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

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Abstract

In its attempt to reduce the subsidy burden of kerosene, the cooking fuel for 48 out of the 52 million Indonesian households in 2004, the Indonesian government launched the "Conversion to Liquefied Petroleum Gas (LPG) Program" in 2007. Cooking with LPG not only reduces indoor pollution due to cooking but also saves cooking time. Using the staggered roll out of the program across provinces and variation in the availability of all-weather roads across communities, we find that the program improved the health and increased the labor force participation of women. The program also had benefits for the rest of the family - improved levels of health and consumption and increase in subjective well-being. Importantly, the program was also associated with increased financial decision-making power with women. In light of the findings that intra-household externalities are one of the main reasons for the lack of adoption of cleaner cooking technology, increased decision-making power with women has important implications for the sustained use of this technology, even in the absence of the subsidy.

PRELIMINARY DRAFT: DO NOT CITE OR CIRCULATE WITHOUT PERMISSION

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1 Introduction

Economists have often been baffled by the surprising low rate of adoption of simple, relative inexpensive, highly-efficacious preventive health technologies (Miguel and Kremer (2004); Cohen and Dupas (2010); Ashraf et al. (2010)).[1] Cleaner cooking fuels or cook stoves are great examples of such technology. Indoor air pollution from primitive household cooking fires is the biggest environmental cause of death in the world, and leads to more deaths than those attributed to malaria (Martin et al. (2011)). The take-up of cleaner cooking methods, however, is surprisingly low and slow-moving even though the affected people are aware of the costs.[2][3]

Motivated by the lack of adoption and the potentially high gains, $60 million of the initial commitment goal of $250 million for the Global Alliance for Clean Cook-stoves was allocated to dissemination of improved cookstove technologies (Smith (2010)). However, the empirical evidence on benefits of improved cook stoves or cleaner fuel is limited and present conflicting findings.[4]

We revisit the question on whether switching to a cleaner fuel has positive impact on health, consumption and living standards of the switchers. We identify the impact of switching to a cleaner fuel using the exogenous staggered roll-out of the "Conversion to Liquefied Petroleum Gas (LPG) Program" in Indonesia that started in 2007. We find that the policy that triggered a massive uptake of LPG as the primary cooking fuel had impacts on schooling, community and labor force participation of women. Most of these effects result from the time-saving nature of the LPG-based cooking technology. We also find that the policy was associated with increased and improved consumption for the entire household and had indirect effects on health. The impact on respiratory health seem to be weak. we find evidence that households invest in

[1]This has also been found of other technologies that improve the quality of life. For examples, see Foster and Rosenzweig (1995), Bandiera and Rasul (2006), Duflo et al. (2008), Conley and Udry (2010), and Foster and Rosenzweig (2010).

[2]Half of the world's population and close to 95 % of the population in poor countries relied on solid fuels in 2010 (Duflo et al. (2012)).

[3]Miller and Mobarak (2013), in their experiment with people from rural Bangladesh find that "94% of respondents believe that smoke from stoves is harmful to health. 69% of households believe that smoke from a traditional stove is more harmful than breathing dust from sweeping, but only 11% and 18% believe that it is more harmful than consuming "unclean" water and spoiled food. Given contaminants in both surface and ground water in Bangladesh (Harvey et al., 2002; Michael & Voss, 2008), these beliefs reflect the realities of the disease environment."

[4]Duflo et al. (2012), in an evaluation of a randomized distribution of cleaner cooking stoves in rural Orissa in India, 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)). Silwal and McKay (2015) find that Indonesian individuals living in households that cook with firewood have 11.2 per cent lower lung capacity than those that cook with cleaner fuels. Gajate-Garrido (2013), in her study of Peruvian children, finds that even after the inclusion of individual fixed effects and a variety of confounding variables, children are more likely to report respiratory illnesses if their household cooks with firewood.

mitigation mechanisms to avoid the harmful effect of indoor air pollution. 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 implication for the sustained use of LPG even after the subsidy is withdrawn.

Our paper contributes on multiple levels. It is the first paper to evaluate the impact of the "Conversion to Liquefied Petroleum Gas (LPG) Program" on the health and general-well being of the adult Indonesian population. The results show that the benefits of the policy went far beyond the saved subsidy expenditure, the main motivation behind the program. It is also the first paper to document the health and other economic benefits of switching from kerosene, in particular, to LPG. Second, the findings suggest that switch to cleaner and faster cooking methods, like LPG, can prove to be the engines of liberation for women in developing countries (Greenwood et al. (2005)). It suggests an easy-to-implement policy measure to ensure greater labor force participation and decision making power for women. Third, the impact of the policy on decision-making power of the women provides insights into policies that can ensure a sustained use of LPG by the households even after the subsidy is withdrawn.

The rest of the paper is organized as follows. Section 2 describes the program in detail. 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.

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)). Kerosene was highly subsidized by the government 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.[5] 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.

[5] 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.

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. Calculation 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 the end-user energy equivalence 1 litre of kerosene was 0.39 kg LPG (Budya and Arofat (2011)).[6] 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.[7] 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 2007-08, 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, regions of Lampung, South Sulawesi, East and West Kalimatan, South and North Sumatra, and Riau had received the program. By 2011, entire of Aceh, North Sumatra, Riau, Jambi, Bengkulu, Lampung, entire of Kalimatan except central Kalimatan, and entire of Sulawesi except central and Southeast Sulawesi were covered by the program. 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 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. The variation in roll-out of the program is depicted in figure 1.

Under the program, all eligible citizens were to receive a free 'initial pack' consisting of 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 in Cempaka Baru Village, Kemayoran District, Central Jakarta, on August 1, 2006. 500 families were given the 'initial pack' and their responses and user behaviors 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 as a whole. The general picture from these market tests was that households were

[6] 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.

[7] See Lam et al. (2012) and Organization et al. (2014) for a review.

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 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 increased from 1.9 per cent in 2005 to 13.5 per cent in 2013, while the share of kerosene dropped considerably from 18 per cent in 2005 to 1.8 per cent 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 withing 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 greatly 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.[8]

3 Data and Identification

For our main analysis, we 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 will make use of information on health, education, employment, migration, etc., of respondents. At the household level, we will utilize the information on main cooking fuel of the household and whether the kitchen is inside the

[8]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

house. Availability of roads play an important role in the implementation of program. Good road infrastructure not only ensures timely supply to the LPG distribution centers, but also affects the cost, to the households, of going to the distribution center to acquire the cylinder and to get it refilled each time the gas is used up completely. We will use the community-level information on availability of an all-weather road collected in the survey combined with information on program roll-out to define our exposure variable.

The information on the variation in program roll-out across regions is obtained from Budya and Arofat (2011). As described above, in certain cases only a part of a province was covered in a particular year. The rest of the province covered in the following years. Unfortunately, there 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 treatment only if the entire province was covered. That is, the treatment variable takes value '0' for a province in a particular year if the province is partially or not covered at all by that year, and takes '1' for all years after the province has been fully 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 depicted in figure 2.

4 Empirical Specification

We begin by examining the impact of the program on the households' choice of cooking fuel using the following specification:

$$LPG_{jcdpt} = \alpha + \beta * years_{pt} * road_{cd,2007} + \nu_d * road_{cd,2007} + \delta_{pt} + \omega_j + \varepsilon_{jcdpt} \quad (1)$$

where LPG_{jcdpt} takes value '1' if household j in community c of sub-district (*kecamatan*, in Indonesia) d of province p uses LPG as their main fuel in year t ($t \in \{2007, 2014\}$). $years_{pt}$ is the number of years since the 'Conversion to LPG' program was launched in the province. $road_{cd,2007}$ is an indicator variable that takes value '1' if community c of sub-district d, in 2007, had an all-weather asphalt cement road that was open twelve months in that year. We include separate sub-district fixed effects for communities with and without all-weather all-year roads in the district. They account for time-invariant differences in communities with roads in different sub-district, communities without roads in different sub-district, and differences between communities with and without roads within sub-district. δ_{pt} and ω_j control for time-varying province-level and time-invariant household-specific unobservables, respectively.

Once we establish the impact of the program on the household choice of cooking fuel, we look at the reduced form impact of the program on a variety of outcome variables that are related to the status of women or to the welfare of the entire household. Since information on many of the outcomes of interest, like employment and schooling, are available at the level of the individuals, we modify the specification in (1) accordingly to:

$$Outcome_{icdpt} = \alpha + \beta * years_{pt} * road_2 007_{cd} + \nu_d * road_2 007_{cd} + \delta_{pt} + \tau_i + \varepsilon_{icdpt} \quad (2)$$

where i indexes individuals. We check the robustness of our results in a variety of ways. In one of the checks, we replace the $years_{pt}$ with a dummy indicator of whether or not the province had received the program by the survey wave in year t. In another check, we redefine the $road_{cd,2007}$ variable to take value '1' if the community representative believes that the road is adequate for their purposes, '0' if not.

