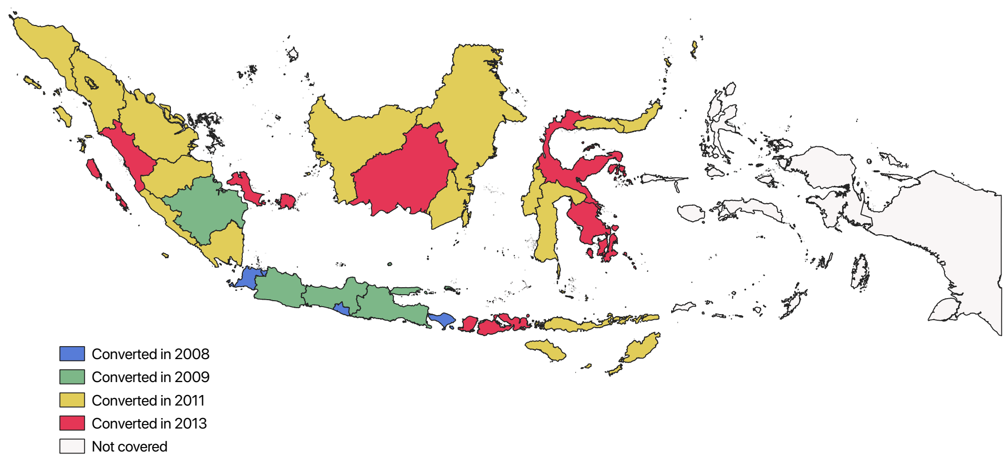
Notes: Based on the World Bank national accounts data, and OECD National Accounts data files. GDP per capita in constant US$ terms.

Figure 2: Labor force participation in Indonesian and worldwide



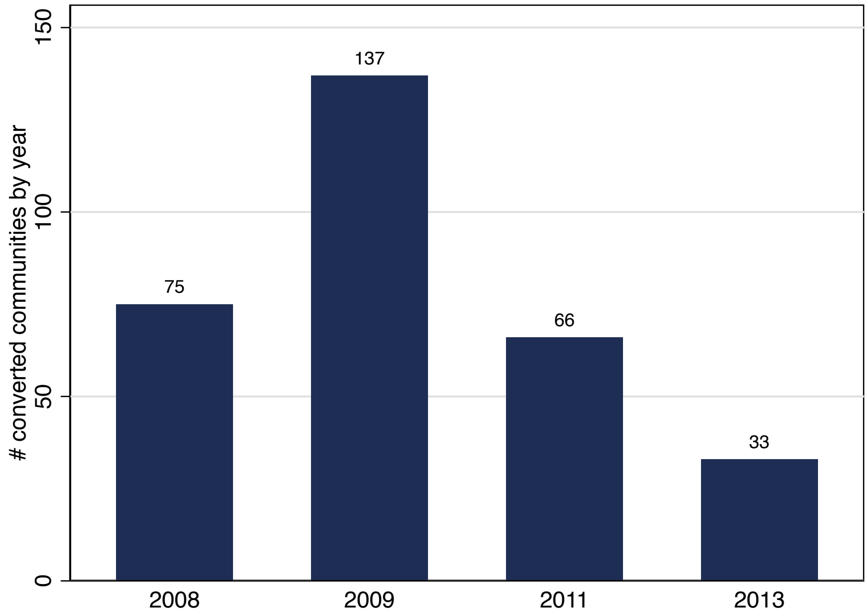
Notes: Based on the World Bank national accounts data, and OECD National Accounts data files.

Figure 3: Staggered rollout of the LPG subsidy program across provinces



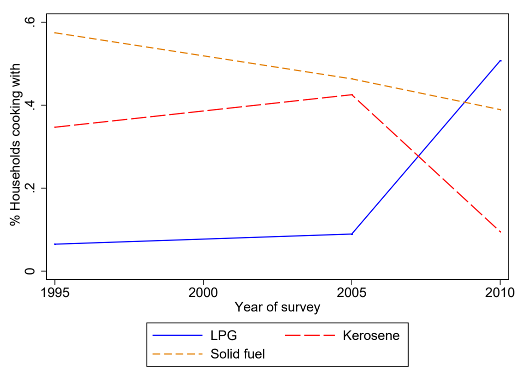
Notes: In some cases, the program was rolled out in different areas within a province in two consecutive years. However, we do not have information on roll-out at a finer level. For this reason, we define a province to have received the program only once all areas within the province were covered.

