Doctoral Dissertation

Essays on Indonesia Household Consumption: Assessing SDGs through Individual Household Perspective

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Abstract

In September 2015, 2030 Agenda for Sustainable Development had been adopted in the United Nations Sustainable Development Summit. Since then, a collection of 17 sustainable development goals (SDGs) became a strategical action that required active involvement and joint contribution or cooperation from multidisciplinary individuals, sectors, industries, both developed or developing countries. While policymakers and institutional plays the leading roles in pursuing SDGs, households, as the smallest social unit, were also crucial stakeholders to the success of this global ambition.

In this dissertation, household perspectives and actions in consumption behaviors were studied for a better understanding of how one can contribute or responds towards the call of SDGs actions. The introduction chapter will explain why this series of studies were conducted in Indonesia and briefly elaborate on the structure of typical Indonesian household consumptions.

This essay complies with three case studies that addressed different targets of SDGs. The first study is the *Effect of building types and materials on household electricity consumption in Indonesia*. This study examines the necessity type of consumption, which is electricity. It is an association type of research using Blinder-Oaxaca decomposition (O.D.) and Firpo, Fortin, and Lemieux (FFL) decomposition methods to decompose the changes in electricity consumption of households and its relationship to the residential housing building types. It addressed the SDG goal number 7 on affordable and clean energy and goal number 11 on sustainable cities and communities. This issue is especially relevant in the context of Indonesia as developing countries with the world 4th largest population that strive to provide a full national electrification rate. With the tremendous growth from 54% in the year 2005, Indonesia had successfully achieved a 98.86% electrification rate in the year 2019. The situation of high growth in electricity demands that stressed on the stable and reliable supply of electricity also raise an alert to balance out this high raised demands with some mitigation approaches that could be plausible through the utilization of traditional residential housing that leads to the study of this chapter. As the finding from this study, utilizing natural material residential buildings are associated with a slightly lower increase in household electricity consumption from 2007 to 2011. This finding is valid in

both urban and rural regions when we look at the mean consumption. It is also found to be true even among the top quantile electricity users in urban areas.

The second study is *Do Fishery Levies Abolition Policy Indirectly Impact on Animal Protein Intake in Indonesia?*. This study examines the comfort types of consumption. Fish consumption is regarded as "comfort" to human needs in this context, as it is one of the many food varieties that open to individual choice. Fish consumption is not a "necessity" that will raise a problem in a sustainable development context. Yet, given with the high nutritious level fish can provide to a human being, from the long-term health perspective, it is more desirable for an ordinary individual to have fish intake in maintaining a balanced diet habit. This second study takes in the opportunities provided by the quasi-experiment context where some of the provinces in Indonesia established the fishery levies abolition policy to explore the causal impact of it on Indonesia's household fish consumption. Thus, this chapter addressed the SDG goal number 2 on zero hunger, and goal number 3 on good health and well-being. The findings from this study show that fishery levies abolition leads to a reduction in fish price, which further leads to a small increase in the physical consumption quantity of fresh fish with a decrease in monetary expenditure on fresh fish. At the same time, it also increased both the physical and monetary consumption of chicken/duck meat. This finding may shed light on plausible effective methods for the policymaker to encourage healthier food consumption in pursuing SDG goal 3.

The third study is the *Long-term impacts of fetal origin exposure to tobacco smoke on the individual*. This study examines the luxury types of consumption, which is tobacco consumption among Indonesia households. In this study, it is attempted to verify the negative consequences of one of the most commonly found household consumption in Indonesia, which is neither beneficial nor necessarily for living. This chapter addressed the SDG goal number 3 on good health and well-being as tobacco consumption only leads to adverse health impact and create extra burdens on household consumption. The tobacco consumption of family members during the maternal pregnancy period can lead to the early life fetal origin type exposure of tobacco smoke. These exposures were found to be executing a long-term impact on the fetus even after they were in schooling age. As a result, exposure to tobacco smoke is associated with a negative effect on language abilities. However, the gaps were fade for the Indonesian language once they entered junior high school, while maths and English language scores are still found to be lower when the ratio of smokers among family members are higher. Since the negative impacts are found on tobacco consumption, the high prevalence rate of smoking among male Indonesian today is alarming the policymaker to interfere with the market for desirable outcomes.

In this essay, all three studies were approach and analyze using secondary data sources from the Central Bureau of Statistics (BPS) of Indonesia, National Socio-Economic Surveys (SUSENAS) data, and Research ANd Development (RAND) corporation, Indonesia Family Life Survey (IFLS) data. The unit of analysis was mainly on a household unit basis with the individual outcome were examine in the third study. Although each of these studies has different objectives and research questions, they were all related to the household consumption point of view.

With the findings of all these three cases, a concluding chapter is made in comparison with other countries' situations of household consumption to highlight the stands of Indonesia on the current point. Since individual involvement in the achievement of SDG is crucially contributing to the success of SDGs, the decision making in the regulation formulation or encouragement policy shall be examined and take consideration from a household behavioral and consumption as well.

Acknowledgements

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List of Abbreviations

BD	Blinder-Oaxaca Decomposition
BPS	*Badan Pusat Statistik* / Central Bureau of Statistics
CPI	Consumer Price Index
CV	Cross-Validation
EBTANAS	Evaluasi Belajar Tahap Akhir Nasional
ETS	Exposure to Tobacco Smoke
FFL	Firpo, Fortin, and Lemieux
KTR	*Kawasan Tanpa Rokok* / Smoke free zone
IFLS	Indonesia Family Life Survey
LBW	Low Birth Weight
MDG	Millenium Development Goal
PLN	*Perusahaan Listrik Negara*
RAND	Research ANd Development corporation
SDG	Sustainable Development Goal
SGA	Small for Gestational Age
SHS	Second-hand Smoke
SUSENAS	*Survei Sosial Ekonomi Nasional* / National Socio-Economic Surveys
U.N.	United Nation
UAN	Ujian Akhir Nasional
UHI	Urban Heat Island
UN	Ujian Nasional
WEIRD	Western, Educated, Industrialized, Rich, and Democratic

1 Introduction

1.1 Background

Households as the smallest social units playing vital roles, especially when reacting to the called of regulators or policymakers for policy implementation. The studies of household consumptions with sustainable development are not rare in the literature. Under goal number 12 of SDGs, responsible consumption and production, several studies were attempts to studies the household behavioral and rational in their consumption behavior. Sustainability issues were brought to the context since the generation of Millenium Development Goals (MDGs) or even before. For instances, Limits to Growth (1972) and Our Common Future (1987) are some of the most remarkable archives that serve as the milestone in the development of the ideology of sustainability.

Academically, sustainable consumption has also been tremendously studied from different types of perspectives, as such from the determinants, triggers or causes side like mindfulness psychological perspective, dilemmas choices and behavioral norms, or the output evaluation side like indicators and implication (Bartolj et al., 2018; Caeiro et al., 2012; Fischer et al., 2017; Peattie, 2010; Spangenberg & Lorek, 2002; Vringer et al., 2017). These series of studies mainly focused on the western, educated, industrialized, rich, and democratic (WEIRD) countries and gradually expanded to developing countries, although still within the limited range in energy consumption aspects (Cobbinah et al., 2015; Oseni, 2012; Salo et al., 2016; Zhou et al., 2008).

Unlike these series of studies that concern on the sustainable consumption within households, in this dissertation, it is merely three different studies that brought together under a big frame of household consumption. The decision and allocation of the available household budget to all different categories of consumption of which are a necessity, luxury, or inferiors can tell us the rationale of decision making in households. These three chapters individually demonstrated how households could have reacted or already reacted to different SDG goals besides goal number 12. Thus, the research gaps addressed, and specific research objectives will only be discussed in detail under each chapter.

1.2 Indonesia as target of study

Indonesia is the country selected for all these three case studies in this dissertation. Before moving on to the specific reasons why Indonesia served as a good selection of geographic areas under different chapters and specific research objectives motivated viewpoint, in this section, some key common characteristics of significances of Indonesia will be discussed under this section.

According to world bank (2020) statistics, Indonesia ranked as the fourth populous country, with 267,663 million population in the year 2018. Given the rapid economic growth with average annual GDP growth at 5.5% over the last 18 years in the period of 2000 to 2018, the urbanization and average purchasing power parity of Indonesian had greatly increased. Thus, Indonesian households under such an emerging economy can serve as a great representative of developing countries in studying the structures and breakdown of household consumptions. Furthermore, the nature of Indonesia as archipelago that consists of about 6000 inhabitants islands also hampering the inequality in national economic development. These geographical barriers create heterogeneity and urban-rural disparity, which were taken into account into case studies, and derives some meaningful results.

1.3 Typical Indonesian Household Consumptions

An intuitive short descriptive statistics were generated from SUSENAS 2014 data to provide a quick overview of a typical Indonesia household's final consumption structures. SUSENAS is a national representative survey conducted by the BPS with repeated cross-sectional basis except for the year 2008 to the year 2010, where they once collected a panel household data. This quick short descriptive is calculated using the SUSENAS module surveys of household expenditures. By defaults, the household consumption data were collected on two major sections: (i) food and (ii) non-food. Nine main staples and non-staples food categories were included under the food section. At the same time, the consumptions were approached on both physical and monetary quantities on a self-production and purchasing basis. Meanwhile, six main categories were included under the non-food section.

On average, Indonesian household's monthly expenditure is IDR 2,884,858 (approx.. USD 210). After deducting the rare or infrequent expenses as such for housing renovation or vehicle purchases that recorded on an annual basis, the monthly expenditure value is reduced to IDR 2,822,725 (approx. USD205). The breakdown of the ratio of expenditures by category in four quantile households is shown in Table 1.1.

Table 1.1: Descriptive statistics of household consumption/expenditures in 2014 based on SUSENAS data

	Household Consumption/Expenditures				
VARIABLES	**Mean**	**Q1**	**Q2**	**Q3**	**Q4**
Monthly total expenditures in IDR	2,884,858	1,013,590	1,767,186	2,662,407	6,096,247
Monthly total expenditures in IDR (exclude non-frequent expenses)	2,822,725	1,013,360	1,766,089	2,657,256	5,854,194
Ratio of food expenditure over total expenditure	59.05	65.21	63.07	59.33	48.60
Ratio of non-food expenditure over total expenditure	40.95	34.79	36.93	40.67	51.40
Ratio of tobacco expenditure over total expenditure	1.70	1.44	1.93	1.99	1.46
Ratio of utilities over total expenditure	8.29	9.01	8.18	8.02	7.96
Ratio of electricity consumption over total expenditure	2.46	2.47	2.32	2.42	2.64
Number of Observation	285,400	71,350	71,350	71,350	71,350

Notes: The ratios are count based on information recorded in SUSENAS 2014 data. It is reported instead of raw value for a quick understanding of the portion of consumption structures. IDR exchange rate to USD is approximate at 1 USD equal to 13,737 IDR in the year 2014.

Among all the aspects, food expenditure remains the largest expenditure for Indonesian households, which is similar to most of the developing countries' situation. When we breakdown the households into four quantiles based on their monthly spending as shown in Fig.1, we can see that the mean of the ratio of food expenditures over total monthly expenditures are ranged between 47.71% to 65.2%. Even for the fourth quantiles households, food expenditures remains as the highest expenditure for most of them. In extreme cases, 98.7% of spending was on food, which is recorded in Papua provinces, the poorest province of Indonesia, where the non-food expenditure is only for energy (firewood) and self-cleansing (shampoo and detergent). Whereas, as a benchmark comparison, in households from developed countries like the U.S., the ratio of mean food expenditure is 12.6%, and 24% for Japan (BLS, 2016; eStat, 2015).

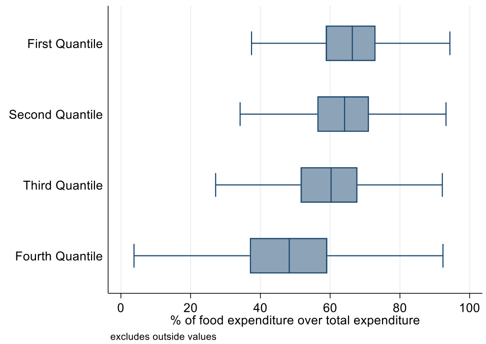


Figure 1-1: Ratio of Food Expenditures for Four Quantiles Households

The significance of food spending is not just for zero hunger, yet the rationale for food choice is closely related to health issues in terms of balanced nutrition diets. Thus, this is linked to the second case study that examines the policy impacts on food items pricing to the food consumption of households. This sheds the possibility for policymakers to influence or intervene in the desirable's food choice to achieve a healthy diet of a citizen.