5 Results

5.1 Fuel of choice

As is clear from figure 3, use of LPG as the primary household cooking fuel increased significantly between 2000 and 2014. There is a small increase between 2000 and 2007 consistent with the fact that only four provinces had received the program by 2007. The increase in LPG subsidy was accompanied by a decrease in subsidy on kersone. Consistent with this, we find that most of those who change their primary cooking fuel switch from kerosene to LPG. A smaller but significant number of them move form firewood to LPG. To test this more rigorously, we examine the impact of the program on households' choice of primary cooking fuel using the specification detailed in section 4. Table 1 presents the results. Consistent with figure 3 and the findings of Andadari et al. (2014), we find that the program led to a significant increase in the use of LPG as the primary cooking fuel among the surveyed households.

According to column (1), each additional year of exposure to the program led to a 2 percent increase in the use of LPG as the primary cooking fuel. Given that the average duration since the roll-out of the program across communities was 3.14 years, this meant a little over 6 percent increase in the use of LPG across communities, on average, since the program began. In column (2), we replace the continuous years since exposure variable with a dummy indicator of whether or not a community had received the program by the fifth wave of the IFLS survey. We find that having received the program increased the proportion of households in a community using LPG by fifteen percent, on average. Since the mean probability of having received the program is 0.58, this implies an average increase of almost 9 percent across communities. In columns (3) and (4), we check the robustness of our results to a change in the definition of the road infrastructure from the availability of an all-weather road that was operational for all twelve months in 2007 to whether the respondent to the community-questionnaire considered the road-infrastructure in 2007 adequate for the community's purposes. Our findings are consistent with those in columns (1) and (2).

5.2 Health impacts

As depicted in figure 4, there are multiple channels through which a change in a household's choice of cooking fuel can affect the well-being of the household members, especially women. Much of the motivation behind the huge subsidies on cleaner cooking stoves and fuels come from their potential positive impact on health, and in particular, respiratory health of women through reduction in indoor air pollution. 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 cleaner cooking stoves in a randomized trial in rural Orissa in India. They find reduction in the amount of smoke inhaled in the first year after the take up of the stove. However, there are 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 those that cook with cleaner fuels. However, since the instrument of their choice for household's fuel choice, the availability of an all-whether road in the community, is highly likely to violate the exclusion restriction, the results are best interpreted at associations. Gajate-Garrido (2013) uses a two-wave panel survey of Peruvian children and finds that even after the inclusion of individual fixed effects and a variety of confounding variables, children are more likely to report respiratory illnesses if their household cooks with firewood. Surprisingly, she finds an impact only on young boys and not on girls even though girl are more likely to be indoors and to be exposed to indoor air pollution from cooking.

To test the impact of the program on health, we make use of four sets of health-related information from the IFLS. We use health indicators directly measured by the IFLS investigators as our main set of health outcomes. However, we supplement this with self-reported information on acute morbidity symptoms, on chronic illness diagnosis by a health professional, and on the respondents' subjective evaluations of their own health. The IFLS measures lung capacity, a measure of respiratory health, of respondents above nine years of age using a peak flow meter. footnoteLung capacity has been found to be a important correlate of later-life health and functioning limitation. The interviewer makes three measurements of the respondent's lung capacity. For our analysis, we use the maximum measured lung capacity of the respondent among the three measurements. The findings are reported in column (1) of table 2. The higher the number of years since the roll-out of the program, the higher is the lung capacity of the women in the household exposed. This is consistent with research in epidemiological and respiratory medicine that find air pollution from varied sources reduce lung functioning. This is also consistent with our findings on the impact of the program on acute morbidity symptoms in women presented in table A2. Although statistically insignificant, there appears to have been a decline in individual reports of coughing for those exposed to the program. When we decompose this further, we find that there is a significant decrease in women reporting cough with phlegm and bloody cough accompanied by an increase in dry cough. It is quite possible that those with more serious symptoms like cough with phlegm and bloody cough have seen some alleviation of these symptoms and now report having dry cough instead. The estimated impact of exposure to the program on chronic illness diagnosis by a doctor, nurse, paramedic, or midwife is also consistent with better respiratory health. The results, reported in table A4, find an decrease in the probability of an exposed woman being diagnosed with asthma and other lung- and heart-related conditions, with the estimated impact on other-lung conditions almost significant at the ten percent level.

Interestingly, there is an increase in the probability of being diagnosed with tuberculosis and of reporting acute morbidity symptoms of fever, diarrhea, and tooth ache. While these conditions are not directly related to indoor air pollution, they do suggest an increase in infectious diseases among the women exposed to the policy.The evidence on the association between indoor air pollution and tuberculosis is weak, at best (Lin et al. (2007);Slama et al. (2010); Kan et al. (2011); Sumpter and Chandramohan (2013)). If the program led to an increase in contact with infected people from outside the households for these women, such an effect is imaginable. We discuss the chances of increased contact with people outside the household for these women in the next section.

In comparison to the males, who are less likely to be in charge of cooking in Indonesian households and, as a result, less likely to be exposed to the indoor air pollution from the activity, the impact of the program on the respiratory health of women is clearly stronger.[9] However, in themselves, the results do not appear to be large, especially when weighed against the high expectations from a switch to cleaner fuels.[10] There are two possible explanations for this. First, most of the households that change their primary cooking fuel switch from kerosene to LPG. Kerosene has been found to be as almost clean as LPG in household cooking settings (Mehta and Shahpar (2004)). For others, as is clear from column (1) of table 3, those who cook with solid fuels are significantly more likely to have kitchen outside their main building. This is consistent with the findings of Pitt et al. (2006) - households understand the harmful effects of indoor air pollution generated due to cooking and invest in mitigation mechanisms. Kan et al. (2011) also 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 a separate building to mitigate the harmful effects of cooking with solid-fuels. While we do not have information on the type

[9]See tables A1, A3, and the lower panel of A4 for the corresponding results for males.

[10]For example, the impact on lung capacity suggest that even after over three years of exposure to the program, the lung capacity of women in the households improved by less than a percent.

of ventilation in the kitchen of these household in our sample, we do find that households who switch to cleaner fuels between the rounds start cooking inside more often (Column (2) of table 3). This suggests that the location of the kitchen is strategically chosen to mitigate the negative impact of indoor air pollution due to cooking. It is possible that these household also invest in other methods of mitigation, including better ventilation in the kitchen. The small effects on the respiratory health of women, therefore, is not entirely surprising.

General health could have also improved due to improvement in consumption, leisure time, education, employment, community participation activities, etc, as a result of the program. With respect to other health measures, there seems to be no impact on the probability of being overweight or the resting pulse rates of the women from the exposed households (table 2). However, their grip strengths show a significant improvement.[11] While the improvement in lung capacities of women supports a direct effect of using cleaner fuel on their respiratory health, the impact on grip strength suggests that other mechanisms outlined in figure 4 might also be operational. This is clearer when we compare the findings for the women in the households with that for the men (table A1). Unlike the direct impact on the respiratory health, there is no reason to believe that the effect of the program on health through these other pathways will be limited to women alone. While the men see no improvement in their lung capacities like the women, they see a significant positive impact on their grip strengths. Interestingly, the impact on the grip strength for men is higher than that for women. The impact of the program on self-reported subjective evaluation of health presented in tables A5 and A6 for females and males, respectively, and on mental health presented in A7 also support the view that general health improved for all both adult females and males.

With respect to men, program exposure seems to be associated with increase in lifestyle diseases - likelihood of being overweight (table A1, column (2)) and probability of being diagnosed with diabetes/high blood sugar and heart-related problems (table A4, columns (12) and (16), respectively.) This is possible if, for example, the exposed males witnessed an increase in the consumption of food and non-food items and a decrease in their physical activity. in summary, the program led to an improvement in the respiratory health of women and the general health of all exposed adults. However, it also led to an increase in infectious diseases in women and lifestyle diseases in men. In the next section, we look at the impact of the program on variables that clarify how exposed individuals use their time and propose possible explanations for the rise in infectious and lifestyle diseases.

[11] Grip strength, measured using a dynamometer by IFLS interviewers, is an important factor that has been shown to predict musculo-skeletal diseases such as rheumatoid arthritis, bone mineral density, likelihood of falls and fractures in osteoporosis, complications and general morbidity after surgical interventions, myocardial infarction or stroke, general disability and future outcome in older age and cause- specific and overall mortality in elderly people (See Angst et al. (2010), for details).

5.3 Time use

Another substantial benefit of switching from solid-fuels or kerosene to LPG is the time saved. Igniting the solid-fuel or kerosene stoves to full capacity is substantially more work than turning on the LPG stove by turning a knob. Unfortunately, IFLS does not collect time use information. For this reason, we use indirect ways to assess if switching to LPG might have saved the exposed women time.In their 2016 study of the Indonesian domestic biogas program of 2009, Gurung and Setyowati (2016) find 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. LPG stoves do not require these elaborate processes to keep it running. In addition, compared to solid-fuels that the households might need to collect themselves, LPG is readily available commercially. The cylinder, purchased from the LPG cylinder distribution station, is often bought by the males of the household and requires almost no extra time. Moreover, unlike LPG, bio-gas did not replace the conventional cooking fuel completely. These observations suggest that there might be significant time saving from faster cooking methods.