Figure 4: Difference in LPG program roll-out across IFLS communities



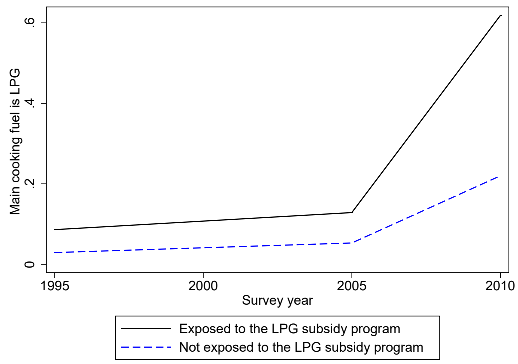
In some cases, the program was rolled out in different areas within a province in two consecutive years. However, we do not have information on roll-out at a finer level. For this reason, we define all communities within a province to have received the program only once all areas within the province were covered.

Figure 5: Primary cooking fuel (Survey: IPC and SUPAS)



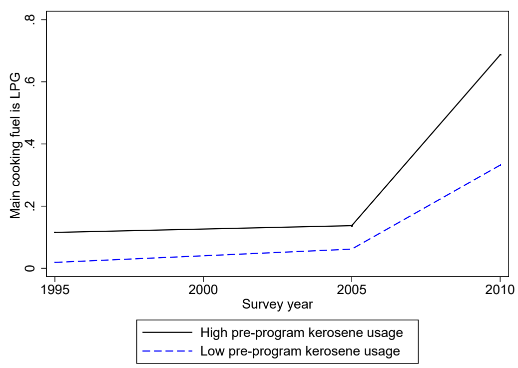
Notes: We use information from the Indonesian Population Census (IPC) of 2010 and Intercensal Population Survey of Indonesia (SUPAS) waves 1995 and 2005 for the figure. IPC 2000 does not contain information about household's primary cooking fuel.

Figure 6: Primary cooking fuel by program exposure status (Survey: IPC and SUPAS)



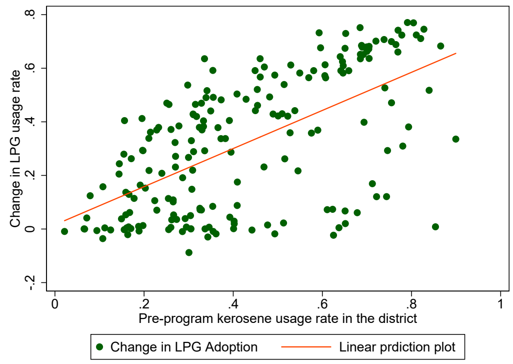
Notes: We use information from the Indonesian Population Census (IPC) of 2010 and Intercensal Population Survey of Indonesia (SUPAS) waves 1995 and 2005 for the figure. IPC 2000 does not contain information about household's primary cooking fuel.

Figure 7: Primary cooking fuel by pre-program kerosene usage (Survey: IPC and SUPAS)



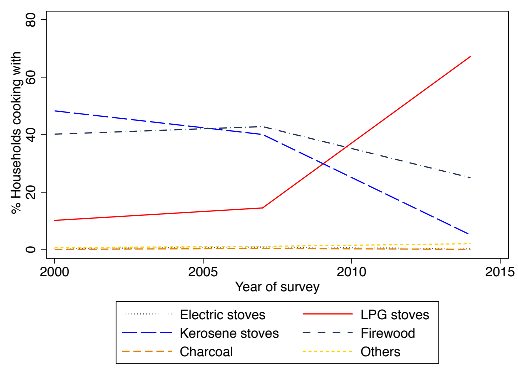
Notes: We use information from the Indonesian Population Census (IPC) of 2010 and Intercensal Population Survey of Indonesia (SUPAS) waves 1995 and 2005 for the figure. IPC 2000 does not contain information about household's primary cooking fuel.