Next, energy consumption complies with 8.3% of the total monthly expenditure. In this category, a low disparity between households from different quantiles can be seen. Energy/utility expenses for Indonesian household ranges between 8% to 9%, and quite similar to those households from developed countries, in which U.S. households spent 7%, and Japan households spent 8% in it. However, when we scope down the energy type to electricity, the expenditures are only around 2.4%, which is reasonable as only 84.35% electrification rate is achieved in the year 2014 (PT PLN, 2019). Electricity is considered as basic human needs and necessity, SDG goals number 7, affordable and clean energy, spells the rights of everyone to access for clean energy. However, the natural geography of Indonesia is challenging for policymakers to provides electrification to all citizens. With the increase in electricity demand year to year, while the supplies might not be able to cope up as quickly as the demand, some alternate mitigation strategies were needed, as well as to the sustainable electricity consumption. Thus, electricity consumption is closely related to the first case study that decomposes the increase in electricity consumption from 2007 to 2011 with its relation to residential building types.

Lastly, undesirable or harmful goods as such alcohol and tobacco consumption are being examined. Indonesia, as a country with a dominant muslim population, doesn't have the problems of excessive alcohol consumption in general. Yet, tobacco consumption and smoking prevalence rate is considerably higher than average countries. According to WHO (2015), the smoking prevalence rate among persons aged 15 years and older for a male is 76.2%, and for a female is 3.6%. By looking SUSENAS 2014 data, 67.4% of households are reported with tobacco consumption. By excluding the zero consumption households, it ranges between 2.14% to 2.7% of total expenditure, which is about IDR 27.9k to 109.4k per month. Figure 1.2 shows that even for the lowest quantile households, the median spending is still more than 2%.

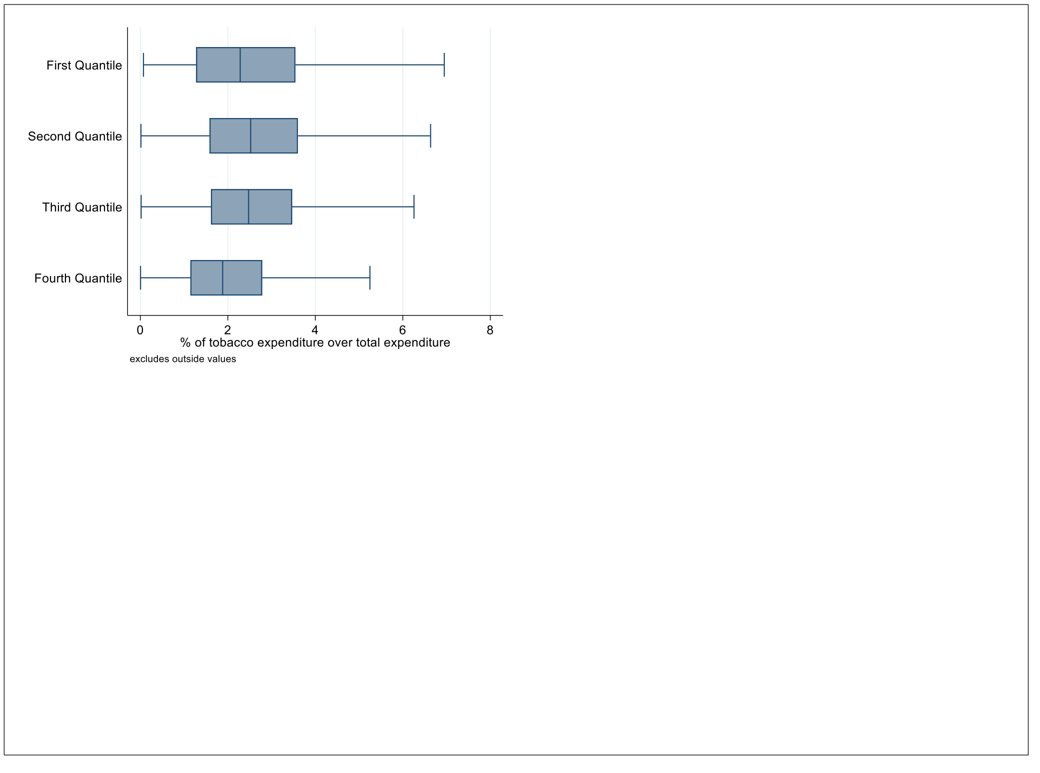


Figure 1-2: Ratio of Tobacco Expenditure for Four Quantiles Households

Meanwhile, there also had been studies reported the negative association of tobacco with other household expenditures in Bangladesh as a representative of a developing country, and lower socioeconomic status households spend more in tobacco compare to their counterparts in the U.S. as representing a developed country (Husain et al., 2018; Siahpush et al., 2018). Thus, in the third case study, the negative impacts of tobacco smoke exposure to the fetus after an individual grow up are studied to documents the undesirable situation. The high prevalence of tobacco consumption alarmed the need for the intervention of policymakers since households are not actively reacted to and responded to it for the SDG goals number 3 that highlight the importance of good health and well being.

1.4 Dissertation Structures

Chapter 1 provides the introduction to household consumptions, its connection with SDGs goals, the general background of Indonesia, and a simple discussion of a typical household consumption structure breakdowns in Indonesia based on SUSENAS year 2014 data.

The following structures of the dissertations will consist of the three central case studies from chapter 2 to chapter 4 that took place in Indonesia with different research questions and purposes.

Chapter 2: "*Effects of building types and materials on household electricity consumption in Indonesia*".

Chapter 3: *"Do fishery levies abolition policy indirectly impact on animal protein intake in Indonesia?"*

Chapter 4: *"Long-term impacts of fetal origin exposure to tobacco smoke on the individual."*

Although limited discussion and connection with SDGs were made in each of the branches of case studies, a overall conclusion in chapter 5 will link them back to the SDGs cores and talks about how households can more proactively contribute to the common goals of the global nation.

2 Effects of building types and materials on household electricity consumption in Indonesia

2.1 Introduction

Income is a primary force driving changes in residential electricity consumption in developing countries; increased income is typically accompanied by increased ownership of home appliances, leading to lifestyle and behavioral changes and an increase in residential electricity demand. Evidence suggests that as people in tropical regions become wealthier, they tend to increasingly rely on air conditioning to achieve indoor thermal comfort (Davis & Gertler, 2015; G. Y. Yun & Steemers, 2011), but an increase in income (in the context of urbanization and rapid economic growth) often also leads to changes in the way residential houses are constructed. The implications for the residential electricity demand due to changes in the design and structure of residential buildings can vary in both direction and magnitude depending on the location, floor space and type of building materials used for construction(Santamouris, 2016; Singh & Sadhu, 2019).

Residents often take two broad approaches to improve indoor thermal comfort in tropical climates (Latha et al., 2015). The first is the use of mechanical cooling devices, typically electric air conditioners as noted above, that not only result in increased electricity demand but also significant amounts of air conditioner heat exhaust, which may further increase electricity demand for thermal comfort (by intensifying the urban heat island (UHI) effect). The second approach is to rely on passive cooling techniques, of which there are many (Samuel et al., 2013; Santamouris, 2007; Santamouris & Kolokotsa, 2013). In fact, many passive techniques have been developed based on the use of natural building materials and/or the appropriate structural design of buildings and some of these passive techniques are effective in tropical climates(Santamouris & Kolokotsa, 2013; Sharifi & Yamagata, 2015). These passive approaches have proven to be effective in curbing the increase in residential electricity consumption (Cicelsky & Meir, 2014; Daghigh, 2015; Latha et al., 2015; Osman & Sevinc, 2019; Ran & Tang, 2018; Roslan et al., 2016).

The use of these passive cooling techniques to achieve thermal comfort is not a completely new concept as such approaches have been frequently applied to the design and construction of traditional buildings and communities(Bahadori, 1978; Hatamipour & Abedi, 2008; John et al., 2005; Zhai & Previtali, 2010). For example, Chong (2012) argued that older residential buildings built prior to the 1970s in southern California consumed less electricity than newer buildings constructed under stringent building energy codes. Chong (2012) explained that one plausible reason for the higher electricity consumption in the new buildings is differences in thermal design that resulted from less passive shading, more structural complexity, and a higher ceiling.

Meanwhile, Hatamipour and Abedi (2008) examined traditional buildings in southern Iran and found that indoor comfort could be achieved with wooden window frames or wooden roofs covered with leaves and mud. Moreover, Michael et al. (2017) conducted a study regarding the influence of natural ventilation on the indoor thermal comfort of vernacular buildings in Cyprus. Results demonstrate the effectiveness of natural ventilation as a passive technique. Santamouris et al. (2010) quantified the absolute energy contribution of nocturnal ventilation to the electricity demand of vernacular residential buildings in Greece and concluded that the cooling load reduction can reach 40 $kWh/m^2/y$ and that the mean contribution is 12 $kWh/m^2/y$.

In tropical climates, Nguyen et al.(2011) found that vernacular design techniques consisting of brick walls and clay tile roof tops, in combination with natural ventilation and building orientation strategies, were fairly adapted to the local climatic conditions and provide reasonable energy saving benefits.. A study at Kerala, India during summer by Dili et al.(2011) also reported that traditional buildings made from clay tile roofs and wooden ceilings have high thermal insulation properties and better low-temperature control that provides evaporative cooling to the occupants. In Thailand, Chiraratananon and Hien (2011) compared a traditional type of wall material with low thermal mass properties to a modern type with high thermal mass properties and highlighted the thermal benefits of vernacular housing. While not all previous studies have focused on old and traditional buildings, they consistently demonstrate the significance of natural ventilation and wooden materials for reducing the residential electricity consumption in vernacular residential buildings.

However, all these findings were derived from a single case or small-scale in-situ measurements that do not necessarily represent the national situation. While we highlight our findings from a macro perspective, our objective in this paper is to analyze the quantile effects of natural ventilation and wooden materials on household electricity consumption. We intend to study the quantile effects in the context of a rapidly growing economy in a tropical climate, where residential electricity demand is sharply increasing in parallel to socio-demographic changes, to understand the implications for the regulatory policy framework of residential buildings and urbanization. "Quantile effects" in this context refer to the disparity in the growth of electricity consumption and the strength or direction of the correlation coefficients between the growth determinates, among different quantile users. To the best of our knowledge, there is no such study in the literature. Accordingly, we take Indonesia as the first case as its economy has been steadily growing over the last decade, and it has the largest population among the ASEAN countries.

As a preliminary effort to address this issue, we use two waves of nationally representative household surveys, i.e., the National Socio-Economic Surveys (SUSENAS) core and module surveys of 2007 and 2011, and we apply the Blinder-Oaxaca (BD) and the Firpo, Fortin and Lemieux (FFL) decomposition analyses (Firpo et al., 2009; Oaxaca, 1973) to examine the quantile changes in electricity consumption. The former captures the effects of the changes/differences in covariates and their coefficients on the changes/differences in the mean household electricity consumption, whereas the latter captures these effects on the changes/differences in quantiles of household electricity consumption. Here, as a determinant of household electricity consumption, the type of material used in residential buildings is included in the covariates. These decomposition analyses have been applied in various fields of study, such as the study of wage inequality in economics (S. Ahmed & McGillivray, 2015; Longhi et al., 2013; Sakellariou, 2012), but to the best of our knowledge, no study has applied these methods to estimate the changes in household electricity consumption.The remainder of this paper is structured as follows. The next section provides the contextual background of Indonesia, followed by a summary of the major factors affecting household electricity consumption in Section 2.3. Details on materials and methods are presented in Section 2.4.Section 2.5 reports the major results. In the concluding section, a synthesis of the discussions is provided and some possible future studies are discussed.

2.2 Background - Indonesia as a case study

While countries such as China and India have received significant attention in global discussions on sustainable development, Indonesia, as the 4^{th} most populous nation in the world, is also worthy of attention. During the period from 2000 to 2017, the total population of Indonesia increased from 211.5 million to 263.9 million at an annual average growth rate of 1.31%. Parallel to the population growth, the GDP has also grown at an average annual growth rate of 5.28% leading to a GDP per capita of $3,846 (The World Bank, 2018). The steady economic growth triggers and enhances the urbanization, electrification and electricity demand of the nation. The rapid improvements in the household electrification rate from 52% in 2001 to 95% in 2017 has resulted in the continuous growth of residential electricity consumption at an average annual growth rate of 6.31% (ESDM, 2018). To cope with the great increase in electricity demand, the Indonesian government has built more power plants and imports electricity from its neighbor, Malaysia (Hasnie, 2017).

At the same time, there could be several possible means to mitigate the sharp increase in residential electricity consumption, such as the promotion of high-efficiency electric appliances, environmental education to encourage energy-saving behavior, introduction of stricter building codes for greater energy efficiency, and so on. Among them, vernacular and climate-compatible building design with natural materials can be a viable approach for Indonesia, as the country is in a tropical and humid climate region with rich natural resources.

As a fire prevention measure, the Indonesian government encourages replacing traditional buildings made of natural materials with modern concrete buildings (BAPPENAS, 1991); moreover, the use of natural materials for building construction is an indicator of poverty. Therefore, as a poverty eradication measure and to perform better in terms of the overall regional development index, local governments tend to minimize the number of traditional buildings made of natural materials (Isdijoso et al., 2016; Pemerintah Kota Batam, 2014). Consequently, there are institutional factors that drive a transition from traditional to modern residential housing on the one hand, while on the other hand, some concerned architects and communities acknowledge the benefits that traditional vernacular buildings made of natural materials can offer with regard to indoor thermal comfort and reducing energy demand (Juwono, 2017; Santy et al., 2017; Utama & Gheewala, 2009).