Gurung and Setyowati (2016) also find that most of the saved time is spent in productive activities (Results reproduced in table 4). In tables 5 and 6, we examine the impact of the LPG conversion program on the labor force participation of women. As is clear from column (1) of table 5, women in communities with longer exposure to the program are much more likely to report 'work for pay' as their primary activity during the week preceding the survey. In comparison, the coefficient for males suggests a decrease, though not significant, in their likelihood of reporting 'work for pay' as their primary activity. Consistent with this, in column (1) of table 6, we find that women report having worked for pay in the week preceding the survey more often. Interestingly, this does not come at the cost of housekeeping activities. In fact, exposed women also appear to be engaged in housekeeping more often. This seems to suggest that, similar to the findings of Gurung and Setyowati (2016), women might indeed be saving time in cooking and using it in productive activities. In comparison, as expected, there is no change in the primary activity, or probability of working for pay, attending school, housekeeping, or job searching for males.

These effects on employment might also explain the puzzling rise in the rates on infectious diseases in women and lifestyle diseases in men. If women are working for pay more often, it is quite likely that some of this work requires spending time outside the household. As a result, they might be more likely to come in contact with infected people. At the same time, men exposed to the program, who are working as often as or less than before but enjoying more food and non-food consumption (see section 5.4), might be leading a life too sedentary in comparison to their calorie intake.

Consistent with no adverse impact on schooling, columns (1)-(6) of table 7 shows that women from exposed communities are spending more time in school while no such effect is detected for the boys. From columns (7)-(12), it seems that women are also combining work and school more often. This too suggests that they are saving time elsewhere. As is clear from table 8, this has not had any negative impact on educational outcome. If anything, exposed women are less likely to fail a class in elementary school. Table 9 shows that the exposed women are also more likely to spend time in community activities, especially those that involve women exclusively.

In summary, women with longer exposure to the program are more likely to be working for pay and housekeeping, spending more time in school, and participating in community events. Taken together, the results suggest that women save significant amount of time in cooking due to the program and not all the saved time is consumed as leisure.

5.4 Consumption

The increase in the women labor force participation has implications on the household's consumption mix and expenditure. In table 10, we find that exposure to the program led to an increase in the food expenditure on the amount of home-prepared food consumed at home. This is consistent with subsidy-induced reduction in cooking cost, both monetary and in terms of time. This is also additional evidence that women did not sidestep their traditional housekeeping responsibilities to work for pay more often. The total expenditure on food in the month preceding the survey appears to have increased but the change is not significant. This is consistent with the theory of low-elasticity of demand for necessary commodities like food. Table 11 reports the impact of the program on non-food expenditures of different kinds. While expenditure on all non-food items seems to have gone up, the increase is significant for 'arisan' contributions and non-food expenditure on items for which a reference period on one year was used in the survey. This increase in consumption expenditure is hardly surprising. Increased labor force participation of women must have supplemented the household income and improved consumption.

However, the consumption expenditure is recorded at the level of the household. There is a possibility that while the overall household consumption increased, that of women remained the same or even decreased. To rule out this possibility, we make use of information on frequency of consumption on specific food items that is available at the level of the individual. The results are presented in table A8. As is clear from the table, there appears to have been an increase in the frequency of consumption of protein-rich food items for both males and females exposed to the program.

Th increase in meat consumption of women signals an overall increase in their control over resources and their overall welfare, and not just a compensation for the increased energy requirements stemming from their greater labor force participation. This is clearer when we examine the impact of the program on the subjective well-being of exposed individuals.

Exposure to the program is associated with an improvement along almost all dimensions of subjective well-being recorded in IFLS (tables A9 and A10), especially for women. Interestingly, the program has somewhat stronger impact on the level of satisfaction of women from the state of their children. This is, perhaps, an indication that women spend a part of the saved time on childcare, and are more satisfied with personal attention they provide their children.

5.5 Decision making

Switching to LPG, it seems, had unambiguous benefits for the everyone in the household, especially the women. The natural question that then arises is if switching to LPG has high returns, why are households not doing it themselves? Credit constraint are unlikely to be the reason to hold around 80 percent of the Indonesian households from using LPG (see figure 3). 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.

It is possible that if women had more say in financial decisions, there might be a higher rate of adoption of cleaner cooking fuel. Working women tend to have more decision-making power, and the LPG program increased women labor force participation. Therefore, one might expect that the program also increased the decision-making power of women in exposed households. IFLS collects information pertaining to financial and other household decisions. In these questions, the respondent is given the liberty to choose more than one person as the decision-maker. This means that any analysis using a binary indicator of whether or not the respondent is the sole decision-maker might not be able to capture subtler shifts in decision-making power. For this reason, we use the responses to create four different measures of decision-making power. The results for females are presented in the four panels of table 12. The results suggest that women exposed to the program for longer have substantially higher decision-making power, especially in financial matters. They are also less likely to be involved in decisions pertaining to their spouse's clothes and time-use. This is also echoed in the findings for males present in table A11. They report a decrease in their decision-making power in financial matter and in household purchases. They too report lower involvement in decisions pertaining to their spouse's clothes but seems to have gained more say in choice of food at home.

This change in decision-making power is, most-likely, as a result of increased schooling, and work-force participation of women. Since intrahousehold externalities and gender differences in preferences seem to be plausible factors behind the low adoption of LPG as a cooking fuel, these findings suggest that an LPG subsidy can, perhaps, trigger a sustained use of the fuel even after the subsidy is withdrawn through its impact on the decision-making power of the women.

6 Conclusion

In an attempt to reduce the subsidy burden of kerosene, the Indonesian government sought to replace it with subsidized LPG. One of the reasons for choosing LPG as the replacement fuel was the low-levels of indoor pollution it generates. This was expected to benefit the respiratory health of the women who switched to LPG. We evaluate the impact of this program on the health and well-being of those exposed.

Our results suggest that the impact of the program on the respiratory health of exposed women were modest. This is not surprising as most households that switch to LPG were earlier cooking with kerosene, a fuel with equally low levels of emissions. We provide suggestive evidence that households cooking with solid-fuels were investing in other technologies to mitigate the harmful effects of the emissions. However, switching to LPG reduced the amount of time needed for cooking. This, it seems, led to increased labor force participation for women, which had implications for everyone in the family. It led to significant improvements in the consumption mix and expenditure, general health, and subjective well-being of all exposed adults. Increased labor force participation, we believe, gave women more economic freedom. Consistent with this, we find that the program was associated with increased decision-making power with women.

The results have important implications on the cost-benefit analysis of the subsidy program. They suggest that focusing on the respiratory health alone might underestimate the benefits of such programs. A comprehensive analysis should account for benefits along other dimensions of well-being. Another important take away pertains to private incentives to switch to LPG. Intra-household externalities are considered one of the main reasons for not switching to cleaner fuels. While we find that all members of the household stand to benefit from the switch, in traditional societies with conventional gender roles, the benefits accrue disproportionately to the women in charge of cooking. The cost, however, is paid by the earning members of the family who are most-often males with no cooking responsibilities. The results suggest that such a subsidy policy, if it liberates women to work for pay and wins them higher decision-making power in financial matters, could, even when it is short-lived, lead to increased adoption and sustained usage of LPG. The results also provide a relatively inexpensive policy option to ensure higher labor force participation of women in regions where the lack of participation arises from time constraints due to housekeeping responsibilities.

The analysis leaves a lot to be desired. An direct examination of the impact of the program on the time use of the exposed women will serve as an important validation check for the pathways we propose. Similarly, a causal analysis of the impact of the decision-making power with women on the adoption of cleaner fuel will be able to verify if the policy has triggered the virtuous cycle of more work for women and cleaner fuel adoption. Due to data limitations, we leave this for future research.