Figure 8: Change in LPG usage by pre-program kerosene usage (Survey: IPC and SUPAS)



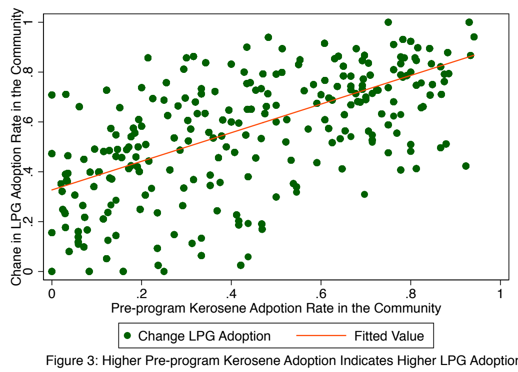
Notes: We use information from the Indonesian Population Census (IPC) of 2010 and Intercensal Population Survey of Indonesia (SUPAS) wave 2005 for the figure.

Figure 9: Primary cooking fuel (Survey: IFLS)



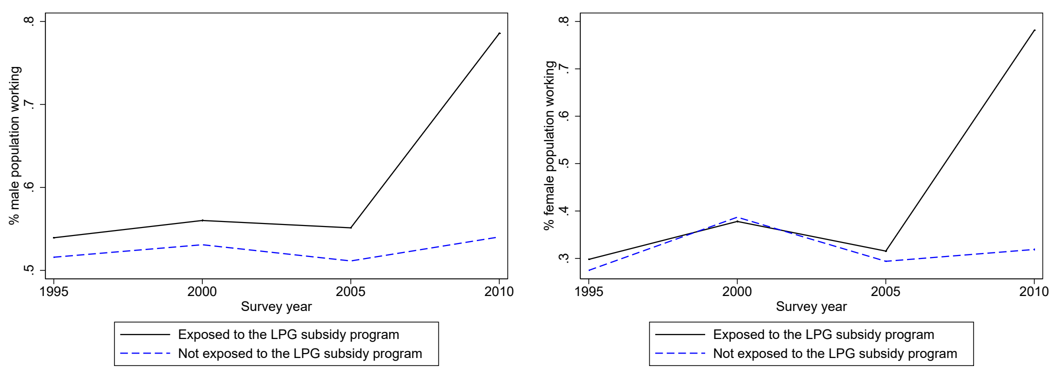
Notes: We use information from the third (2000), fourth (2007), and fifth (2014) waves of Indonesian Family Life Survey for the figure.

Figure 10: Change in LPG usage by pre-program kerosene usage (Survey: IFLS)



Notes: We use information from the third (2000), fourth (2007), and fifth (2014) waves of Indonesian Family Life Survey for the figure.

Figure 11: Labor force participation by program exposure status (Survey: IPC and SUPAS)



Notes: We use information from the Indonesian Population Census (IPC) of 2000 and 2010 and Intercensal Population Survey of Indonesia (SUPAS) waves 1995 and 2005 for the figure.

Table 1: Summary Statistics (Data: IPC and SUPAS)

	1995	2000	2005	2010
Observations	718,837	20,112,539	1,090,892	20,337,271
Number of households	166,033	5,124,971	266,732	5,364,132
Number of districts	200	267	258	206
Number of provinces	17	26	25	18
		Mean (S.D. in brackets)		
Kerosene usage rate	0.35	NA	0.42	0.09
	[0.48]		[0.49]	[0.29]
LPG usage rate in	0.06	NA	0.09	0.51
	[0.24]		[0.28]	[0.50]
Labor force participation rate of men	0.53	0.55	0.53	0.72
	[0.50]	[0.50]	[0.50]	[0.45]
Labor force participation rate of women	0.30	0.38	0.30	0.65
	[0.46]	[0.49]	[0.46]	[0.48]

Notes: Information on cooking fuel was not collected during the IPC of 2000. The SUPAS did not interview the province of Aceh due to the 2004 Indian Ocean earthquake and tsunami that affected the province.