As a case in point, different perspectives on whether to choose traditional or modern residential housing were observed during the post-disaster reconstruction activities in Aceh (after the 2004 tsunami) and Yogyakarta (after the 2006 earthquake). Stone and concrete are the main materials used for the reconstruction of residential buildings in Aceh, mainly due to the preference of local communities for modern buildings, the pressure felt by the local government to complete the reconstruction of a certain number of houses within a specified time period[1], and the environmental concern of donors regarding the excessive use of local timber (Kennedy et al., 2008). However, a large number of reconstructed houses had to be demolished and rebuilt due to quality control

[1] Stone and concrete materials are considered readily available, but legal sources of timber are lacking.

failures after a couple of years[2] (Chang et al., 2010). In Yogyakarta by contrast, in addition to the lessons learned in Aceh, local communities showed a strong desire to conserve the traditional architecture and cultural heritage, locally known as Joglo (Prihatmaji et al., 2014), so the donors also attempted to satisfy their preferences. Consequently, traditional buildings made of local natural materials dominate the reconstructed houses in Yogyakarta (The World Bank, 2012), and the step-by-step reconstruction of residential buildings from temporary and makeshift shelters made of locally available bamboo, mud and wood to advanced green buildings constructed from local natural materials is considered a success. Unlike the case of Aceh, the reconstructed (traditional) residential buildings in the disaster-affected areas are expected to be used by the residents without the need for demolition after a short period of time (I. Ahmed & O'Brien, 2009); furthermore, these traditional buildings with natural roof materials are usually lightweight and thus demonstrate satisfactory seismic resistance (The World Bank, 2012). Moreover, the use of local natural materials results in improved environmental performances by not only facilitating passive cooling, but also reducing life-cycle environmental impacts (I. Ahmed & O'Brien, 2009; Utama & Gheewala, 2009).

Amid these circumstances, the stock dynamics of residential buildings and their collective implications for residential electricity demand in Indonesia, as a rapidly growing and urbanizing country, are unknown and warrant empirical examination. Therefore, cases in this country provide a great opportunity to empirically demonstrate the energy saving properties and potentials of residential buildings that employ passive cooling features. Although several studies have investigated the energy implications of building materials and building designs in tropical climates, the lack of macro scale analyses remains a challenge as most of these investigations are case studies of individual or a limited number of buildings (Chiraratananon & Hien, 2011; Dili et al., 2011; Juwono, 2017; Nguyen et al., 2011; Santy et al., 2017; Toe & Kubota, 2015; Utama & Gheewala, 2009). Therefore, the focus of our paper is on examining the situation from a macro perspective, through which we attempt to capture the general changes in the residential building stock in Indonesia and the impacts on the residential electricity demand.

2.3 Factors affecting household electricity consumption

In this section we briefly review studies that examine factors affecting residential electricity

[2] A large number of reconstructed houses are reported to be of low quality and do not last long.

consumption and identify those that can be used for the purpose of this study. There is a broad consensus in the literature that factors affecting household energy consumption can be classified into four major categories: i) socioeconomic, ii) demographic, iii) building and appliance, and iv) climatic conditions (Jones et al., 2015; McLoughlin et al., 2012; Williams & Gomez, 2016; G. Y. Yun & Steemers, 2011). Climatic or geographical factors are mainly applied in seasonal countries (Abreu et al., 2012; Bartusch et al., 2012; Motlagh et al., 2015) and are thus excluded from this study due to the absence of seasonal variations in Indonesia. Meanwhile, the existence and usage of electrical appliances are also excluded due to unavailability of data in SUSENAS 2007. The detailed justification of determinants selected to be included in this study is available in the supplementary appendix, while the descriptive statistics, mean value of each variable, are shown in Table 2.1.

Table 2.1: Descriptive statistics of the factors used for the analyses in this study

	2007		2011	
VARIABLES	Urban	Rural	Urban	Rural
<u>Building Factors</u>	1.1	1.2	1.3	1.4
Log of floor width in square meters	1.54.091	1.74.105	1.94.066	1.114.050
	1.6(0.776)	1.8(0.585)	1.10(0.707)	1.12(0.558)
Building ownership	1.130.722	1.150.889	1.170.694	1.190.864
	1.14(0.448)	1.16(0.314)	1.18(0.461)	1.20(0.343)
1.21 1.22 1.23	1			
Building Types	1.25	1.26	1.27	1.28
Natural material	1.290.019	1.310.053	1.330.019	1.350.048
	1.30(0.135)	1.32(0.224)	1.34(0.135)	1.36(0.213)
Clay tile I	1.370.070	1.390.199	1.410.052	1.430.139
	1.38(0.255)	1.40(0.399)	1.42(0.222)	1.44(0.346)
Zinc	1.450.273	1.470.336	1.490.394	1.510.469
	1.46(0.445)	1.48(0.472)	1.50(0.489)	1.52(0.499)
Clay tile II	1.530.523	1.550.349	1.570.426	1.590.263
	1.54(0.499)	1.56(0.477)	1.58(0.494)	1.60(0.440)
Concrete	1.610.095	1.630.023	1.650.088	1.670.033
	1.62(0.294)	1.64(0.150)	1.66(0.283)	1.68(0.178)
Others	1.690.020	1.710.040	1.730.022	1.750.048
	1.70(0.140)	1.72(0.196)	1.74(0.148)	1.76(0.215)
1.77 1.78 1.79	1			
<u>Demographic Factors</u>	1.81	1.82	1.83	1.84
Family size	1.854.214	1.874.104	1.893.934	1.913.937
	1.86(1.744)	1.88(1.708)	1.90(1.775)	1.92(1.738)
Household head educational level	1.939.244	1.956.824	1.979.625	1.997.328
	1.94(4.015)	1.96(3.542)	1.98(3.957)	1.100(3.521)
Number of children aged 0 to 4	1.1010.387	1.1030.385	1.1050.369	1.1070.383
	1.102(0.593)	1.104(0.583)	1.106(0.581)	1.108(0.587)
Number of school-aged children ≤ 18	1.1090.952	1.1110.917	1.1130.866	1.1150.890
	1.110(1.052)	1.112(0.996)	1.114(1.003)	1.116(1.011)

Presence of elderly members	1.1170.148	1.1190.188	1.1210.138	1.1230.171
	1.118(0.355)	1.120(0.391)	1.122(0.345)	1.124(0.377)
Household head age	1.12546.778	1.12747.969	1.12945.963	1.13147.115
	1.126(13.280)	1.128(13.823)	1.130(13.719)	1.132(13.985)
Household head job sectors	1.133	1.134	1.135	1.136
Agricultural sector	1.1370.121	1.1390.544	1.1410.139	1.1430.562
	1.138(0.326)	1.140(0.498)	1.142(0.346)	1.144(0.496)
Public sector	1.1450.315	1.1470.143	1.1490.294	1.1510.126
	1.146(0.465)	1.148(0.351)	1.150(0.456)	1.152(0.331)
Industrial sector	1.1530.211	1.1550.094	1.1570.211	1.1590.092
	1.154(0.408)	1.156(0.292)	1.158(0.408)	1.160(0.289)
Service sector	1.1610.194	1.1630.124	1.1650.198	1.1670.126
	1.162(0.395)	1.164(0.329)	1.166(0.398)	1.168(0.331)
1.169 1.170 1.171	1			
Socioeconomic Factors	1.173	1.174	1.175	1.176
Log of monthly rent for building (IDR in	1.17710.716	1.1799.686	1.18110.965	1.18310.084
2011 real terms)	1.178(1.053)	1.180(0.879)	1.182(0.981)	1.184(0.890)
RASKIN program subsidy receivers	1.1850.179	1.1870.349	1.1890.336	1.1910.580
	1.186(0.383)	1.188(0.477)	1.190(0.472)	1.192(0.493)
Log of non-food expenditures (IDR in 2011	1.19312.315	1.19511.559	1.19712.453	1.19911.820
real terms)	1.194(0.857)	1.196(0.753)	1.198(0.926)	1.200(0.832)
Log of food expenditures (IDR in 2011 real	1.20112.522	1.20312.244	1.20512.562	1.20712.334
terms)	1.202(0.503)	1.204(0.452)	1.206(0.608)	1.208(0.583)
1.209 1.210 1.211	1			
Observations	25,261	32,317	28,000	33,101

Notes: Values reported in this table is the mean value for each respective variable. Columns (1) and (2) show the statistics of the urban and rural groups in 2007, respectively, whereas Columns (3) and (4) show the statistics in 2011. Building ownership, building type, presence of elderly members, household head job sector, and RASKIN program subsidy receivers are dummy variables. Standard deviations are shown in parentheses. 1 IDR is equal to 0.000111 USD in January 2011 (source: X-Rates.com).

For the purpose of this study, we specifically defined the five most common residential building categories (in Indonesia) considering the main building materials and the common structural designs. By using combinations of factors such as the types of roof and wall materials, the thermal mass of materials, the level of natural ventilation, and the extent of nocturnal passive cooling, these five residential building categories were carefully defined. We also use the stipulations of the Division of Building and Construction Technology (1998), Szokolay (2008), and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) (2009) to extract the thermal mass capacity and U-values of the materials. The five building types are named based on the main rooftop material as follows: (i) *natural material*, (ii) *clay tile I*, (iii) *zinc*, (iv) *clay tile II*, and (v) *concrete*. The basic characteristics of each building type are summarized in Table 2.2.

Table 2.2: Building types and their key thermal properties (the source of all figures is Google Maps)

1. Natural Material		
Main roof materials	Straw, leaves or wood shingles	

Main wall materials	Wood or bamboo	
Thermal mass	Lowest	
Natural air ventilation	Highest	
Night-time passive cooling	High	
2. Clay Tile I		
Main roof materials	Tiles	
Main wall materials	Wood or bamboo	
Thermal mass	Low	
Natural air ventilation	High	
Night-time passive cooling	Medium	
3. Zinc		
Main roof materials	Zinc	
Main wall materials	Wood, bamboo, bricks, etc.	
Thermal mass	Medium	
Natural air ventilation	Medium	
Night-time passive cooling	Highest	
4. Clay Tile II		
Main roof materials	Tiles	
Main wall materials	Bricks	
Thermal mass	High	
Natural air ventilation	Low	
Night-time passive cooling	Low	
5. Concrete		
Main roof materials	Concrete or asbestos	
Main wall materials	Bricks	
Thermal mass	High	
Natural air ventilation	Lowest	
Night-time passive cooling	Lowest	
6. Others		
Main roof materials	Various	-
Main wall materials	Various	
Thermal mass	Various	
Natural air ventilation	Various	
Night-time passive cooling	Various	

Notes: All the characteristics are summarized by referring to the Division of Building and Construction Technology (1998), Szokolay(2008), and ASHRAE (2009). The photos are screenshots from Google Maps (2017).

Natural material and *clay tile I* are traditional types of housing made of wood or bamboo walls; the only difference between them is the rooftop material, which consists of straw leaves or wood shingles for the former and clay tiles for the latter. These traditional houses are usually regarded as good in terms of natural ventilation as well as heat absorption and release functions, so these types perform well in terms of passive cooling. The variation in indoor temperature in these buildings is much lower than that of the outdoor temperature, but since these types are not airtight and have a lower thermal mass property, high amounts of electricity may be consumed to achieve thermal comfort in daytime. For instance, heavy electricity users in the upper quantile, who are also the most intensive air conditioner users, may further increase their reliance on mechanical cooling devices on a hot day, thus leading to high electricity consumption and demand.

Zinc is designated as a separate type due to the specific heat transfer properties of zinc roofs in combination with any wall material. Among the common materials used in Indonesian housing, *zinc* is the material with the highest heat conductivity. Although *zinc* is desirable for achieving passive cooling at night, it leads to the highest indoor temperature during the day (compared with other rooftop materials).

Among the five building types, *clay tile II*, which uses clay tiles for the rooftop and bricks for the walls, is the most common, and it is characterized by high thermal mass, low R-value (high conductivity), and high heat absorption capacity. Similar to *clay tile II*, the *concrete* type has concrete or asbestos for the rooftop and bricks for the walls and also exhibits relatively higher thermal mass than the other types. *Concrete's* high air-tightness contributes to reducing the electricity consumption for air conditioning by maintaining the desirable indoor temperature for a longer period of time, but due to the heat island phenomenon, the property of higher indoor temperature inertia might lead to high electricity demand for air conditioning during tropical nights(Arifwidodo & Chandrasiri, 2015).

Finally, all the less popular miscellaneous combinations of rooftop and wall materials are defined as *others*. From the Table 1, we can see that occupants of *clay tile II* made up 52.3% of urban households in 2007 and then faced a small reduction but remained the largest group among urban households in 2011 at 42.6%. Among the rural households, *clay tile II* occupants were once the largest groups in 2007 at 34.9%, but the proportion declined to 26.3% in 2011. The *zinc* building type, at 46.9%, was the largest group among the rural households in 2011.