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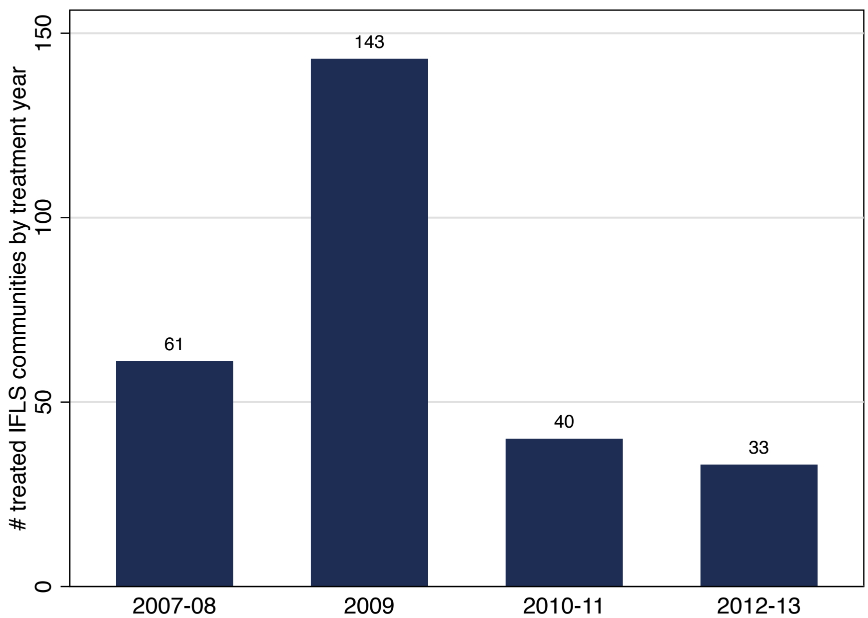
Figure 1: Difference in LPG program roll-out across provinces

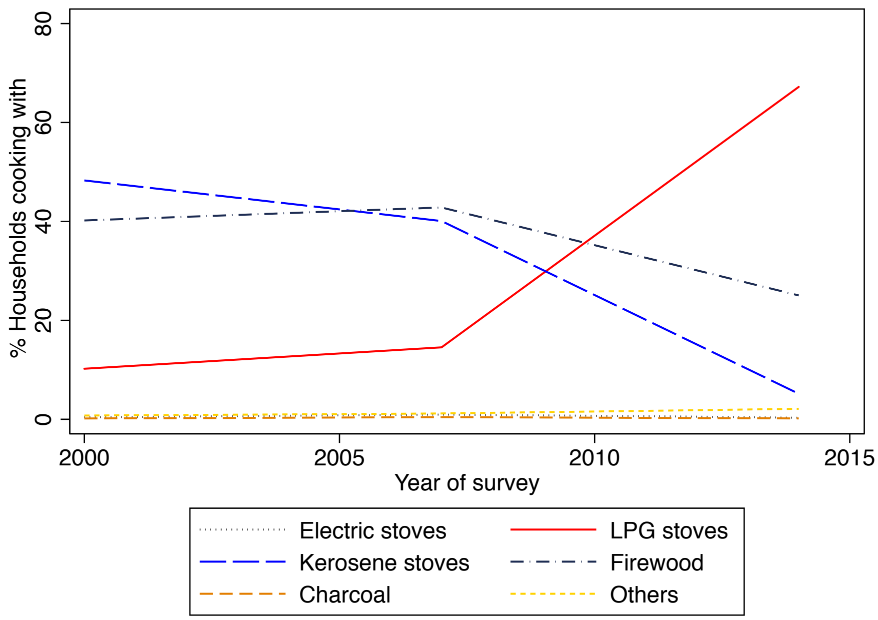
Notes: In some cases, the program was rolled out in different areas within a province in two consecutive years. However, we do not have information on roll-out at a finer level. For this reason, we define a province to have received the program only once all areas within the province were covered.

Figure 2: Difference in LPG program roll-out across IFLS communities



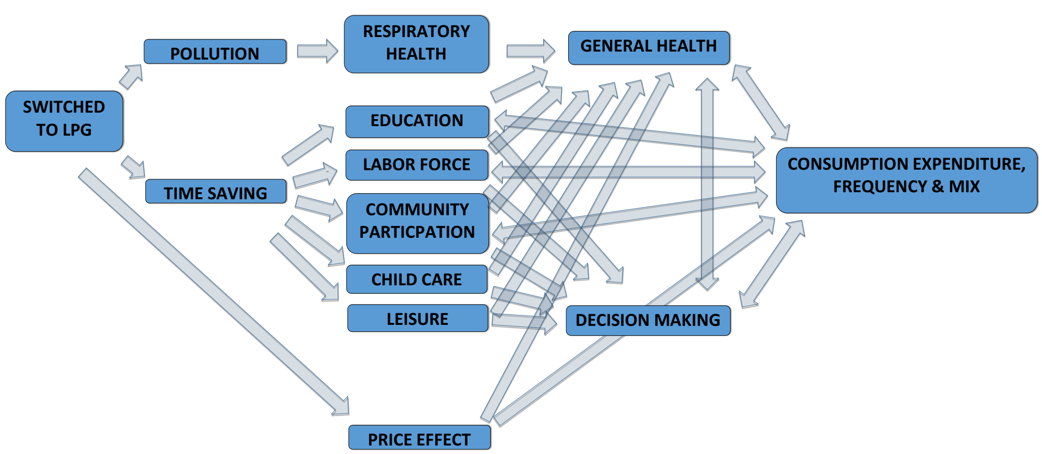
Notes: In some cases, the program was rolled out in different areas within a province in two consecutive years. However, we do not have information on roll-out at a finer level. For this reason, we define all communities within a province to have received the program only once all areas within the province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

Figure 3: Primary cooking fuel



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

Figure 4: Benefit mechanisms



Notes: A switch to LPG as the primary cooking fuel can benefit the women via multiple pathways. The picture depicts some of the most-likely pathways.

Table 1: Impact on household's choice of cooking fuel

	(1)	(2)	(3)	(4)
VARIABLES	Household uses LPG as primary cooking fuel			
Years since LPG program roll-out * All-weather navigable road in 2007	0.02***			
	(0.003)			
Community received LPG program * All-weather navigable road in 2007		0.15***		
		(0.02)		
Years since LPG program roll-out * Adequate road infrastructure in 2007			0.01***	
			(0.002)	
Community received LPG program * Adequate road infrastructure in 2007				0.10***
				(0.01)
Mean of dependent variable	0.39	0.39	0.39	0.39
Mean years since program roll-out	3.14		3.14	
Mean probability of program exposure		0.58		0.58
Probability that community had a working all-weather road in 2007	0.86	0.86		
Probability that community had adequate road infrastructure in 2007			0.86	0.86
Observations	13,996	13,996	13,996	13,996
Number of households	6,998	6,998	6,998	6,998
R-squared	0.55	0.55	0.54	0.55
FE	Household	Household	Household	Household

Notes: *** p<0.01, ** p<0.05, * p<0. Robust standard errors in parentheses. 'All-weather navigable road in 2007' takes value '1' if the community had a road that was navigable all twelve months in 2007, '0' otherwise. 'Adequate road infrastructure' takes value '1' if the community representative believed that the community roads were adequate for the purposes of the community, '0' if not. Other controls include sub-district×(all-weather navigable/adequate road infrastructure) fixed effect, province×survey-wave fixed effect, and household fixed effect.

Table 2: Impact on measured health indicators of women

VARIABLES	(1) Maximum lung capacity	(2) Overweight	(3) Right hand grip strength	(4) Pulse rate between 60 and 100
Years since LPG program roll-out * All-weather navigable road in 2007	0.70*	-0.003	0.10*	0.002
	(0.42)	(0.003)	(0.06)	(0.002)
Mean of dependent variable	287.82	0.39	21.84	0.94
Mean years since roll-out	3.13	3.13	3.13	3.13
Probability that community had a working all-weather road in 2007	0.86	0.86	0.86	0.86
Observations	14,214	13,352	14,034	14,486
Number of individuals	7,107	6,676	7,017	7,243
R-squared	0.10	0.08	0.25	0.01
FE	Individual	Individual	Individual	Individual
Gender	Female	Female	Female	Female

Notes: *** p<0.01, ** p<0.05, * p<0. Robust standard errors in parentheses. 'All-weather navigable road in 2007' takes value '1' if the community had a road that was navigable all twelve months in 2007, '0' otherwise. Other controls include sub-district×(all-weather navigable/adequate road infrastructure) fixed effect, province×survey-wave fixed effect, and individual fixed effect.

Table 3: Mitigation

VARIABLES	(1) Kitchen outside	(2) Move kitchen inside
Firwood /Charcoal users	0.0355***	
	(0.0081)	
Switch to a cleaner fuel		0.1083***
		(0.0348)
Switch to a dirtier fuel		0.0225
		(0.0723)
Observations	24,586	7,883
R-squared	0.1720	0.0639
Mean of DV	0.254	0.0238
FE	Community	Community

Table 4: Utilization of saved time from the Indonesian domestic biogas program, 2009 (Gurung and Setyowati (2016))

	% of time savings allocated to
Productive activities	26.98
Leisure	14.74
Caring for children	14.59
Cooking	10.42
Cleaning the house	5.53
Cooking for animals	5.31
Cleaning utensils	4.01
Washing clothes	3.97
Washing self	3.44
Cleaning stable and collecting dung	3.17
Community activities	2.29
Putting dung into biodigester	1.39
Putting bio-slurry into pit	1.31
Fuelwood collection	1.18
Collection of water	0.99
Stirring the biogas digester	0.67
Total	100

Table 5: Impact on labor force participation

VARIABLES	(1)	(2)
	Primary activity is work for pay	
Years since LPG program roll-out * All-weather navigable road in 2007	0.011***	-0.00003
	(0.004)	(0.003)
Mean of dependent variable	0.46	0.82
Mean years since roll-out	3.13	3.16
Probability that community had a working all-weather road in 2007	0.86	0.86
Observations	14,960	12,250
Number of individuals	7,480	6,125
R-squared	0.017	0.010
FE	Individual	Individual
Gender	Female	Male

Notes: Robust standard errors in parentheses. ‘All-weather navigable road in 2007’ takes value ‘1’ if the community had a road that was navigable all twelve months in 2007, ‘0’ otherwise. Other controls include sub-district×(all-weather navigable/adequate road infrastructure) fixed effect, province×survey-wave fixed effect, and individual fixed effect.