Table 2: Summary Statistics (Data: IFLS)

	2000	2007	2014
Observations	20,729	21,487	23,226
Number of households	7,360	8,224	8,816
Number of communities	311	310	311
Number of kecamatan	29	30	30
Number of provinces	15	15	15
	Mean (S.D. in brackets)		
Kerosene usage rate	0.49	0.40	0.05
	[0.50]	[0.49]	[0.22]
LPG usage rate in	0.12	0.16	0.69
	[0.33]	[0.36]	[0.46]
Labor force participation rate of men	0.74	0.76	0.77
	[0.43]	[0.42]	[0.42]
Labor force participation rate of women	0.46	0.43	0.41
	[0.50]	[0.50]	[0.49]

Table 3: Impact on household's LPG usage status (Data: IPC and SUPAS)

	(1)	(2)	(3)	(4)	(5)
	Primary cooking fuel is LPG				
Post × Treat	0.37***	0.37***	0.37***	0.37***	0.20***
	(0.06)	(0.03)	(0.05)	(0.03)	(0.05)
Post × Treat × Pre-program kersone usage rate					0.39***
					(0.11)
District FE	NO	NO	YES	YES	YES
Province FE	YES	YES	NO	NO	NO
Year FE	YES	YES	YES	YES	NO
Province-year FE	NO	NO	NO	NO	YES
Year FE by pre-program LPG usage	NO	NO	NO	NO	YES
SE Clusters	Province	District	Province	District	District
Mean of DV	0.47	0.47	0.47	0.47	0.48
District-level mean of the pre-program kerosene usage rate					0.43
Observations	21,971,944	21,971,944	21,971,944	21,971,944	21,393,142

Note: * $p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Robust standard errors in parentheses are clustered at the level of the district.

Table 4: Impact on household's LPG usage status (Data: IFLS)

	(1)	(2)	(3)
	Primary cooking fuel is LPG		
Post × Pre-program kersone usage rate	0.40***	0.46***	0.44***
	(0.042)	(0.052)	(0.055)
Household FE	NO	YES	YES
Community FE	YES	NO	NO
Year FE	YES	YES	NO
Province-year FE	NO	NO	YES
Mean of DV	0.32	0.32	0.32
Community-level mean of the pre-program LPG usage rate	0.48	0.48	0.48
Observations	24,564	24,564	24,564

Note: * $p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Robust standard errors in parentheses are clustered at the level of the community.

Table 5: Impact on labor force participation status (Data: IPC and SUPAS)

	(1)	(2)	(3)	(4)
VARIABLES	Labor force participation indicator			
Post × Treat	0.33***	0.20***	-0.03	-0.10***
	(0.01)	(0.01)	(0.02)	(0.02)
Post × Treat × Female		0.26***		0.15***
		(0.01)		(0.03)
Post × Treat × Pre-program kersone usage rate			0.10***	-0.02
			(0.04)	(0.04)
Post × Treat × Female × Pre-program kersone usage rate				0.24***
				(0.05)
District FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Province-year FE	YES	YES	YES	YES
Mean of DV	0.57	0.57	0.57	0.57
Pre-program kerosene usage rate			0.43	0.43
Observations	42,247,030	42,247,030	41,424,338	41,424,338

Note: * $p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Robust standard errors in parentheses are clustered at the level of the district.

Table 6: Impact on labor force participation status (Data: IFLS)

	(1)	(2)	(3)	(4)	(5)	(6)
	Primary activity		Activities past week			
	work for pay	housekeeping	work for pay	work with w/o pay	housekeeping	job search
Post × Pre-program kersone rate	0 .03	0.00	0.03	0.03	-0.06**	0.01
	(0.02)	(0.01)	(0.02)	(0.02)	(0.03)	(0.01)
Post × Pre-program kersone rate × Female	0.07*	-0.07**	0.02	0.04	0.02	0.00
	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.01)
Estimated Effect for females	0.10***	-0.07**	0.05*	0.06**	-0.04*	0.01**
	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.01)
p-value for females	0.00	0.04	0.06	0.01	0.08	0.04
Community Fixed-effect	YES	YES	YES	YES	YES	YES
Province-Year Fixed-effect	YES	YES	YES	YES	YES	YES
Mean of DV	0.59	0.24	0.64	0.65	0.47	0.04
Pre-program kerosene usage rate	0.49	0.49	0.49	0.49	0.49	0.49
Observations	63,633	63,633	63,838	65,341	63,841	63,837

Note: * $p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Robust standard errors in parentheses are clustered at the level of the community.