The *natural material* building type in urban areas remained constant at 1.9%, but declined by 0.5% in rural regions from 2007 to 2011. *Clay tile I* and *clay tile II* declined over time in both urban and rural regions, whereas *zinc* increased by 12.1% among urban households and 13.3% among rural occupants. The *concrete* building stock was decreased by 0.7% among urban areas and increased by 1% among rural regions.

2.4 Data and methodology

2.4.1 Data

This study utilizes data from the SUSENAS core and module surveys of 2007 and 2011. SUSENAS is a national representative survey conducted by the Central Bureau of Statistics (BPS). The classification of urban and rural household was based on the SUSENAS default settings. The total number of observations in the dataset is 125,981 repeated cross-sectional households (57,578 for 2007 and 61,101 for 2011). After the data cleaning process[3], the final number of observations used in our data analysis was 118,679. Details of the data sources and data processing information can be found in the supplementary appendix, section (ii). The average household electricity consumption values (in both log and monetary form) and the differences between the 2007 and 2011 values are reported in Table 2.3.

Table 2.3: Average household electricity consumption per capita in both log and monetary form

	Household Electricity Consumption per Capita					
	Log form			Monetary form (IDR in 2011 real term)		
VARIABLES	2007	2011	Differences (2011-2007)	2007	2011	Differences (2011-2007)
Panel A: All households						
1.213 Mean	1.2149.089	1.2159.437	1.216.348	1.21714,266.52	1.21818,616.12	1.2194,349.59
1.220	1.221	1.222	1.223(.006)	1.224	1.225	1.226(149.56)
1.227 10th Quantile	1.2287.909	1.2298.407	1.230.498	1.2312,722.28	1.2324,477.11	1.2331,754.84
1.234	1.235	1.236	1.237(.009)	1.238	1.239	1.240(34.53)
1.241 50th Quantile	1.2429.074	1.2439.413	1.244.340	1.2458,721.45	1.24612,249.09	1.2473,527.63
1.248	1.249	1.250	1.251(.007)	1.252	1.253	1.254(76.54)
1.255 90th Quantile	1.25610.324	1.25710.528	1.258.204	1.25930,463.65	1.26037,345.50	1.2616,881.85
	1.262	1.263	1.264(.011)	1.266	1.267	1.268(387.94)
			1.265			
Observations	1.26957,578	1.27061,101	1.271	1.27257,578	1.27361,101	1.274
Panel B: Urban households						
1.275 Mean	1.2769.434	1.2779.754	1.278.319	1.27919,082.68	1.28024,956.32	1.2815,873.64
1.282	1.283	1.284	1.285(.008)	1.286	1.287	1.288(269.00)
1.289 10th Quantile	1.2908.295	1.2918.737	1.292.442	1.2934,003.17	1.2946,228.22	1.2952,225.05
1.296	1.297	1.298	1.299(.014)	1.300	1.301	1.302(76.13)
1.303 50th Quantile	1.3049.443	1.3059.725	1.306.282	1.30712,619.24	1.30816,727.06	1.3094,107.82
1.310	1.311	1.312	1.313(.011)	1.314	1.315	1.316(151.89)

[3] See supplementary appendix for details.

1.317 90th Quantile	1.31810.583	1.31910.822	1.320.240	1.32139,443.21	1.32250,108.57	1.32310,665.35
	1.324	1.325	1.326(.015)	1.327	1.328	1.329(668.41)
Observations	1.33025,261	1.33128,000	1.332	1.33325,261	1.33428,000	1.335
Panel C: Rural households						
1.336 Mean	1.3378.694	1.3389.108	1.339.414	1.3408,745.47	1.34112,031.46	1.3423,285.99
1.343	1.344	1.345	1.346(.007)	1.347	1.348	1.349(94.48)
1.350 10th Quantile	1.3517.662	1.3528.211	1.353.548	1.3542,126.82	1.3553,681.55	1.3561,554.74
1.357	1.358	1.359	1.360(.011)	1.361	1.362	1.363(34.89)
1.364 50th Quantile	1.3658.695	1.3669.103	1.367.407	1.3685,975.48	1.3698,980.58	1.3703,005.10
1.371	1.372	1.373	1.374(.009)	1.375	1.376	1.377(65.81)
1.378 90th Quantile	1.3799.775	1.38010.052	1.381.277	1.38217,581.31	1.38323,202.84	1.3845,621.53
	1.385	1.386	1.387(.012)	1.388	1.389	1.390(267.77)
Observations	1.39132,317	1.39233,101	1.393	1.39432,317	1.39533,101	1.396

Notes: In real terms, the log of household electricity consumption is converted to 2011 prices. The standard error of the mean is in parentheses. 1 IDR is equal to 0.000111 USD in January 2011 (source: X-Rates.com).

The changes in electricity consumption trends are similar in urban and rural regions, but in a different momentum. Across all quantiles, the 2011 average per capita consumption of rural households was lower than the 2007 consumption values of urban households, which highlights the potential for bias if we pool all households together in a single analysis. Furthermore, the disparities in electricity consumption become larger when we separate observations by quantile and region. The urban household electricity consumption in the 10th, 50th, and 90th quantiles increased by 44%, 28%, and 24%, respectively. Whereas, the rural household electricity consumption in the 10th, 50th, and 90th quantiles increased more, by 55%, 41%, and 28% respectively. The percentage point differences in the electricity consumption of urban and rural households of corresponding quantiles are -11% (10th quantile), -13% (50th quantile) and -4% (90th quantile), which further directs us to quantile studies because explanatory variables usually have different effects on the electricity usage of households that depend on its distribution (Huang, 2015). For example, Huang (2015) found that number of elderly members is negatively correlated to electricity consumption among 10th quantile user, but positively correlated to electricity consumption among 90th quantile user.

A larger increase in electricity consumption was found among rural households that could indicate that rural households are catching up to population averages, especially from the lower-quantile groups after income growth. In such a situation, it is more appropriate to analyze urban and rural households separately rather than as one pooled aggregation as their socioeconomic and demographic characteristics are quite different. Additionally, the environment, particularly the outdoor temperature, was also different between the two regions, which would critically influence our interpretation of the results regarding the passive cooling techniques and thermal comfort properties of different building types and materials.

2.4.2 Methodology

This study applied BD and FFL decomposition methods to analyze the disparity that exists in household electricity consumption throughout the years of 2007 and 2011 in Indonesia (Firpo et al., 2009; Oaxaca, 1973). Detailed step-by-step discussions are also provided in the supplementary appendix for readers not familiar with these two decomposition methods.

BD decomposition is a popular framework in labor economics developed by Oaxaca(1973)to analyze race or gender discrimination in terms of the wage differential. The advantages of this methodology lie in its ability to explain the differences between the outcome variable of two groups by decomposing the influences into individual contributions from each independent variable. We conduct the mean BD decomposition to examine, on average, how much of the change in electricity consumption throughout the year is subject to building types and materials. This analysis allows us to decompose the electricity consumption increment to the determinants mentioned in Section 3, which are further classified into two categories as explained below.

The analysis started with a simple ordinary least squares (OLS) regression by groups followed by decomposing each component that leads to differences in the electricity consumption of (1) the urban households and (2) the rural households in 2007 and 2011.

$$Y_{tji} = \beta_{tj0} + \sum_{n=1}^{N} X_{in}\beta_{tjn} + U_{tji}, \tag{2.1}$$

where t = A: 2011, B: 2007 and j = C: urban, D: rural, N is the total number of covariates selected, i represents individual households, and U represents the residual error terms. It is given that E(Utji|Xi = 0), and X is the vector of the covariates Xi = [Xi1,..., Xin]. By taking the differences between the two years for the urban and rural groups, we can obtain the following:

$$\hat{\Delta}_O^{\mu} = \underbrace{\left(\widehat{\beta_{AJ0}} - \widehat{\beta_{BJ0}}\right) + \sum_{n=1}^{N} \overline{X_{AJn}}\left(\widehat{\beta_{AJn}} - \widehat{\beta_{BJn}}\right)}_{\hat{\Delta}_S^{\mu}\ (Coefficient\ effects)} + \underbrace{\sum_{n=1}^{N}\left(\overline{X_{AJn}} - \overline{X_{BJn}}\right)\beta_{BJn}}_{\hat{\Delta}_X^{\mu}\ (Characteristic\ effects)} \tag{2.2}$$

where $\widehat{\beta_{tJ0}}$ and $\widehat{\beta_{tJn}}$ $(n = 1, \ldots, k)$ are the estimated intercept and slope coefficients, respectively. The coefficient effects refer to the return to covariates that identified which of the determinants, such as building types and materials, are more favorable to the changes in electricity consumption.

Coefficient effects can be interpreted as contributions of some other unobservable characteristics that are not directly included in the model, but highly related with other covariates included. For example, thermal mass or natural air ventilation rates of certain building types.

Meanwhile, characteristic effects simply refer to the portion of the variability that can be directly explained by the changes in covariates during the years. As suggested by Yun(2005), we also applied the deviation contrast transform to obtain an unbiased result from categorical variables based on the grand mean. This method avoids the drawback in which the contribution of dummy variables heavily depends on the choice of the base category.

In regard to the differences in variance between quantiles, we apply FFL decomposition with the re-centered influence function (RIF) to estimate the specific effects of each covariate on the unconditional quantiles (UQs) of Indonesian household electricity consumption(Firpo et al., 2009).

$$\mathrm{RIF}\left(Y_{tji}: Q_{\tau}\right) = \beta_{tj0} + \sum_{n=1}^{N} X_{in}\beta_{tjn} + U_{tji} \tag{2.3}$$

The advantage of this approach is that it generates outcomes that are not subject to the other independent variables, which may change in different quantiles through the application of kernel density. The re-estimated quantile value based on the RIF is used to replace the observed outcome value in the OLS equation to construct a counterfactual amount of household electricity consumption. This approach allows us to discover our main interest in how the heterogeneity in certain building types or materials changes across the quantile distribution without a path dependency related to other covariates from demographic or socioeconomics factors.

Note that although we presume that income increase will lead to increase in ownership of air conditioners, thus the electricity consumption which is shown in literature (McNeil & Letschert, 2010; Wolfram et al., 2012), due to the data limitation on air-conditioners ownership, we are not able to directly test this relationship in our equation. Also the precise climatic condition variation and heterogeneity of location are some factors that we are not able to separate out from our coefficient effects parameter. However, we believe such variation from local climatic conditions should be small, as according to the Köppen climate classification, all regions of Indonesia have similar climatic conditions and also no seasonal variations exist. According to our computations based on the statistical data of 34 provinces released by BPS (2017a , 2017b, 2017c), the average temperature is 27.2 ± 0.149 °C, average precipitation is 1871.03 ± 122.82 (mm), average wind velocity is 2.42 ± 0.146 (m/sec), and average humidity is 79.53 ± 0.686 (%).[4]

2.5 Main Results and Discussions

2.5.1 BD decomposition

The OLS coefficients for the main variables, five building types, to electricity consumption are all highly significant with the base group of Clay Tile II building type. The only exception is Concrete building type. The detailed OLS table for all sample, urban sub-sample and rural sub-sample for both years can be found in the supplementary appendix (Table A.1).

To better illustrate the results, a coefficient plot of our unique building factor variables is presented in Figure 2-1, while the BD decomposition results table are shown in Table 2.4. In line with the findings reported in the literature (Esmaeilimoakher et al., 2016; Huebner et al., 2016; McLoughlin et al., 2012; Romero-Jordán et al., 2016; Thogersen & Gronhoj, 2010; Wallis et al., 2016), socioeconomic factors were the main contributors to the differences in electricity consumption followed by demographic factors.

Table 2.4: Average household electricity consumption per capita in both log and monetary form

1.397	**1.398Urban Households**		**1.399Rural Households**	
1.400VARIABLES	**1.401Characteristic Effects**	**1.402Coefficient Effects**	**1.403Characteristic Effects**	**1.404Coefficient Effects**
1.405Percent Differences	**32.22%*** (0.006)**	**67.78%*** (0.006)**	**25.40%*** (0.005)**	**74.60 %*** (0.006)**
<u>Building Factors</u>	1.406	1.407	1.408	1.409
Building Types	1.410	1.411	1.412	1.413
1.414Natural material	1.4150.17%*** (0.000)	1.416-0.58%*** (0.000)	1.4170.33%*** (0.000)	1.418-0.25% (0.001)
1.419Clay tile I	1.420-0.33%*** (0.000)	1.4210.60% (0.009)	1.4220.19% (0.001)	1.423-3.34%*** (0.005)
1.424Zinc	1.425-0.09% (0.000)	1.4260.82% (0.003)	1.427-0.02% (0.000)	1.4282.66%*** (0.004)
1.429Clay tile II	1.430-0.20%*** (0.000)	1.4311.49%*** (0.002)	1.432-0.43%*** (0.000)	1.433-0.85% (0.004)
1.434Concrete	1.4350.60%*** (0.000)	1.4360.25% (0.002)	1.4370.29%*** (0.000)	1.4380.05% (0.001)
1.439Other	1.4400.10% (0.000)	1.4410.42%** (0.001)	1.442-0.09%*** (0.000)	1.4430.18% (0.001)
1.444Log of floor width (m^2)	1.445-5.17%*** (0.001)	1.44648.97%*** (0.042)	1.447-1.02%*** (0.001)	1.4488.49%*** (0.045)

[4] The latest available statistical data published by BPS is for 2015 that covers all 34 provinces in Indonesia. We are unable to incorporate this directly into our data due to the incomplete information in previous year data in some provinces.