Table 6: Activities in the week preceding the survey

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				In the last week, did you				
VARIABLES	work for pay	attend school	housekeeping	job search	work for pay	attend school	housekeeping	job search
Years since LPG program roll-out X All-weather navigable road in 2007	0.008**	-0.0004	0.005**	-0.001	0.002	-0.001	-0.003	-0.001
	(0.004)	(0.001)	(0.002)	(0.001)	(0.003)	(0.001)	(0.004)	(0.002)
Observations	14,959	14,960	14,960	14,960	12,243	12,244	12,244	12,244
Number of individuals	7,480	7,480	7,480	7,480	6,122	6,122	6,122	6,122
R-squared	0.011	0.047	0.017	0.015	0.011	0.046	0.138	0.035
Mean of dependent variable	0.59	0.03	0.90	0.01	0.85	0.04	0.34	0.07
Mean years since roll-out	3.13	3.13	3.13	3.13	3.16	3.16	3.16	3.16
Probability that community had a working all-weather road in 2007	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
FE	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual
Gender	Female	Female	Female	Female	Male	Male	Male	Male

Notes: *** p<0.01, ** p<0.05, * p<0. Robust standard errors in parentheses. 'All-weather navigable road in 2007' takes value '1' if the community had a road that was navigable all twelve months in 2007, '0' otherwise. Other controls include sub-district×(all-weather navigable/adequate road infrastructure) fixed effect, province×survey-wave fixed effect, and individual fixed effect.

Table 7: Schooling outcomes I

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	How many hours everyday did you spend						Did you work while					
VARIABLES	Elementary School		Junior High		Senior High		Elementary School		Junior High		Senior High	
Years since roll-out * Road in 2007	0.0212	0.2633***	0.0952	0.3592***	0.1983	0.0230	0.0356	0.0199	0.0342	0.0626*	0.0776	0.1061**
	(0.1302)	(0.0882)	(0.1618)	(0.1367)	(0.1966)	(0.1478)	(0.0372)	(0.0262)	(0.0430)	(0.0334)	(0.0587)	(0.0528)
Asphalt/Cement Road	-0.0834	-0.1449**	-0.0866	-0.0897	-0.0456	0.0710	-0.0170	0.0250*	-0.0144	0.0054	-0.0257	-0.0122
	(0.0661)	(0.0716)	(0.1009)	(0.0890)	(0.1167)	(0.1250)	(0.0266)	(0.0144)	(0.0336)	(0.0212)	(0.0518)	(0.0272)
Post	-0.1676	-0.2865***	-0.1282	-0.3505**	-0.1902	0.1672	-0.0188	-0.0312	-0.0097	-0.0574*	-0.0728	-0.1184**
	(0.1480)	(0.1063)	(0.1755)	(0.1564)	(0.2039)	(0.1605)	(0.0382)	(0.0273)	(0.0454)	(0.0343)	(0.0608)	(0.0540)
Fixed Effects	Community											
Fuel before treatment	Any											
Gender	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Mean of DV	2.1629	2.0400	0.2240	0.1384	0.0205	0 .0056	0.0183	0.0040				
Observations	6,239	6,559	5,513	5,702	4,422	4,590	13,536	13,607	10,080	9,618	7,163	6,789
R-squared	0.1902	0.2062	0.2059	0.2170	0.2080	0.2115	0.0997	0.0772	0.0954	0.0838	0.1161	0.0949

Notes: *** p<0.01, ** p<0.05, * p<0. Robust standard errors in parentheses. ‘All-weather navigable road in 2007’ takes value ‘1’ if the community had a road that was navigable all twelve months in 2007, ‘0’ otherwise. Other controls include sub-district×(all-weather navigable/adequate road infrastructure) fixed effect, province×survey-wave fixed effect, and individual fixed effect.

Table 8: Schooling outcomes II

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			Failed ever in					
VARIABLES	Education level completed		Elementary school		Junior high		Senior high	
Years since roll-out * Road in 2007	-0.0077	-0.0452	-0.1033***	-0.0830***	-0.0020	-0.0053	-0.0178	-0.0040
	(0.0312)	(0.0429)	(0.0325)	(0.0276)	(0.0102)	(0.0038)	(0.0185)	(0.0053)
Fixed Effects	Community							
Fuel before treatment	Any							
Gender	Male	Female	Male	Female	Male	Female	Male	Female
Observations	28,042	28,779	13,534	13,608	10,078	9,621	7,164	6,790
R-squared	0.3201	0.3632	0.1104	0.0957	0.0572	0.0369	0.0722	0.0717

Notes: *** p<0.01, ** p<0.05, * p<0. Robust standard errors in parentheses. ‘All-weather navigable road in 2007’ takes value ‘1’ if the community had a road that was navigable all twelve months in 2007, ‘0’ otherwise. Other controls include sub-district×(all-weather navigable/adequate road infrastructure) fixed effect, province×survey-wave fixed effect, and individual fixed effect.

Table 9: Impact on community participation

VARIABLES	(1) Participated in Community meeting	(2) Participated in Neighborhood improvement	(3) Participated in Women Association activities	(4) Participated in Community weighing post
Years since LPG program roll-out * All-weather navigable road in 2007	0.0528*	-0.0295	0.0747*	0.0492**
	(0.0313)	(0.0540)	(0.0429)	(0.0240)
Observations	8,828	8,838	8,838	8,844
Number of pidlink	4,414	4,419	4,419	4,422
R-squared	0.17	0.14	0.31	0.23
FE	Individual	Individual	Individual	Individual
Gender	Female	Female	Female	Female

Notes: *** p<0.01, ** p<0.05, * p<0. Robust standard errors in parentheses. 'All-weather navigable road in 2007' takes value '1' if the community had a road that was navigable all twelve months in 2007, '0' otherwise. Other controls include sub-district×(all-weather navigable/adequate road infrastructure) fixed effect, province×survey-wave fixed effect, and household fixed effect. Information used for the analyses presented in the table were responses to questions pertaining to expenditures made on specific food-related items in the week preceding the survey.

Table 10: Impact on household's food expenditure

VARIABLES	(1) Expenditure on prepared food eaten at home	(2) Expenditure on prepared food eaten away from home	(3) Total Food expenditure on all food items
Years since LPG program roll-out X All-weather navigable road in 2007	856.76***	128.16	1,419.67
	(320.33)	(281.67)	(1,633.21)
Mean of dependent variable	23587.94	13543.36	325083.59
Mean years since roll-out	3.14	3.14	3.14
Probability that community had a working all-weather road in 2007	0.86	0.86	0.86
Observations	13,872	13,850	13,996
Number of households	6,936	6,925	6,998
R-squared	0.10	0.06	0.31
FE	Household	Household	Household

Notes: *** p<0.01, ** p<0.05, * p<0. Robust standard errors in parentheses. 'All-weather navigable road in 2007' takes value '1' if the community had a road that was navigable all twelve months in 2007, '0' otherwise. Other controls include sub-district×(all-weather navigable/adequate road infrastructure) fixed effect, province×survey-wave fixed effect, and household fixed effect. Information used for the analyses presented in the table were responses to questions pertaining to expenditures made on specific food-related items in the week preceding the survey.

Table 11: Impact on household's non-food expenditure

	(1)	(2)	(3)	(4)
	Arisan		Non-food expenditure on	
VARIABLES	contributions	monthly items	yearly items (except education)	education
Years since LPG * All-weather navigable road in 2007	5,611.86**	73,103.01	443,594.38**	90,739.42
	(2,490.22)	(91,053.23)	(210,514.84)	(85,218.13)
Mean of dependent variable	96689.43	1528106.22	9219034.76	3326378.18
Mean years since roll-out	3.14	3.14	3.14	3.14
Probability that community had all-weather road in 2007	0.86	0.86	0.86	0.86
Observations	13,908	13,996	13,996	13,996
Number of households	6,954	6,998	6,998	6,998
R-squared	0.01	0.01	0.00	0.02
FE	Household	Household	Household	Household

Notes: *** p<0.01, ** p<0.05, * p<0. Robust standard errors in parentheses. 'All-weather navigable road in 2007' takes value '1' if the community had a road that was navigable all twelve months in 2007, '0' otherwise. Other controls include sub-district×(all-weather navigable/adequate road infrastructure) fixed effect, province×survey-wave fixed effect, and individual fixed effect.