Table 7: Impact on labor force participation in previous years (Data: IFLS)

	(1)	(2)	(3)	(4)	(5)	(6)
	Ever held a job in the previous					
	year	two years	three years	four years	five years	six years
Post × Pre-program kersone usage rate	0.02	0.02	0.01	0.01	0.01	0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Post × Pre-program kersone usage rate × Female	0.06**	0.06**	0.07***	0.07***	0.07***	0.07***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Estimated Effect for females	0.07***	0.08***	0.08***	0.08***	0.08***	0.08***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
p-value for females	0.00	0.00	0.00	0.00	0.00	0.00
Community Fixed-effect	YES	YES	YES	YES	YES	YES
Province-Year Fixed-effect	YES	YES	YES	YES	YES	YES
Mean of DV	0.72	0.73	0.74	0.75	0.75	0.76
Pre-program kerosene usage rate	0.49	0.49	0.49	0.49	0.49	0.49
Observations	65,341	65,341	65,341	65,341	65,341	65,341

Note: $^{*}\ p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Robust standard errors in parentheses are clustered at the level of the community.

Table 8: Impact on measured health (Data: IFLS)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Max. lung capacity	BMI<18	BMI≥ 25	Grip strength	Pulse	Systolic BP	Diastolic BP
Post × Pre-program kersone usage rate	-5.15	0.00	0.02***	-0.34	2.09***	1.21	0.32
	(6.24)	(0.01)	(0.01)	(1.25)	(0.59)	(0.74)	(0.51)
Post × Pre-program kersone usage rate × Female	2.27	0.00	0.01	0.48	-1.34*	-1.79*	-0.59
	(5.61)	(0.02)	(0.01)	(0.61)	(0.71)	(0.99)	(0.66)
Estimated Effect for females	-2.88	0.00	0.03**	0.13	0.74	-0.58	-0.27
	(4.34)	(0.01)	(0.01)	(1.22)	(0.62)	(0.90)	(0.60)
p-value for female	0.51	0.86	0.01	0.91	0.23	0.52	0.66
Community Fixed-effect	YES	YES	YES	YES	YES	YES	YES
Province-Year Fixed-effect	YES	YES	YES	YES	YES	YES	YES
Mean of DV	341.70	0.14	0.06	23.82	78.15	128.87	79.92
Pre-program kerosene usage rate	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Observations	65,502	54,326	54,326	41,296	62,324	62,254	62,254

Note: $^{*}\ p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Robust standard errors in parentheses are clustered at the level of the community.

Table 9: Impact on reported diagnosis of health conditions (Data: IFLS, for age above 40 only)

	(1) Hypertension	(2) Diabetes	(3) TB	(4) Asthma	(5) Other lung conditions	(6) Heart conditions	(7) Liver problems	(8) Stroke	(9) Arthritis
Post × Pre-program kersone usage rate	-0.004	-0.014	0.003	-0.013	0.006	0.011	-0.002	0.006	-0.028
	(0.023)	(0.013)	(0.008)	(0.012)	(0.011)	(0.010)	(0.007)	(0.008)	(0.018)
Post × Pre-program kersone usage rate × Female	-0.045	0.029*	0.004	0.003	0.001	-0.001	0.006	-0.005	0.052**
	(0.032)	(0.016)	(0.010)	(0.015)	(0.013)	(0.012)	(0.008)	(0.011)	(0.026)
Estimated Effect for females	-0.049*	0.014	0.007	-0.010	0.007	0.010	0.004	0.001	0.024
	(0.026)	(0.011)	(0.005)	(0.010)	(0.010)	(0.009)	(0.005)	(0.008)	(0.022)
p-value for females	0.059	0.181	0.160	0.323	0.470	0.272	0.355	0.946	0.272
Community Fixed-effect	YES	YES	YES	YES	YES	YES	YES	YES	YES
Province-Year Fixed-effect	YES	YES	YES	YES	YES	YES	YES	YES	YES
Mean of DV	0.21	0.04	0.01	0.03	0.02	0.03	0.01	0.02	0.11
Pre-program kerosene usage rate	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Observations	19252	19249	19256	19256	19253	19253	19256	19257	19252

Note: * $p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Robust standard errors in parentheses are clustered at the level of the community.