1.449Building ownership	1.450-0.64%*** (0.001)	1.451-1.57%*** (0.007)	1.452-0.12%*** (0.000)	1.4536.75%*** (0.009)
1.454	1.455	1.456	1.457	1.458
1.459**Demographic Factors**	1.4609.11% (0.006)	1.461-81.30% (0.106)	1.4628.50% (0.006)	1.463-91.37% (0.099)
1.464**Socioeconomic Factors**	1.46528.68% (0.008)	1.466-649.10% (0.482)	1.46717.75% (0.008)	1.468-490.40% (0.433)
1.469	1.470	1.471	1.472	1.473
1.474Constants	1.475	1.476748.97%*** (0.171)	1.477	1.478642.68%*** (0.178)
1.479	1.480	1.481	1.482	1.483

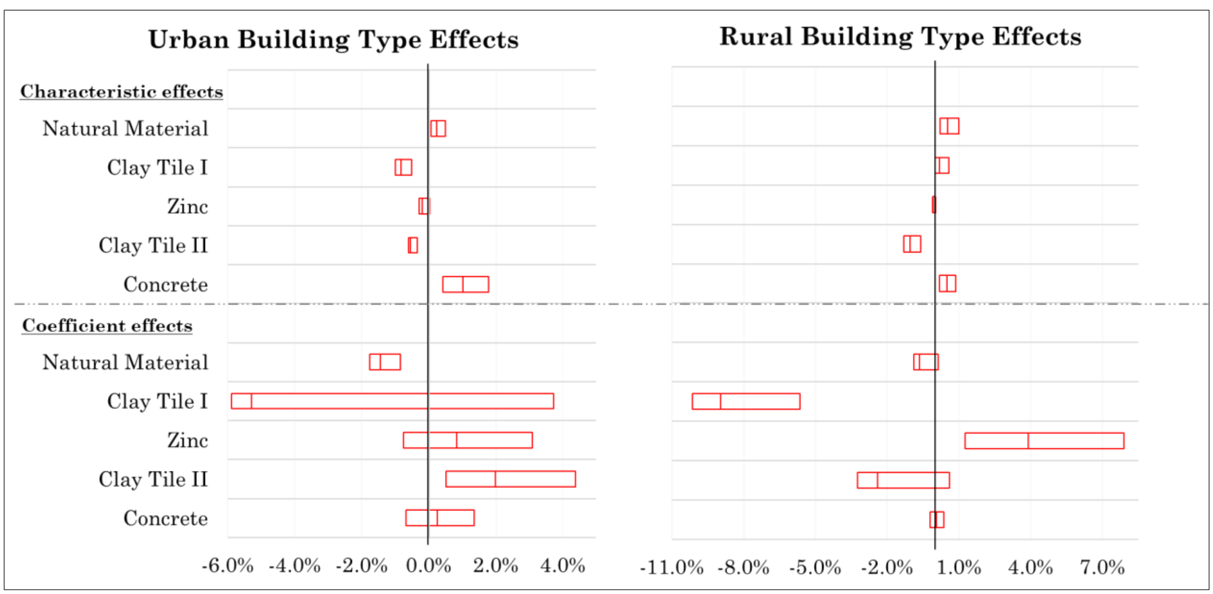
Notes: Columns (1) and (2) are the Blinder-Oaxaca decomposition between the 2 periods, 2007 and 2011, respectively, among urban households, whereas Columns (3) and (4) show the results among rural households. The percent difference between the characteristic effects and coefficient effects sum to 100% for each panel of urban or rural households, and the numbers in parentheses are the standard error before transformation into percentages. Both household demographic factors and household socioeconomic factors are the aggregate percentages of a few variables under the groups. *, **, and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Within the urban group, a 0.319 increment in the log electricity consumption (IDR in real terms) can be decomposed into 32.22% total characteristic effects and 67.78% coefficient effects. This 32.22% increment was simply due to the changes in the determinants throughout the year, whereas the 67.78% was the dynamic effects that show the influence of certain covariates that lead to higher household electricity consumption.

By looking into each category, building factors accounted for -6.85% of the characteristic effect and 22.25% of the coefficient effect. Throughout the years, changes in the patterns of building stock were observed with concrete building accounting for 0.6% and natural material building accounting for 0.17% of the increase in electricity consumption. Natural material building outperformed the other types of buildings and significantly contributed -0.58% to electricity consumption. This implies that the characteristics of natural material, which include good natural air ventilation, can help occupants to achieve indoor thermal comfort and reduce their electricity consumption. Meanwhile, although people were renovating their buildings away from clay tile II building to zinc and others from 2007 to 2011, clay tile II occupants in the urban group are still associated with a significant 1.49% increase in electricity consumption. The characteristics of clay tile II in terms of high thermal mass and low natural air ventilation seem to worsen the indoor thermal comfort of urban occupants, thus inducing the reliance on mechanical cooling devices that require more electricity.

Within the rural group, the 0.414 increment in log electricity consumption (IDR in real terms) can be decomposed into 25.4% total characteristic effects and 74.6% coefficient effects. The following are the positive or negative changes in electricity consumption attributed to the different building types: increased consumption in the natural material and concrete and decreased consumption in the clay tile I. However, following these direct impacts, the only significant mitigation effect in electricity consumption was -3.34% associated with clay tile I building. Unlike the situation in urban regions, rural households benefitted more from the second type of vernacular building, clay tile I. Although clay tile I has relatively higher thermal mass compared to natural material, the roof tiles still contribute to the passive cooling features through characteristic air pores.

Throughout the years, the household floor space decreased in both urban and rural households, but electricity consumption was still highly induced by floor space, accounting for 48.97% within the urban group and 8.49% within the rural group. Finally, homeownership decreased throughout the years in both regions, but this variable had different coefficient effects in the urban and rural groups. In urban regions, it reduced electricity consumption by -1.57%, but in rural regions, it has a greater effect on increasing consumption by 6.75%. These results indicate that household floor space declined over time, but households with relatively larger floor spaces in both regions still tended to demand more electricity. Additionally, the magnitude was also six times higher in urban households compared to rural households. Homeowners in urban regions also tended to consume less electricity than their rural counterparts. However, this only shows the correlation and understanding the true cause requires further investigation.



1.484

1.485 Notes: These figures are the coefficient plot graphs that illustrate the results for 5 main building types. Each of the horizontal bars show the 90% confidence interval, while the middle line in the bar represents the point estimator. The scale of each graph is not the same due to the differences in the coefficients.

Figure 2-1: Coefficient plot of urban and rural building type effects

2.5.2 FFL decomposition

As mean decomposition only reassembles the sample mean, we further decompose the increment of electricity consumption throughout the years on its distribution to extract meaningful results from the long-skewed tail distribution of electricity consumption outcomes. We selected 10^{th}, 50^{th} (median), and 90^{th} quantiles to represent the most extreme (lower and upper end) and most common types of users.

Similarly, the unconditional quantile regression results for our main variables are all highly significant with the base group of *Clay Tile II* building types. The only exception is *Concrete* building type. For more details, the readers are referred to the supplementary appendix (Table A.2 to A.3).

By virtue of the nature of unconditional quantile regression, FFL decomposition ensures the heterogeneity independency of all other covariates, so the characteristic effects and coefficient effects should not be mixed and misinterpreted as conditional effects on other covariates. The coefficient plot of the five types of residential buildings is presented in Figure 2-2, and the results of the FFL decomposition are shown in Table 2.5.

By closely analyzing the quantile effects, *natural material* buildings account for the increase in electricity consumption throughout the years by all quantile users in both urban and rural households in its characteristic effects. However, the relative coefficient effects demonstrate that the electricity consumption of *natural material* building occupants declined, and these mitigating effects on electricity consumption were constantly found among urban households within a significant reduction range of 0.44% to 0.74%. The greatest reduction in electricity consumption was -0.74% by the urban 90^{th} quantile household, which was also the quantile that experienced the greatest increase in the proportion of *natural material* building stock. This reduction in energy consumption can be attributed to the energy-saving properties of the *natural material* building, but among the rural households, such reductions were only found in the lowest quantile group with -0.92%.

Plausible explanations for this situation are the low thermal mass and high natural air ventilation properties of *natural material* buildings that help urban occupants, especially those in the upper extreme quantile, mitigate their needs for mechanical cooling devices. However, such a situation was not observed in the rural region, probably due to the absence of the UHI phenomenon.

The UHI phenomenon is the trapping of anthropogenic heat around city areas that causes the temperature to be warmer compared to the surrounding rural areas. The joint impact from UHI and stronger thermal mass properties will exacerbate the need to rely on mechanical cooling devices, which explained why the *clay tile II* coefficient effects were associated with a significant positive change of 1.74% by the 50^{th} quantile households and 3.71% by the uppermost quantile households.

The second type of vernacular building, *clay tile I*, accounted for a reduction in electricity consumption among urban households, with -0.75% at the 10^{th} quantile and -0.31% at the 50^{th} quantile. However, such reductions probably resulted from the decrease in the *clay tile I* building stocks and did not have any significant coefficient effects.

In all quantiles, we also found that both urban and rural households with concrete buildings experienced a characteristic effect of increased electricity consumption, but no coefficient effects were observed. Zinc buildings were responsible for a 3.03% increase in electricity consumption by the 50th quantile among urban households, and a 2.03% and 4.91% increase in the 50th and 90th quantiles, respectively, among rural households without significant changes in characteristic effect. The zinc results were difficult to interpret due to the high heat conductivity characteristic of these buildings. For instance, zinc buildings can easily release heat at night to achieve passive cooling, but heat absorption also will lead to the highest indoor temperature during the day.

From the FFL results, we can see that while moving across the upper quantile in both urban and rural areas, the reduction in log floor width exhibited a constant significant negative impact on electricity consumption in characteristic effects with a greater reduction found among urban households. However, this reduction in the floor width of houses did not have any significant consequences for electricity consumption in the coefficient effects. Moreover, highly positive impacts that trigger electricity consumption (coefficient effects) were observed for the lower quantiles of urban households, amounting to 93.54% of the total increment. A reduction in floor space may reduce the lighting fees and cooling fees, but with increasing income, people may still purchase more home appliances despite occupying smaller houses, eventually resulting in higher electricity demands.

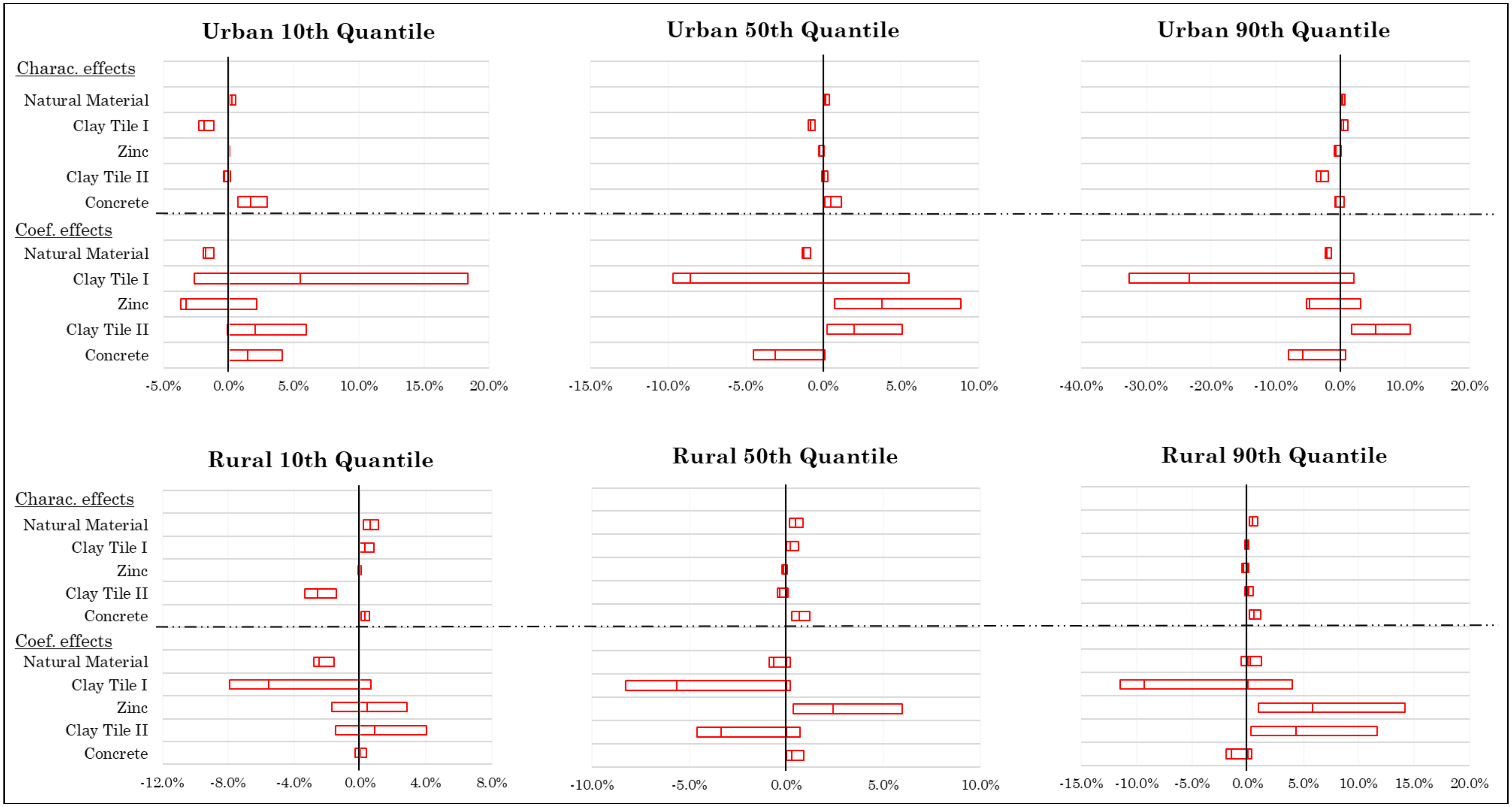
Finally, homeownership was reduced throughout the years in the lower and median quantiles of the urban group, and the change did not significant impact electricity consumption among rural households. Examining the distribution of each quantile, the coefficient effect of homeownership reduced electricity consumption in urban areas but not significantly. A significant opposite impact of increasing electricity consumption was observable in the rural group. Homeowners in rural regions may be more willing to invest in electrical home appliances that exacerbate their electricity consumption than house renters.