Table 12: Impact on decision-making power of women

	How does your family make decisions about expenditures and use of time on [...]							
	choice of food at home	household items	your clothes	spouse's clothes	gifts in parties	arisan contribution	monthly savings	husband's socializing time
	Response: Respondent is the sole decision-maker							
Years since LPG program roll-out * All-weather navigable road in 2007	0.003	0.004	0.005	-0.012**	0.004	0.014***	0.016***	-0.006
	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
R-squared	0.032	0.059	0.182	0.116	0.150	0.130	0.136	0.038
Mean of dependent variable	0.698	0.688	0.644	0.364	0.226	0.270	0.178	0.111
	Response: Spouse of the respondent is the primary decision-maker							
Years since LPG program roll-out * All-weather navigable road in 2007	-0.005*	-0.005*	-0.007**	0.006	-0.001	-0.002	0.002	0.013**
	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.002)	(0.002)	(0.005)
R-squared	0.015	0.019	0.013	0.048	0.044	0.028	0.034	0.123
Mean of dependent variable	0.051	0.067	0.064	0.267	0.073	0.046	0.055	0.463
	Response: Respondent has some say the decision-making process.							
Years since LPG program roll-out * All-weather navigable road in 2007	0.004	0.007**	0.005	-0.009*	0.002	0.001	0.004	-0.013**
	(0.003)	(0.003)	(0.003)	(0.005)	(0.003)	(0.005)	(0.005)	(0.005)
R-squared	0.015	0.019	0.020	0.067	0.049	0.088	0.079	0.124
Mean of dependent variable	0.911	0.899	0.916	0.712	0.92	0.556	0.453	0.535
	Response: Respondent and spouse take the decision jointly.							
Years since LPG program roll-out * All-weather navigable road in 2007	0.002	0.002	0.0003	0.004	-0.003	-0.012***	-0.012***	-0.007
	(0.003)	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)	(0.004)	(0.005)
R-squared	0.056	0.102	0.251	0.238	0.211	0.081	0.084	0.161
Mean of dependent variable	0.167	0.179	0.267	0.346	0.69	0.281	0.272	0.424
Mean years since roll-out	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14
Probability that community had a working all-weather road in 2007	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Observations	8,846	8,848	8,838	8,836	8,828	8,838	8,838	8,844
Number of pidlink	4,423	4,424	4,419	4,418	4,414	4,419	4,419	4,422
FE	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual
Gender	Female	Female	Female	Female	Female	Female	Female	Female

Notes: *** $p<0.01$, ** $p<0.05$, * $p<0$. Robust standard errors in parentheses. 'All-weather navigable road in 2007' takes value '1' if the community had a road that was navigable all twelve months in 2007, '0' otherwise. Other controls include sub-district×(all-weather navigable/adequate road infrastructure) fixed effect, province×survey-wave fixed effect, and individual fixed effect.

Table A1: Impact on measured health indicators of men

VARIABLES	(1) Maximum lung capacity	(2) Overweight	(3) Right hand grip strength	(4) Pulse rate between 60 and 100
Years since LPG program roll-out * All-weather navigable road in 2007	0.98	0.006***	0.20***	0.002
	(0.62)	(0.002)	(0.07)	(0.003)
Mean of dependent variable	424.90	0.20	34.51	0.90
Mean years since roll-out	3.15	3.15	3.15	3.15
Probability that community had a working all-weather road in 2007	0.86	0.86	0.86	0.86
Observations	11,462	10,490	11,362	11,616
Number of individuals	5,731	5,245	5,681	5,808
R-squared	0.094	0.044	0.237	0.011
FE	Individual	Individual	Individual	Individual
Gender	Male	Male	Male	Male

Notes: *** $p<0.01$, ** $p<0.05$, * $p<0$. Robust standard errors in parentheses. 'All-weather navigable road in 2007' takes value '1' if the community had a road that was navigable all twelve months in 2007, '0' otherwise. Other controls include sub-district×(all-weather navigable/adequate road infrastructure) fixed effect, province×survey-wave fixed effect, and individual fixed effect.

A Appendix

Table A2: Impact on acute morbidity symptoms in females

VARIABLES	(1) Headache	(2) Runny nose	(3) Cough	(4) Dry cough	(5) Cough with phlegm	(6) Bloody cough	(7) Difficulty breathing	(8) Wheezing Wheezing	(9) Short rapid breath	(10) Fever Fever
Years * Road in 2007	-0.004	-0.001	-0.0004	0.021*	-0.020*	-0.004*	-0.001	0.022	-0.005	0.006*
	(0.004)	(0.004)	(0.004)	(0.011)	(0.011)	(0.003)	(0.004)	(0.032)	(0.024)	(0.003)
Mean of dependent variable	0.60	0.40	0.33	0.59	0.45	0.01	0.12	0.38	0.79	0.19
Mean years since roll-out	3.13	3.13	3.13	3.17	3.17	3.17	3.13	3.16	3.16	3.13
Probability of working all-weather road in 2007	0.86	0.86	0.86	0.90	0.90	0.90	0.86	0.85	0.85	0.86
Observations	14,870	14,878	14,882	2,166	2,166	2,166	14,886	330	330	14,882
Number of pidlink	7,435	7,439	7,441	1,083	1,083	1,083	7,443	165	165	7,441
R-squared	0.03	0.02	0.04	0.02	0.04	0.02	0.01	0.2	0.16	0.02
VARIABLES	(11) Stomach ache	(12) Nausea/ Vomiting	(13) Diarrhea	(14) with blood	(15) Diarrhea with mucous	(16) Diarrhea pale liquid	(17) Skin infection	(18) Eye infection	(19) Toothache Toothache	(20) Swollen legs
Years * Road in 2007	-0.0002	0.003	0.005*	0.007	-0.050	-0.014	0.0002	-0.001	0.006**	0.003
	(0.003)	(0.003)	(0.002)	(0.012)	(0.038)	(0.062)	(0.003)	(0.002)	(0.003)	(0.002)
Mean of dependent variable	0.25	0.14	0.09	0.02	0.31	0.57	0.11	0.06	0.14	0.04
Mean years since roll-out	3.14	3.14	3.13	3.20	3.20	3.20	3.13	3.13	3.13	3.13
Probability of working all-weather road in 2007	0.86	0.86	0.86	0.90	0.90	0.90	0.86	0.86	0.86	0.86
Observations	14,876	14,880	14,876	202	202	202	14,882	14,884	14,884	14,882
Number of pidlink	7,438	7,440	7,438	101	101	101	7,441	7,442	7,442	7,441
R-squared	0.04	0.02	0.03	0.2	0.1	0.11	0.04	0.01	0.02	0.02
FE	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual
Gender	Female	Female	Female	Female	Female	Female	Female	Female	Female	Female

Table A3: Impact on acute morbidity symptoms in males

VARIABLES	(1) Headache	(2) Runny nose	(3) Cough	(4) Dry cough	(5) Cough with phlegm	(6) Bloody cough	(7) Difficulty breathing	(8) Wheezing	(9) Short rapid breath	(10) Fever
Years * Road in 2007	-0.006	0.002	0.002	0.011	-0.015	-0.003	0.003	0.010	-0.004	0.006*
	(0.004)	-0.004	(0.004)	(0.012)	(0.012)	(0.003)	(0.004)	(0.037)	(0.033)	(0.003)
Mean of dependent variable	0.48	0.41	0.36	0.53	0.52	0.02	0.16	0.38	0.78	0.18
Mean years since roll-out	3.16	3.16	3.16	3.21	3.21	3.21	3.16	3.22	3.22	3.16
Probability of working all-weather road in 2007	0.86	0.86	0.86	0.87	0.87	0.87	0.86	0.83	0.83	0.86
Observations	12,166	12,172	12,172	2,052	2,052	2,052	12,176	226	226	12,168
Number of individuals	6,083	6,086	6,086	1,026	1,026	1,026	6,088	113	113	6,084
R-squared	0.037	0.033	0.054	0.040	0.064	0.028	0.012	0.127	0.152	0.014
VARIABLES	(11) Stomach ache	(12) Nausea/ Vomiting	(13) Diarrhea	(14) Diarrhea with blood	(15) Diarrhea with mucous	(16) Diarrhea pale liquid	(17) Skin infection	(18) Eye infection	(19) Toothache	(20) Swollen legs
Years * Road in 2007	0.0003	0.003	0.002	-0.041	0.024	-0.052	0.003	-0.001	0.0002	-0.001
	(0.004)	(0.002)	(0.003)	(0.030)	(0.062)	(0.040)	(0.003)	(0.002)	(0.003)	(0.002)
Mean of dependent variable	0.2	0.09	0.08	0.09	0.37	0.5	0.13	0.06	0.13	0.03
Mean years since roll-out	3.16	3.16	3.16	3.55	3.55	3.55	3.16	3.16	3.16	3.16
Probability of working all-weather road in 2007	0.86	0.86	0.86	.9	.9	.9	0.86	0.86	0.86	0.86
Observations	12,170	12,168	12,158	140	140	140	12,174	12,174	12,174	12,174
R-squared	0.039	0.031	0.017	0.263	0.336	0.317	0.037	0.014	0.017	0.018
Number of individuals	6,085	6,084	6,079	70	70	70	6,087	6,087	6,087	6,087
FE	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual
Gender	Male	Male	Male	Male	Male	Male	Male	Male	Male	Male