Table 10: Impact on expenditure (Data: IFLS)

	(1)	(2)	(3)	(4)
	Expenditure on			
	Food last week†	Non-food last month†	Non-food last year†	Education last year †
Post × Pre-program kersone usage rate	3.612***	-63.879	-319.554	7.756
	(1.354)	(65.243)	(508.615)	(56.029)
Community FE	YES	YES	YES	YES
Province-year FE	YES	YES	YES	YES
Mean of DV	24.66	123.95	610.49	236.23
Pre-program kerosene usage rate	0.48	0.48	0.48	0.48
Observations	24564	24564	24564	24564

Note: * $p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Robust standard errors in parentheses are clustered at the level of the community.
† Expenditure converted to USD according to the exchange rate at the time of each survey.

Table 11: Impact on food items (Data: IFLS)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Consumed [...] in the previous week											
	Sweet Potatoes	Eggs	Fish	Meat	Dairy	Green Leafy vegetables	Banana	Papaya	Carrot	Mango	Any fruit	Any protein
Post × Pre-program kersone usage rate	0.009	0.018	0.020	0.024	0.005	-0.029	0.105***	0.065**	0.010	0.016	0.035	0.004
	(0.039)	(0.025)	(0.022)	(0.038)	(0.031)	(0.019)	(0.031)	(0.031)	(0.041)	(0.093)	(0.034)	(0.023)
Post × Pre-program kersone usage rate × Female	0.028	-0.013	0.010	0.010	0.005	0.019	0.008	0.028	0.010	0.007	0.025	0.003
	(0.029)	(0.021)	(0.022)	(0.026)	(0.026)	(0.019)	(0.026)	(0.028)	(0.025)	(0.026)	(0.020)	(0.022)
Estimated Effect for females	0.037	0.005	0.030	0.035	0.011	-0.010	0.113***	0.093***	0.020	0.022	0.060*	0.006
	(0.037)	(0.023)	(0.024)	(0.037)	(0.027)	(0.017)	(0.031)	(0.032)	(0.044)	(0.094)	(0.031)	(0.022)
p-value for females	0.312	0.832	0.222	0.353	0.690	0.549	0.000	0.004	0.648	0.811	0.056	0.771
Community FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Province-year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Mean of DV	0.44	0.82	0.83	0.61	0.31	0.91	0.61	0.30	0.48	0.36	0.86	0.81
Pre-program kerosene usage rate	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Observations	41099	41099	41098	41098	41098	41098	41098	41098	41098	41098	41098	39967

Note: $^{*}\ p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Robust standard errors in parentheses are clustered at the level of the community.

Table 12: Impact on expenditure on fuel and utilities (Data: IFLS)

	(1) Fuel expenditure last month†	(2) Ratio of fuel to non-food expenditure	(3) Utility expenditure last month†	(4) Ratio of utility to non-food expenditure	(5) Community-level kerosene price per liter†
Post × Pre-program kersone usage rate	-3.088	-0.032**	-5.926	-0.143***	-0.092***
	(10.628)	(0.014)	(12.517)	(0.046)	(0.023)
Community FE	YES	YES	YES	YES	YES
Province-year FE	YES	YES	YES	YES	YES
Mean of DV	7.613	0.120	20.092	0.443	0.494
Pre-program kerosene usage rate	0.479	0.479	0.480	0.480	0.528
Observations	17066	17018	24439	24342	928

Note: $^{*}\ p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Robust standard errors in parentheses are clustered at the level of the community.
† Expenditure converted to USD according to the exchange rate at the time of each survey.

Table 13: Subjective well-being (Data: IFLS)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	On which economic step			Concerned about			Happiness
	Today	Five year ago	Five year later	Standard of living	Food consumption	Health status	Scale (0-5)
Post × Pre-program kersone usage rate	-0.001	-0.036	0.125*	-0.020	-0.009	-0.029	0.009
	(0.049)	(0.053)	(0.068)	(0.020)	(0.017)	(0.022)	(0.024)
Post × Pre-program kersone usage × Female	-0.014	0.009	0.043	-0.020	-0.030	0.003	0.037
	(0.046)	(0.054)	(0.061)	(0.020)	(0.019)	(0.022)	(0.028)
Estimated Effect for females	-0.015	-0.027	0.168	-0.039	-0.039	-0.026	0.046
	0.053	0.055	0.069	0.020	0.017	0.018	0.024
p-value for females	0.775	0.625	0.016	0.048	0.022	0.158	0.060
Community FE	YES	YES	YES	YES	YES	YES	YES
Province-year FE	YES	YES	YES	YES	YES	YES	YES
Mean of DV	2.897	2.713	3.576	0.187	0.126	0.172	2.988
Pre-program kerosene usage rate	0.490	0.491	0.489	0.490	0.490	0.490	0.486
Observations	61539	61319	58849	61781	61781	61781	41257

Note: $^{*}\ p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Robust standard errors in parentheses are clustered at the level of the community.