Table 2.5: FFL decomposition for 2007 and 2011

1.486		1.487Urban			1.488Rural	
1.489VARIABLES	**1.49010th**	**1.49150th**	**1.49290th**	**1.49310th**	**1.49450th**	**1.49590th**
1.496<u>Building Factors</u>	**1.497**	**1.498**	1.499	1.500	1.501	1.502
1.503Building Types	1.504	1.505	1.506	1.507	1.508	1.509
1.510Natural material	1.5110.19%**	1.5120.12%**	1.5130.23%***	1.5140.37%***	1.5150.29%***	1.5160.29%***
1.517Clay tile I	1.518-0.75%***	1.519-0.31%***	1.5200.39%**	1.5210.28%	1.5220.21%	1.523-0.06%
1.524Zinc	1.5250.02%	1.526-0.09%	1.527-0.27%	1.5280.00%	1.529-0.07%	1.530-0.16%
1.531Clay tile II	1.532-0.07%	1.5330.05%	1.534-1.21%***	1.535-1.11%***	1.536-0.12%	1.5370.09%
1.538Concrete	1.5391.00%***	1.5400.39%**	1.541-0.01%	1.5420.20%***	1.5430.41%***	1.5440.40%**
1.545Others	1.546-0.07%	1.5470.15%**	1.5480.32%**	1.549-0.20%***	1.550-0.13%***	1.5510.18%**
1.552Log of floor width (m^2)	1.553-3.40%***	1.554-4.72%***	1.555-8.75%***	1.556-0.95%***	1.557-0.81%***	1.558-1.55%***
1.559Building ownership	1.560-0.31%**	1.561-0.56%***	1.5620.05%	1.563-0.14%***	1.5640.01%	1.5650.09%
1.566**<u>Demographic Factors</u>**	1.5679.52%	1.56811.46%	1.5694.23%	1.5708.66%	1.5717.82%	1.5729.87%
1.573**<u>Socioeconomic Factors</u>**	1.57410.84%	1.57519.14%	1.57682.83%	1.57711.10%	1.57818.14%	1.57934.47%
1.580Total Characteristic Effects	1.58116.66%***	1.58225.09%***	1.58377.88%***	1.58418.08%***	1.58525.76%***	1.58643.73%***
1.587	1.588	1.589	1.590	1.591	1.592	1.593
1.594<u>Building Factors</u>	**1.595**	**1.596**	1.597	1.598	1.599	1.600
1.601Building Types	1.602	1.603	1.604	1.605	1.606	1.607
1.608Natural material	1.609-0.63%**	1.610-0.44%**	1.611-0.74%***	1.612-0.92%***	1.613-0.22%	1.6140.24%
1.615Clay tile I	1.6165.50%	1.617-1.10%	1.618-9.26%	1.619-2.35%	1.620-2.63%	1.621-2.18%
1.622Zinc	1.623-0.41%	1.6243.03%**	1.625-0.39%	1.6260.43%	1.6272.03%**	1.6284.91%**
1.629Clay tile II	1.6302.02%	1.6311.74%*	1.6323.71%***	1.6330.90%	1.634-1.24%	1.6354.07%*
1.636Concrete	1.6371.41%*	1.638-1.41%	1.639-2.16%	1.6400.04%	1.6410.30%	1.642-0.49%
1.643 Others	1.6440.15%	1.6450.31%	1.6460.96%**	1.6470.79%**	1.648-0.16%	1.649-0.39%
1.650Log of floor width (m^2)	1.65193.54%***	1.65215.30%	1.6531.42%	1.6548.99%	1.65510.07%	1.6567.65%
1.657Building ownership	1.6580.68%	1.659-2.79%	1.660-4.08%	1.6615.32%**	1.6622.18%	1.66310.68%*

1.664**Demographic Factors**	1.665-102.04%	1.666-127.18%	1.66777.34%	1.668-50.39%	1.669-86.92%	1.670-163.11%
1.671**Socioeconomic Factors**	1.672-92.34%	1.673-1334.12%	1.674-490.82%	1.6758.22%	1.676-706.14%	1.677-1241.54%
1.678Constant	1.679175.47%**	1.6801521.57%***	1.681446.14%**	1.682110.89%*	1.683856.96%***	1.6841436.43%***
1.685Total Coefficient Effects	1.68683.34%***	1.68774.91%***	1.68822.12%***	1.68981.92%***	1.69074.24%***	1.69156.27%***

Notes: Columns (1) to (3) are the FFL decomposition between the 2 periods, 2007 and 2011, respectively, among urban households, whereas Columns (4) to (6) show the results among rural households. All figures shown are calculated as the percentage of the total differences reported in Table 3. The total characteristic effects plus the total coefficient effects equal 100%. Both household demographic factors and household socioeconomic factors are the aggregate percentages of a few variables under the groups. *, **, and *** indicate significance at the 10%, 5% and 1% levels, respectively.



Notes: These figures are the coefficient plot graphs that illustrate the results for the 5 main building types. Each of the horizontal bars show the 90% confidence interval, while the middle line in the bar represents the point estimator. The scale of each graph is not the same due to the differences in the coefficients.

Figure 2-2: Coefficient plot of urban and rural region building type effects by the 10th, 50th and 90th quantiles

2.6 Conclusions and Policy Implications

Indoor thermal comfort is highly demanded by residents, especially those who reside in regions with extreme climatic conditions (Daghigh, 2015; Latha et al., 2015; Roslan et al., 2016). Amidst the rapid economic growth in Indonesia, households have taken two major approaches to adapt to hot and humid climatic conditions and achieve indoor thermal comfort: utilizing mechanical cooling devices and/or restructuring buildings and construction activities according to passive design principles.

The main aim of this study was to determine how building type can contribute to mitigating the significant increase in electricity demand at a macro level, and our findings corroborate previous results indicating that socioeconomic and demographic factors make the largest contributions to household electricity consumption (Jones et al., 2015; Wallis et al., 2016). Moreover, we found some interesting results in terms of our unique building factor variables. Our interpretations here in regard to the comfort level are pre-laying on some assumptions from previous literature findings indicating that passive mechanisms related to building types and material could realize comfort co-benefits (Daghigh, 2015; Latha et al., 2015). We did not attempt to measure any specific levels of thermal comfort of the occupants in our study that could be highly subjective and varies from one person to another.

The main findings of our paper regarding the building types and materials are summarized with the positive and negative signs in Table 2.6.

Table 2.6: Summary of the decomposition and sign of the effects of each variable under building factors on electricity consumption from 2007 to 2011

Variables	Urban				Rural			
	Mean	10^{th}	50^{th}	90^{th}	Mean	10^{th}	50^{th}	90^{th}
Building Types								
Natural material	+	+	+	+	+	+	+	+
Clay tile I	-	-	-	+				
Zinc								
Clay tile II			-	-	-			
Concrete	+	+		+	+	+	+	+
Others		+	+	-	-	-	+	
Log of floor width (m^2)	-	-	-	-	-	-	-	-
Building Ownership	-	-		-	-			-
Total Characteristic Effects	32.22%	16.66%	25.09%	77.88%	25.40%	18.08%	25.76%	43.73%
Building Types								

Natural material	-	-	-	-	-	-		
Clay tile I					+			
Zinc							+	+
Clay tile II	+		+					+
Concrete			+	+				
Others	+			+		+		
Log of floor width (m^2)	+	+			+			
Building Ownership	-				+	+		+
Total Coefficient Effects	67.78%	83.34%	74.91%	22.12%	74.60%	81.92%	74.24%	56.27%

Notes "+" sign shows positive significant to increment of electricity consumption, "-" sign shows negative significant, and empty shows non-significant were found under each covariate.

The *natural material* building stock was found to be declining, especially in rural regions where people are transitioning to *zinc* and *concrete* building types. However, further analysis showed that *natural material* building helped households mitigate the impact of increases in the electricity demand. Table 6 clearly shows that *natural material* building is the only type that moves coefficient to negative direction for electricity consumption. With its low thermal mass and high natural air ventilation properties, *natural material* provides passive cooling benefits to the occupants, and once thermal comfort is realized, occupants can reduce the use of mechanical cooling devices. This mitigation effect even remains among the users in the uppermost quantile of the urban group, but such mitigation impacts are not observed in rural areas, which could be associated with the fact that the UHI only exists in urban regions.

Meanwhile, the second type of vernacular building, *clay tile I*, faced a greater loss in stock. Regardless of the absolute amount of reduction, it still exerted a positive impact on the 93.54% increase in electricity consumption by rural households in the 10th quantile and did not provide any mitigation benefits to occupants in other quantiles and urban regions. The most popular type of building, *clay tile II*, is losing its popularity and failed to help households mitigate the increase in electricity demands. *Clay tile II* performed badly and worsened the indoor thermal comfort of urban occupants while inducing increased electricity consumption.

The proportion of *concrete* buildings increased over the study period, but the positive significant coefficient effects at the 50th and 90th quantiles of urban regions suggested that this building type is responsible for the increase in electricity consumption. These results slightly differed from our initial expectation that these households might be more energy efficient while using the mechanical cooling devices due to the higher thermal mass properties as the control of indoor temperature could be relative stronger compared to other types of buildings associated with less air tightness. The median and upper quantiles of the occupants of the *zinc* buildings in rural regions were negatively affected by the day-time heat-absorbing characteristic of this material. These occupants must rely on mechanical cooling to achieve indoor thermal comfort during the day.

Intuitively, with increasing floor width, households consume more electricity according to the positive significant mean decomposition sign found for both regions (Jones et al., 2015; Wallis et al., 2016). On average, building ownership had a significant negative effect on the increase in electricity consumption among urban households, suggesting the possibility of some unobserved characteristics of or behavior by homeowners that mitigates the increasing electricity demands, such as possibly investing in relatively energy-efficient home appliances. However, such significant negative signs were not found when we studied the extreme or median users. Moreover, homeowners in rural areas exhibited the exact opposite behavior and tended to consume even more energy among mean users and users at both extremes.

Nevertheless, all these perceptions and plausible explanations were simply correlations; a study of the causal relations and detailed questionnaires that cover more details on occupancy time, number of appliances, habits or aspects of behavioral relevance are needed to further confirm our interpretations.

In general, our findings show that buildings constructed with natural material significantly contribute to reducing electricity consumption at the macro level. However, when interpreting the results, it should be noted that this positive result from natural material buildings only shows macro level patterns regarding electricity consumption and detailed analyses related to other potentially important factors have not been made. Further studies are still required to test the viability of application of natural materials in residential buildings from the dimensions of occupant’s comfort levels, safety, building resistance, etc.

3 Do Fishery Levies Abolition Policy Indirectly Impact on Animal Protein Intake in Indonesia?

3.1 Introduction

In the year 2015, UN member states committed to overcoming the food security challenges through the adoption of the 2030 Agenda for Sustainable Development. In this agenda, fisheries and aquaculture aims are set to ensure food security and nutrition balances through the utilization of natural resources in a sustainable way (FAO, 2016). In coastal areas and islands with rich fish resources in developing countries, fish have a vital role in daily diets and nutrition of low-income people (Van Zalinge et al., 2000).