Table A4: Impact on diagnosed chronic illnesses

VARIABLES	(1) Hypertension	(2) Diabetes/ High blood sugar	(3) Tuberculosis	(4) Asthma	(5) Other Lung Conditions	(6) Heart-related problems	(7) Liver problems	(8) Stroke	(9) Cancer or malignant tumor	(10) Arthritis/ rheumatism
Years * Road in 2007	-0.001	0.002	0.002***	-0.002	-0.002	-0.001	-0.0003	-0.002	0.001	0.0002
	(0.004)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.004)
Mean of dependent variable	0.27	0.04	0.01	0.03	0.02	0.03	0.01	0.02	0.01	0.14
Mean years since roll-out	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15
Probability of an all-weather road in 2007	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Observations	7,270	7,264	7,268	7,270	7,268	7,270	7,270	7,270	7,270	7,266
Number of individuals	3,635	3,632	3,634	3,635	3,634	3,635	3,635	3,635	3,635	3,633
R-squared	0.053	0.038	0.006	0.006	0.009	0.016	0.016	0.016	0.006	0.017
FE	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual
Gender	Female	Female	Female	Female	Female	Female	Female	Female	Female	Female
VARIABLES	(11) Hypertension	(12) Diabetes/ High blood sugar	(13) Tubreculosis	(14) Asthma	(15) Other Lung Conditions	(16) Heart-related problems	(17) Liver problems	(18) Stroke	(19) Cancer or malignant tumor	(20) Arthritis/ rheumatism
Years * Road in 2007	0.001	0.003**	-0.001	-0.0001	-0.001	0.003**	-0.001	0.002	0.0001	-0.002
	(0.004)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
Mean of dependent variable	0.15	0.04	0.01	0.03	0.02	0.02	0.01	0.01	0.003	0.09
Mean years since roll-out	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19
Probability of an all-weather road in 2007	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Observations	5,928	5,932	5,934	5,930	5,930	5,930	5,932	5,934	5,932	5,934
Number of individuals	2,964	2,966	2,967	2,965	2,965	2,965	2,966	2,967	2,966	2,967
R-squared	0.043	0.047	0.021	0.012	0.012	0.026	0.035	0.026	0.004	0.009
FE	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual
Gender	Male	Male	Male	Male	Male	Male	Male	Male	Male	Male

Table A5: Impact on self-reported subjective evaluations of health of females

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				If you had to [. . .], could you do it:				
VARIABLES	Carry heavy load	Sweep the floor	Walk 1 km	Walk 5 kms	Draw water from well	Bow/ Squat/kneel	Stand from sitting in a chair	Stand from sitting on the floor
Years * Road in 2007	-0.004	-0.017**	-0.017	-0.003	0.003	0.004	-0.014**	-0.003
	(0.013)	(0.009)	(0.012)	(0.015)	(0.011)	(0.009)	(0.007)	(0.008)
Mean of dependent variable	1.76	1.17	1.7	2.62	1.45	1.31	1.12	1.22
Mean years since roll-out	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15
Probability of working all-weather road in 2007	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Observations	7,274	7,274	7,274	7,274	7,274	7,274	7,274	7,274
Number of individuals	3,637	3,637	3,637	3,637	3,637	3,637	3,637	3,637
R-squared	0.171	0.065	0.164	0.211	0.113	0.151	0.056	0.085
		(9)	(10)	(11)	(12)	(13)	(14)	
VARIABLES		Health today	Primary activity days missed	Days stayed in bed	Health compared to an year ago	Expected health next year	Health compared to others	
Years * Road in 2007		-0.0002	-0.052	-0.031	-0.006	-0.010	-0.010**	
		(0.005)	(0.042)	(0.021)	(0.007)	(0.007)	(0.004)	
Mean of dependent variable		2.1	2.4	0.47	2.7	2.48	1.99	
Mean years since roll-out		3.13	3.13	3.13	3.13	3.13	3.13	
Probability of working all-weather road in 2007		0.86	0.87	0.86	0.86	0.87	0.87	
Observations		14,898	14,878	14,882	14,896	13,812	13,826	
Number of individuals		7,449	7,439	7,441	7,448	6,906	6,913	
R-squared		0.022	0.036	0.017	0.037	0.126	0.016	
FE		Individual	Individual	Individual	Individual	Individual	Individual	
Gender		Female	Female	Female	Female	Female	Female	

Table A6: Impact on self-reported subjective evaluations of health of males

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				If you had to [. . .], could you do it:				
VARIABLES	Carry heavy load	Sweep the floor	Walk 1 km	Walk 5 kms	Draw water from well	Bow/ Squat/kneel	Stand from sitting in a chair	Stand from sitting on the floor
Years * Road in 2007	0.007	-0.006	-0.002	0.005	0.003	0.003	0.004	0.003
	(0.012)	(0.009)	(0.011)	(0.015)	(0.010)	(0.008)	(0.005)	(0.006)
Mean of dependent variable	1.35	1.12	1.36	1.96	1.20	1.18	1.07	1.10
Mean years since roll-out	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19
Probability of working all-weather road in 2007	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Observations	5,936	5,936	5,936	5,936	5,936	5,936	5,936	5,936
Number of individuals	2,968	2,968	2,968	2,968	2,968	2,968	2,968	2,968
R-squared	0.111	0.060	0.115	0.234	0.079	0.117	0.029	0.050
		(9)	(10)	(11)	(12)	(13)	(14)	
VARIABLES		Health today	Primary activity days missed	Days stayed in bed	Health compared to an year ago	Expected health next year	Health compared to others	
Years * Road in 2007		-0.008	0.033	0.009	-0.007	-0.015**	-0.006	
		(0.006)	(0.041)	(0.018)	(0.007)	(0.008)	(0.005)	
Mean of dependent variable		2.04	1.92	0.37	2.72	2.56	1.95	
Mean years since roll-out		3.16	3.16	3.16	3.16	3.15	3.15	
Probability of working all-weather road in 2007		0.86	0.86	0.86	0.86	0.85	0.85	
Observations		12,190	12,166	12,174	12,186	11,198	11,210	
Number of individuals		6,095	6,083	6,087	6,093	5,599	5,605	
R-squared		0.017	0.037	0.013	0.020	0.077	0.019	
FE		Individual	Individual	Individual	Individual	Individual	Individual	
Gender		Male	Male	Male	Male	Male	Male	

Table A7: Impact on mental health

VARIABLES	(1) felt bothered	(2) had trouble concentrating	(3) felt depressed	(4) felt everything was an effort	(5) felt hopeful	(6) felt fearful	(7) sleep was restless	(8) felt happy	(9) felt lonely	(10) could not get going
Years X Road in 2007	-0.003	-0.032	-0.056**	-0.009	0.006	0.006	-0.019	0.003	-0.006	0.020
	(0.025)	(0.023)	(0.028)	(0.016)	(0.009)	(0.023)	(0.018)	(0.009)	(0.039)	(0.032)
Mean of dependent variable	2.12	2.1	2.03	2.27	3.13	2.14	2.43	3.21	2.12	2.12
Mean years since roll-out	3.02	3.1	3.19	3	3.14	3.12	3.13	3.14	3.2	3.27
Probability of an all-weather road in 2007	0.89	0.86	0.88	0.84	0.86	0.89	0.88	0.87	0.88	0.88
Observations	1,722	2,272	1,678	4,362	12,290	2,312	3,854	12,706	764	1,000
Number of individuals	861	1,136	839	2,181	6,145	1,156	1,927	6,353	382	500
R-squared	0.286	0.223	0.308	0.323	0.044	0.230	0.151	0.047	0.284	0.318
FE	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual
Gender	Female	Female	Female	Female	Female	Female	Female	Female	Female	Female
VARIABLES	(11) felt bothered	(12) had trouble concentrating	(13) felt depressed	(14) felt everything was an effort	(15) felt hopeful	(16) felt fearful	(17) sleep was restless	(18) felt happy	(19) felt lonely	(20) could not get going
Years X Road in 2007	-0.036	0.018	-0.005	0.011	0.029***	0.004	0.020	0.018**	-0.066	-0.004
	(0.032)	(0.026)	(0.030)	(0.017)	(0.010)	(0.033)	(0.021)	(0.009)	(0.045)	(0.044)
Mean of dependent variable	2.01	2.07	1.97	2.43	3.11	1.98	2.38	3.18	2.09	2.05
Mean years since roll-out	3.07	3.2	3.27	3.03	3.17	3.18	3.14	3.16	3.17	3.3
Probability of an all-weather road in 2007	0.87	0.87	0.9	0.84	0.85	0.87	0.85	0.85	0.86	0.89
Observations	1,240	1,742	1,358	4,254	10,012	1,110	2,666	10,314	558	752
Number of individuals	620	871	679	2,127	5,006	555	1,333	5,157	279	376
R-squared	0.221	0.186	0.264	0.255	0.050	0.254	0.164	0.046	0.289	0.315
FE	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual
Gender	Male	Male	Male	Male	Male	Male	Male	Male	Male	Male