Table 14: Correlates of fuel choice and decision-making power of women in 2000 (Data: IFLS)

VARIABLES	(1) Cooking with LPG	(2) Cooking with kerosene	(3) Cooking with solid fuel	(4) Some say in all decisions (Score out of 18)	(5) Some say in financial decisions (Score out of 8)
Some say in all decisions (Score out of 18)	-0.004*	-0.003	0.007***		
	(0.002)	(0.003)	(0.003)		
Some say in financial decisions (Score out of 8)	0.010**	0.010	-0.021***		
	(0.005)	(0.008)	(0.006)		
Primary activity is work for pay	0.026***	-0.030***	0.004	0.506***	0.182***
	(0.007)	(0.009)	(0.008)	(0.091)	(0.043)
Years of education	0.017***	-0.002	-0.015***	0.087***	0.054***
	(0.001)	(0.002)	(0.001)	(0.012)	(0.005)
Head of the household	0.040***	0.025	-0.075***	-2.785***	-1.113***
	(0.014)	(0.021)	(0.017)	(0.246)	(0.103)
Wife of the head of the household	0.013	0.027*	-0.044***	10.596***	4.342***
	(0.011)	(0.015)	(0.012)	(0.141)	(0.062)
Household head is female	-0.053***	0.065**	-0.011	1.106***	0.503***
	(0.020)	(0.026)	(0.018)	(0.246)	(0.105)
Community FE	YES	YES	YES	YES	YES
Province-year FE	YES	YES	YES	YES	YES
Mean of dependent variable	0.14	0.53	.33	7.92	3.22
Observations	8,766	8,766	8,766	8,766	8,766

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses are clustered at the level of the community.

Table 15: Impact on decision-making power of women (Data: IFLS)

	Complete say in		Some say in	
	all decisions (Score out of 18)	financial decisions (Score out of 8)	all decisions (Score out of 18)	financial decisions (Score out of 8)
Post × Pre-program kersone rate	0.03	-0.04	-0.49*	-0.47***
	(0.21)	(0.11)	(0.27)	(0.14)
Post × Pre-program kersone × Female	0.43	0.37**	0.80**	0.62***
	(0.28)	(0.15)	(0.35)	(0.18)
Community FE	YES	YES	YES	YES
Province-year FE	YES	YES	YES	YES
Mean of dependent variable	3.52	1.3	10.84	4.58
Pre-program kerosene usage rate	0.48	0.48	0.48	0.48
Observations	44,456	44,456	44,456	44,456

Note: * $p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Robust standard errors in parentheses are clustered at the level of the community. As an example, one of the questions asked to elicit financial decision-making power is "In your household, who makes decisions about money for monthly savings?" Response options are respondent, spouse, son, daughter, mother, father, etc.

Table 16: Impact on household's amenities (Data: IPC and SUPAS)

	(1)	(2)	(3)	(4)	(5)
	Does your household have the access to the following?				
	Sewage System	Electricity	Piped Water	Flush Toilet	Finished Floor
Post * Treat * Pre-program kerosene usage rate	-0.00	0.06	-0.02	0.06	-0.09**
	(0.06)	(0.05)	(0.07)	(0.06)	(0.03)
District FE	YES	YES	YES	YES	YES
Province-Year FE	YES	YES	YES	YES	YES
Mean of DV	0.54	0.94	0.16	0.60	0.88
Observations	21,548,424	21,550,574	21,551,010	21,547,060	21,527,414

Note: * $p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Robust standard errors in parentheses are clustered at the level of the district. Finished floor takes value '1' if the house some kind of concrete, wood, or stone flooring. It is '0' for earth floors.