Mozaffarian and Rimm (2006), Sioen et al. 2007 and Tomić, Matulić, and Jelić (2016) documented that consuming fish at least twice a week has significant good impacts on human health since fish contain high protein, low saturated fat, and numerous healthy nutrients. Many fish species are excessive sources to recommended nutrient intakes for infants, young children, pregnant, and lactating women (Thilsted et al., 2016). However, many significant fisheries producer countries experienced low fish consumption among their residents.

Indonesia is known as one of the leading producer countries in the fisheries sector (FAO, 2016). To reduce the fisheries production costs by 25-35%, on 16 November 2009, Indonesia central government had issued a decree, Nomor. B.636 MEN-KP/XI/09. This decree aims to reduce the tax burden of small scale fishermen, increase their income and livelihood while encouraging the development of the fishery industry (Manadiyanto & Yusuf, 2011; Muninggar et al., 2014). This decree requires the local government in each province to abolish four types of provincial fisheries levies. They are fisheries permit levy, fish port levy, fish auction levy, and fish market levy.

However, due to the complication of lowering regional revenues, some provinces local governments had against the enforcement of this levies abolition policy on their fisheries sector. As a result of compromising from the central government, there a is total of 11 provinces lifted the levies on their wills, while 22 provinces were keeping the existing levies since the year 2010. Those 11 provinces that agreed to lift the levies were being compensated with the special allocation fund from the central government to ensure there is no loss on regional revenues (Kompas, 2009). This situation had provided us with a great opportunity to test the indirect impacts of the abolition of fisheries levies to local fish consumption by comparing the situation in the treatment and control provinces.

As an impact of the levies abolition policy, the low production cost might lead to a reduction of fish price and triggers fish consumption among locals. This kind of impact of pricing effects on the food choice is proved in French, (2003) studies, who employed lower price intervention on healthy food consumption. Afshin et al., (2017) also conducted a meta-analysis that summarizing 10% price reduction can help to increased 12% of healthful food consumption. Yet, most of these previous literatures were focused on developed countries, whereas the research on developing countries circumstances is still limited.

The fish price at Indonesia is originally cheap and the price elasticity is considerably low (Kusumastanto & Jolly, 1997). Therefore, the impact of the levies abolition policy guided increase in fish consumption is still questionable. Furthermore, the decision to absorb or to share out the production cost reduction is depending on the choice of fishermen. Fisherman might choose to keep the price high to increase their income. Alternatively, by reducing the fish price in the market, fishermen might increase production and revenue.

In this paper, we first verify the price trends of fish before and after the levies abolition fishery policy and follow up with analysing the indirect impacts of domestic fish consumption. The first part of the paper will document the observed data on price changes throughout the year. Both fresh fish and salted/smoked fish commodities will be analysed as they are the most directly affected commodities. In addition to fish consumption, chicken/duck meat and eggs consumption are also be included. These are the commodities that appear as the next best substitute to fish as animal proteins that can cover human nutrition needs (Kusumastanto & Jolly, 1997). By including these possible substitutive consumptions, it can also help us to understand the situation clearly if people switch their consumption to other commodities.

The objective of this study is to explore the indirect impact of levies abolition policy in the fisheries sector of Indonesia on the protein consumption and expenditure. We are the pioneer to identify the indirect effect of this levies abolition policy, which is directed and very successful in reducing the cost of fish production. However, the indirect impact of this policy is also very important in the context of residents' protein consumption and expenditure. We organize this paper as follows. Section 3.2 discusses our data and methodology. Section 3.3 presents the estimation results. Finally, section 3.4 concludes the paper and suggest the policies.

3.2 Data and Methodology

3.2.1 Data

The main analysis of this research utilizes the Indonesian Family Life Survey (IFLS) data conducted by the RAND Corporation. IFLS dataset covers a longitudinal survey of households, communities, and individuals in 13 out of 33 provinces in Indonesia. It contains multi-purpose socioeconomic and health information of the respondents and representing around 83% of Indonesia population. Given our main objectives to examine the externalities of levies abolition policy on fisheries sector in the year 2010 to general public fish consumption in Indonesia, we apply IFLS 3 (2000), IFLS 4 (2007) and IFLS 5 (2014) on our study.

These dataset collection dates enable us to cover the period before and after the policy with the panel households and further allows us to conduct a placebo test in pre-period. Noted that although IFLS dataset only covers 13 provinces, it had a well-covered portion of control and treatment provinces as reported in Table 3.1.

Table 3.1: Assigned and unassigned-provinces toward levies abolition policy on the fisheries sector in Indonesia

Total 33 provinces in Indonesia			
Treatment Group 11 assigned-provinces		**Control Group 22 unassigned-provinces**	
5 provinces covered by IFLS data	6 provinces uncovered by IFLS data	8 provinces covered by IFLS data	14 provinces uncovered by IFLS data
South Sumatra	Aceh	North Sumatra	Jambi
Lampung	Riau	West Sumatra	Bengkulu
DKI Jakarta	Riau Islands	Central Java	West Kalimantan
West Java	Bangka Belitung	Yogyakarta	Central Kalimantan
Bali	Banten	East Java	North Sulawesi
	East Kalimantan	West Nusa Tenggara	Gorontalo
		South Kalimantan	Central Sulawesi
		South Sulawesi	West Sulawesi
			Southeast Sulawesi
			East Nusa Tenggara

			Maluku North Maluku Papua West Papua

This study has total 7,502-panel households, which is formed by 2,635 households in the treatment group and 4,867 households in the control group. The summary statistic of the socio-demographic variables between treatment and control households is reported in *Table 3.2.* There are no significant mean differences in household total weekly food expenditure, total monthly non-food expenditures, total yearly non-food expenditure, HH size, which is believed to be crucial in our analysis.

Table 3.2: Descriptive statistics of initial household characteristics in 2007 baseline year

	2007 Baseline year HH demographics						
	Control Group			Treatment Group			
VARIABLES	N	mean	sd	N	mean	sd	
HH size	4,867	6.420	2.744	2,635	6.500	2.999	
Self-producer[a]	4,867	0.546	0.498	2,635	0.527	0.499	
Total Weekly Food Expenditure[b]	4,856	262,847	1,080,731	2,624	306,707	1,036,451	
Total Monthly Non-Food Expenditure[b]	4,867	119,444	3,211,340	2,635	171,815	3,898,147	
Total Yearly Non-Food Expenditure[b]	4,867	8,548,245	33,280,173	2,635	9,185,469	25,619,742	
Urban[a]	4,867	0.446	0.497	2,635	0.564	0.496	(***)
Refrigerator Ownership[a]	4,860	0.357	0.479	2,631	0.448	0.497	(***)
HHH Sex[a]	4,865	0.806	0.396	2,634	0.846	0.361	(***)
HHH Age	4,865	49.496	13.617	2,634	47.946	13.252	(***)
HHH Education Years	4,859	7.760	6.032	2,630	8.822	6.004	(***)

Notes: [a] denotes dummy variables. [b] denotes HH expenditure variable, not in capita. Self-producer refers to any household that does self-producing/ received free from another source for any of the four food commodities (fresh fish, salted/smoked fish, chicken/duck meat, eggs) in our study. The number of observations of some variable are less than 7,502 due to missing value. Asterisk mark represent the significant mean differences.

Due to the data limitation, we could only obtain fresh fish, salted/smoked fish, chicken/duck meat, and egg consumption of the household in terms of consumption expenditure (Indonesian rupiah/capita in a week). The physical quantity amount reported by the household is less precisely and exist of many missing in IFLS survey. Nevertheless, by acknowledging the price level of food commodities are changing as reported in section 2.3, we try to convert the expenditure consumption into physical quantity consumption of each household (kilograms/capita in a week) by using the regional market price average. The regional retail price data in 2000, 2007, and 2014 for 13 different IFLS provinces issued by Central Bureau of Statistics of Indonesia and Ministry of Marine Affairs and Fisheries of Indonesia is used to computed this measurement.

We also utilize the regional Consumer Price Index (CPI) data for general goods and services, food, non-food, and the specific four commodities in the year 2000, 2007, and 2014 for 13 different IFLS provinces. These data are obtained from the Central Bureau of Statistics (BPS) of Indonesia. All the nominal values utilized in the research were adjusted to the 2007 base year real value to remove the impact of inflation.

3.2.2 Methodology

We employ a difference in differences (DiD) approaches to examine the impact of the policy on household's fish consumption. The equation is presented as follow:

$$Y_{it} = \beta_0 + \beta_1 Group_{\mathrm{i}} + \beta_2 Period_{\mathrm{t}} + \beta_3 (group_i \cdot period_t) + \varepsilon_{it} \qquad (3.1)$$

where Y_{it} denotes outcome variables for HH_i in *t* period; $group_i$ denotes group dummy (1 if HH_i lived in treatment province; 0 if HH_i lived in control province); and $period_t$ represents period dummy (1 is after-policy period, the year 2014; 0 is before-policy period, the year 2007). Our main interest is β_3, the DiD estimator representing the impact of *levies abolition policy* on the treatment group (Gertler et al., 2011, 2016; Khandker et al., 2010). By using the panel household data, all the time-invariant unobserved household heterogeneities and time-variant unobserved heterogeneities can be controlled through household fixed effects and year fixed effects.

To the access our main interest, we adopt two different measurements for the household fresh fish and salted/smoked fish consumptions as our outcomes variables: (i) consumption quantity in kg per capita per week; (ii) consumption expenditure in IDR per capita per week (real term)[5]. The purpose of examining the outcomes in different measurements is to cover the changes in fish consumption from two perspectives, such as change in quantity and changing in the total amount of expenditure. In addition to fresh fish and salted/smoked fish, we

[5] We also conducted this study using the third measurement, which is a binary variable that computed using zero consumption expenditure in IDR per capita per week. The result can be found in the annex.

also study chicken/duck meat and eggs consumption using the same measurements.

In addition to our primary analysis, two sub-sample studies had also been conducted to verifying the consistency and robustness of our result. The first sub-sample analysis is denoted as model 2, which is by removing 191 households that migrated in or out of the province in between the year 2000 to the year 2014. By eliminating these households, it is expected to remove some undesirable errors that raised when household suddenly received or removed from the treatment in the period between our data year. The second sub-sample analysis is denoted as model 3, which is by dropping any households that are self-producing or free receiving the food commodities of our interest from another source. It is reasonable to suspect these households may react differently compared to households that only purchased these food commodities. For instance, fisherman household who received direct impacts from the fish levies abolition policy may even adjust their productivity or self-consuming quantity subjected to the market price. However, due to the data unavailability, we are not able to distinguish the fisherman household, as an alternative, we choose to present second sub-sample analysis to ensure our primary analysis consistency.

DiD method calculate the changes in outcomes for the control group to estimate the counterfactual changes in outcomes for the treatment group. Therefore, we need to overlay a parallel trend assumption to derive a bias-free estimation, which states both the treatment and control group will be similar in terms of outcomes trend without the policy intervention. To diagnostics the parallel trend in our data between treatment and control groups, we also conduct a placebo test using a previous period. The specification of this placebo test is similar to our main model except that the period dummy is now changed to the year 2000 equal to zero and year 2007 equal to one as a placebo period. This falsification test is expected to result in non-significance differences between treatment and control groups as the policy are not yet be implemented during the year 2000 to the year 2007.

3.2.3 Price Trends

Understanding the changes in the price trend of fish commodities are crucial for us to grasp the market situation consequences to the fish levies abolition. First of all, Figure 3-1 shows aggregated mean price for both fresh fish and salted/smoked fish commodities in treatment and control provinces. It is essential to notes that average fish prices are growing in upward parallel trends in both treatment and control provinces in years before policy implementation.

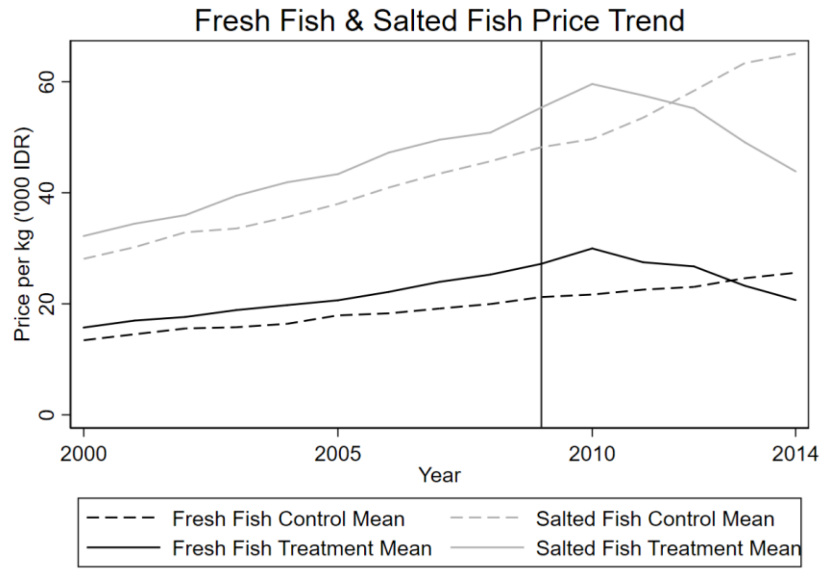


Figure 3-1: Fresh Fish and Salted Fish Price Trends

With the implementation of fish levies abolition, the up-growing trend of fish price in treatment provinces can be regarded to be slowed down by the policy. The reduction in fish price had shown that fishermen were sharing out the benefits obtained from lower production cost to end consumers rather than mark up their own profits only.