Table A8: Impact on consumption frequency of specific food items

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	In the last week, did you eat any [...]									
VARIABLES	Sweet potato	Eggs	Fish	Meat	Dairy	Green leafy vegetables	Banana	Papaya	Carrot	Mangoes
Years X Road in 2007	-0.005	-0.000	0.005**	0.007**	0.004	0.001	0.003	0.001	0.005*	0.004
	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Mean of dependent variable	0.46	0.81	0.83	0.60	0.29	0.92	0.63	0.30	0.48	0.35
Mean years since roll-out	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14
Probability of an all-weather road in 2007	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
Observations	25,010	25,010	25,010	25,010	25,010	25,010	25,010	25,010	25,010	25,010
Number of individuals	12,505	12,505	12,505	12,505	12,505	12,505	12,505	12,505	12,505	12,505
R-squared	0.058	0.021	0.027	0.018	0.022	0.065	0.071	0.031	0.216	0.057
FE	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual
Gender	All	All	All	All	All	All	All	All	All	All
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
VARIABLES	Sweet potato	Eggs	Fish	Meat	Dairy	Green leafy vegetables	Banana	Papaya	Carrot	Mangoes
Years X Road in 2007	0.003	-0.001	0.005	0.008**	0.001	0.000	0.004	-0.001	0.004	0.005
	(0.004)	(0.003)	(0.003)	(0.004)	(0.003)	(0.002)	(0.004)	(0.004)	(0.004)	(0.004)
Mean of dependent variable	0.46	0.81	0.83	0.58	0.26	0.92	0.62	0.32	0.51	0.36
Mean years since roll-out	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13
Probability of an all-weather road in 2007	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Observations	13,810	13,810	13,810	13,810	13,810	13,810	13,810	13,810	13,810	13,810
Number of individuals	6,905	6,905	6,905	6,905	6,905	6,905	6,905	6,905	6,905	6,905
R-squared	0.056	0.020	0.032	0.025	0.019	0.061	0.071	0.033	0.197	0.060
FE	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual
Gender	Female	Female	Female	Female	Female	Female	Female	Female	Female	Female
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
VARIABLES	Sweet potato	Eggs	Fish	Meat	Dairy	Green leafy vegetables	Banana	Papaya	Carrot	Mangoes
Years X Road in 2007	-0.013***	0.001	0.004	0.006	0.008**	0.001	0.003	0.003	0.006	0.002
	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.002)	(0.004)	(0.004)	(0.004)	(0.004)
Mean of dependent variable	0.45	0.81	0.83	0.62	0.32	0.91	0.64	0.29	0.45	0.34
Mean years since roll-out	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15
Probability of an all-weather road in 2007	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Observations	11,192	11,192	11,192	11,192	11,192	11,192	11,192	11,192	11,192	11,192
R-squared	0.071	0.024	0.025	0.017	0.031	0.076	0.075	0.032	0.244	0.061
Number of individuals	5,596	5,596	5,596	5,596	5,596	5,596	5,596	5,596	5,596	5,596
FE	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual
Gender	Male	Male	Male	Male	Male	Male	Male	Male	Male	Male

Table A9: Impact on subjective well-being of women

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				How adequate is [. . .]for your needs?				
	family life	standard of living	food consumption	health status	children's standard of living	children's food comsumption	children's healthcare	children's education
Years X Road in 2007	0.008*	0.009*	0.011**	0.009*	0.007	0.016**	0.017**	0.010
	(0.005)	(0.005)	(0.005)	(0.005)	(0.007)	(0.007)	(0.007)	(0.007)
Mean of dependent variable	1.93	1.96	2.04	1.97	2.03	2.10	2.10	2.05
Mean years since roll-out	3.13	3.13	3.13	3.13	3.10	3.10	3.10	3.10
Probability of an all-weather road in 2007	0.87	0.87	0.87	0.87	0.84	0.84	0.84	0.84
Observations	13,876	13,878	13,880	13,850	5,620	5,616	5,616	5,500
Number of individuals	6,938	6,939	6,940	6,925	2,810	2,808	2,808	2,750
R-squared	0.034	0.037	0.044	0.034	0.037	0.062	0.069	0.053
			(9)	(10)	(11)	(12)		
			On which economic step of the ladder [. . .]?			Keep this		
VARIABLES			are you today	were you five year ago	will you be five years from now	standard of living in next 5 years		
Years X Road in 2007			0.012	0.014*	0.029***	0.012**		
			(0.008)	(0.008)	(0.010)	(0.006)		
Mean of dependent variable			2.94	2.62	3.74	2.52		
Mean years since roll-out			3.13	3.13	3.14	3.13		
Probability of an all-weather road in 2007			0.87	0.87	0.87	0.86		
Observations			13,710	13,588	12,294	13,450		
Number of individuals			6,855	6,794	6,147	6,725		
R-squared			0.052	0.027	0.133	0.082		
Gender	Female	Female	Female	Female	Female	Female	Female	Female
FE	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual

Table A10: Impact on subjective well-being of men

VARIABLES	(5) family life	(6) standard of living	(7) food consumption	(8) health status	(9) children's standard of living	(10) children's food comsumption	(11) children's healthcare	(12) children's education
	How adequate is [. . .]for your needs?							
Years X Road in 2007	0.012***	0.009*	0.006	0.010*	0.011	0.008	0.010	0.013
	(0.005)	(0.005)	(0.005)	(0.005)	(0.008)	(0.007)	(0.008)	(0.008)
Mean of dependent variable	1.90	1.93	2.02	1.93	1.95	2.03	2.00	1.99
Mean years since roll-out	3.15	3.15	3.15	3.15	3.08	3.08	3.08	3.08
Probability of an all-weather road in 2007	0.85	0.85	0.85	0.85	0.83	0.83	0.83	0.83
Observations	11,262	11,272	11,274	11,256	4,446	4,444	4,444	4,338
Number of individuals	0.039	0.032	0.029	0.035	0.037	0.043	0.053	0.042
R-squared	5,631	5,636	5,637	5,628	2,223	2,222	2,222	2,169
			(1)	(2)	(3)	(4)		
			On which economic step of the ladder [. . .]?			Keep this standard of living		
VARIABLES			are you today	were you five year ago	will you be five years from now	in next 5 years		
Years X Road in 2007			0.026***	0.010	0.027**	0.016***		
			(0.008)	(0.009)	(0.011)	(0.006)		
Mean of dependent variable			2.86	2.6	3.66	2.47		
Mean years since roll-out			3.15	3.15	3.16	3.15		
Probability of an all-weather road in 2007			0.85	0.85	0.85	0.85		
Observations			11,202	11,160	10,082	10,938		
Number of individuals			0.025	0.025	0.079	0.042		
R-squared			5,601	5,580	5,041	5,469		
Gender	Female	Female	Female	Female	Female	Female	Female	Female
FE	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual

Table A11: Impact on decision-making power of men

	How does your family make decisions about expenditures and use of time on [...]							
	choice of food at home	household items	your clothes	spouse's clothes	gifts in parties	arisan contribution	monthly savings	husband's socializing time
	Response: Respondent is the sole decision-maker							
Years since LPG program roll-out * All-weather navigable road in 2007	-0.004	-0.001	-0.002	-0.007**	-0.004	-0.003	-0.001	0.0003
	(0.002)	(0.003)	(0.005)	(0.003)	(0.003)	(0.002)	(0.003)	(0.005)
Mean of dependent variable	0.051	0.079	0.321	0.067	0.114	0.07	0.081	0.53
R-squared	0.011	0.025	0.043	0.016	0.061	0.028	0.031	0.116
	Response: Spouse of the respondent is the primary decision-maker							
Years since LPG program roll-out * All-weather navigable road in 2007	-0.008*	-0.003	0.006	0.011**	0.008**	0.005	0.006	0.001
	(0.004)	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)	(0.004)	(0.003)
Mean of dependent variable	0.736	0.695	0.347	0.61	0.168	0.235	0.163	0.058
R-squared	0.023	0.033	0.087	0.217	0.088	0.106	0.114	0.026
	Response: Respondent has some say the decision-making process.							
Years since LPG program roll-out * All-weather navigable road in 2007	0.008*	0.004	-0.005	-0.011**	-0.007*	-0.016***	-0.015***	-0.0003
	(0.004)	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)	(0.003)
Mean of dependent variable	0.241	0.282	0.635	0.376	0.826	0.363	0.367	0.941
R-squared	0.026	0.039	0.104	0.238	0.093	0.070	0.064	0.026
	Response: Respondent and spouse take the decision jointly.							
Years since LPG program roll-out * All-weather navigable road in 2007	0.011***	0.004	-0.003	-0.004	-0.004	-0.013***	-0.013***	-0.002
	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Mean of dependent variable	0.188	0.201	0.312	0.309	0.711	0.292	0.285	0.411
R-squared	0.024	0.053	0.181	0.268	0.157	0.082	0.066	0.158
Mean years since roll-out	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14
Probability that community had a working all-weather road in 2007	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Observations	8,176	8,178	8,172	8,172	8,160	8,158	8,166	8,172
Number of pidlink	4,088	4,089	4,086	4,086	4,080	4,079	4,083	4,086
FE	Individual	Individual	Individual	Individual	Individual	Individual	Individual	Individual
Gender	Male	Male	Male	Male	Male	Male	Male	Male