To further illustrate the market price trends in provincial level, figure 3-1 shows the average retail price trends of fresh fish from the year 2000 to the year 2014 in each province.

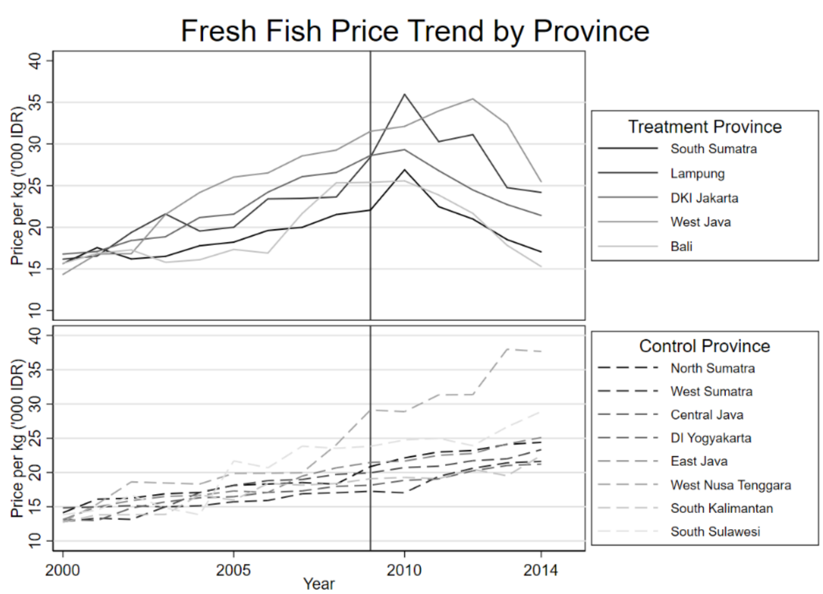


Figure 3-2: Fresh fish price changes in control and treatment provinces

Source: BPS-Statistics Indonesia (2016a; 2016b), Ministry of Marine Affairs and Fisheries of Indonesia (2013; 2015)

After the policy implementation in the year 2009, fresh fish prices were observably decreasing in almost all treatment provinces with one-year lag except West Java. Meanwhile, all control provinces are facing a continuous up-growing increase in fresh fish price except South Sulawesi and South Kalimantan. The growth rate of fresh fish price among control province is from 57% (Central Java) to 195% (West Nusa Tenggara) from the year 2000 to 2014, which is 2.5 times higher than the highest growth rate, 78% of treatment province (West Java).

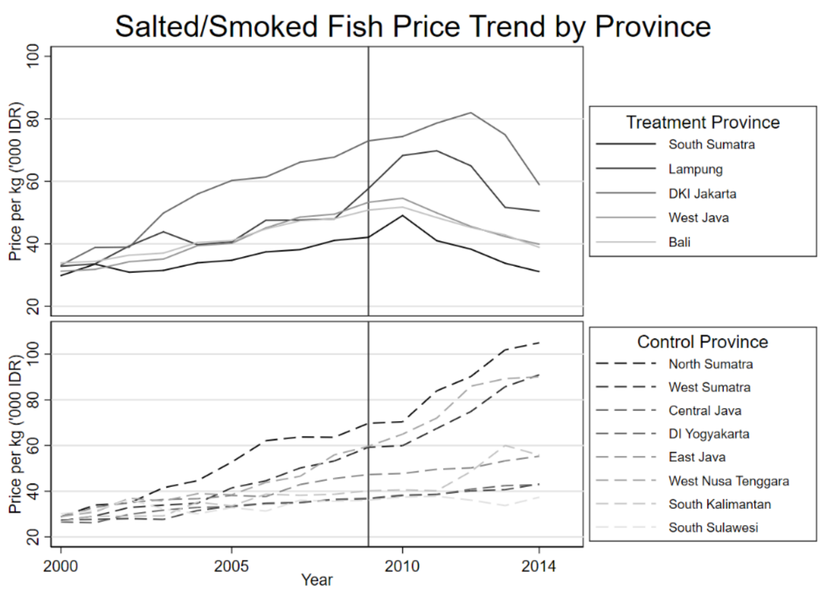


Figure 3-3: Salted/smoked fish price changes in control and treatment provinces

Source: BPS-Statistics Indonesia (2016a; 2016b), Ministry of Marine Affairs and Fisheries of Indonesia (2013; 2015)

Figure 3-3 plots the average retail price trends of salted/smoked fish price from the year 2000 to the year 2014 in each province. Similar to fresh fish price, almost all treatment provinces had a lower salted/smoked fish price after the policy implementation except DKI Jakarta. In the absence of policy, the growth rate of salted/smoked fish price among control province is range from 24% (South Sulawesi) to 264% (North Sumatra) with the average value of 132% increase from the year 2000 to 2014. The highest growth rate of control province is 3.38 times larger than the highest growth rate of treatment province (DKI Jakarta) for salted/smoked fish throughout years.

When the price of fish is reduced, we presume people would increase their fish consumption, which may lead to significant improves of fish protein intakes. However, the consequences of income effect and substitute effects resulted from the fish commodities price reduction may also shift the food protein's demands to other food commodities such as chicken or duck meats and eggs. By considering this situation, Figure 3-4 is plotted to shows the changes in the average prices of chicken or duck meats and eggs in treatment and control provinces.

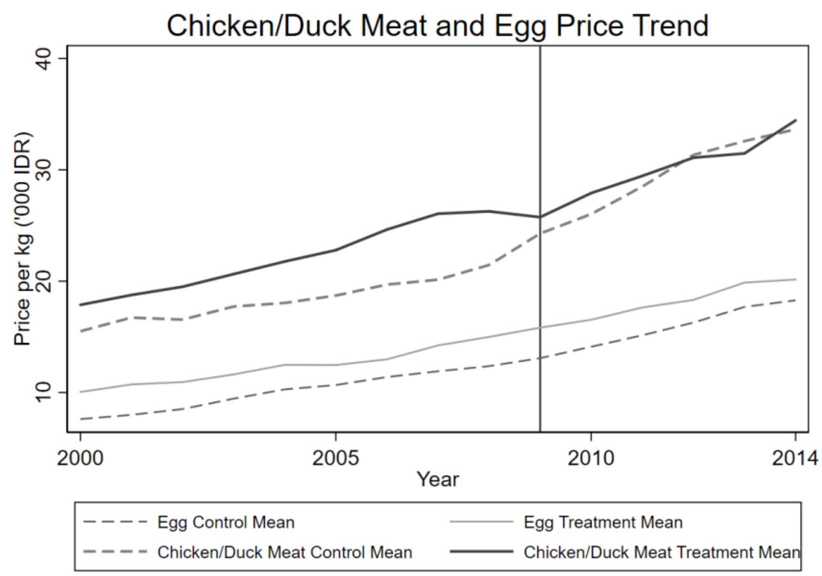


Figure 3-4: Chicken/Duck Meat and Egg price trend in the control and treatment provinces

While egg commodities price trends are steadily growing in both treatment and control provinces, the price of chicken or duck meat commodities were significantly reduced in treatment province in the year before policy implementation. This reduction may be confounded to the indirect impact of fish levies abolition or accelerate the substitution effects from fish price reduction to demands over chicken or duck meat commodities.

Nevertheless, these are just basic descriptive statistic and simple differences that are not enough to explore the indirect impacts of levies abolition fishery policy to fish consumption. Further statistical analysis will be reported in the next section to exploit our main interest outcomes.

3.3 Results and Discussions

Table 3.3 reports the outcomes of our DiD specification for the main model and two sub-sample analysis. The two different outcome measurements are listed in column kg/capita/week and IDR/capita/week, respectively. Model 2 and model 3 of subsample analysis had also been reported in table 3 as a comparison to show the consistency of our findings.

Table 3.3: Main result of DiD on treatment and control province between the year 2007 and 2014

	Model 1		**Model 2**		**Model 3**	
	All households		Permanent households		Permanent households without self-producing capacity	
VARIABLES	Kilograms/capita (in a week)	Indonesian rupiah/capita (in a week)	Kilograms/capita (in a week)	Indonesian rupiah/capita (in a week)	Kilograms/capita (in a week)	Indonesian rupiah/capita (in a week)
Fresh Fish	0.032***	-567.783***	0.030***	-615.165***	0.046***	-242.037
	(0.007)	(191.989)	(0.008)	(196.364)	(0.012)	(291.387)
Salted/ Smoked Fish	0.005*	-178.067	0.005*	-201.047	0.003	-250.045
	(0.003)	(129.816)	(0.003)	(133.927)	(0.004)	(191.093)
Chicken/ Duck Meat	0.026***	993.860***	0.026***	991.186***	0.041***	1,615.036***
	(0.007)	(237.943)	(0.007)	(244.880)	(0.010)	(335.344)
Eggs	0.006	271.442*	0.007	277.797*	0.021*	504.203***
	(0.008)	(139.722)	(0.008)	(143.827)	(0.012)	(177.785)
Number of households	7502	7502	7291	7291	3354	3354
Household fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1 Model 1 includes all samples. Model 2 excludes any HH that migrated from one province to another in between the year 2000 to 2014. Model 3 excludes the migrated HH as well as the HH who are capable to produce by themselves. Outcomes include only purchased amounts, self-producing amounts are not included.

From model 1, we can see that there is an overall increase in consumption quantity of fresh fish and salted/smoked fish. Fresh fish consumption is found to be enhanced by 32g per capita per week, salted/smoked fish is increased by 5g per capita per week and chicken/duck meat is also increased by 26g per capita per week among the treatment group households. Although this consumption quantity variable is a rough measurement computed from the regional retail price, it is informing us of the overall changes in quantity consumed per capita by the local.

Moreover, this increase in the physical quantity of consumption is backed with a highly significant reduction on fresh fish real value consumption per capita. After the policy implementation, household from treatment provinces are now spent IDR 568 less to purchase fresh fish, IDR 994 more to buy chicken/duct meat and IDR 271 more to buy eggs compare to the household from control provinces. People were able to consume more fresh fish with lower monetary expenses compare to before.

Result of model 1 is also consistently proven by the model 2 and model 3 sub-sample analysis. By eliminating the possible bias contaminated household who had migrated in or out the province, we still observed a similar result with a slightly stronger coefficient found in monetary expenses for fresh fish, chicken/duck meat and eggs.

Furthermore, in model 3, we further removing any households that are self-producing or free receiving any of the four food commodities of our study interest, the findings are still retained. The only differences found are (i) the significance of monetary expenses for fresh fish are gone, but the negative trend is maintained, (ii) the monetary costs for chicken/duck meat and egg is even increased by IDR 1615 and IDR 504, respectively. In other words, if we focus on the consumers that were only buying these commodities from the market, they probably weren't spending that much lesser on fresh fish, but it is found that they were gaining the benefits by spending even more on chicken/duck meat and eggs.

Based on these, we can induce that fishery levies abolition policy had caused the household to spend more money on chicken/duck meat and eggs and paid less in both fresh fish and salted/smoked fish. Fishery levies abolition policy is found to trigger the nutrition consumed by households positively. Furthermore, the increase in nutrition is not limited to fish commodities but also found in chicken/duck meat and eggs.

However, the result reported above might subject to biases if the parallel trend assumption doesn't hold in between treatment and control groups. Therefore, we conduct a placebo period test using data in the year 2000. Table 4 shows the result of the placebo period test.

Table 3.4: Placebo period result on treatment and control province between year 2000 and 2007

VARIABLES	Model 1		Model 2		Model 3	
	All households		Permanent households		Permanent households without self-producing capacity	
	Kilograms/capita (in a week)	Indonesian rupiah/capita (in a week)	Kilograms/capita (in a week)	Indonesian rupiah/capita (in a week)	Kilograms/capita (in a week)	Indonesian rupiah/capita (in a week)
Fresh Fish	0.001	-127.493	0.000	-130.521	-0.011	-171.105
	(0.006)	(126.884)	(0.006)	(130.627)	(0.010)	(192.952)
Salted/ Smoked Fish	0.002	54.579	0.002	64.204	0.003	116.659
	(0.003)	(121.363)	(0.003)	(125.824)	(0.004)	(181.164)
Chicken/ Duck Meat	0.003	494.879***	0.003	497.705***	0.001	467.792***
	(0.006)	(150.996)	(0.006)	(156.253)	(0.008)	(181.324)
Eggs	0.009	176.248	0.007	159.721	-0.004	19.125
	(0.008)	(108.229)	(0.008)	(111.334)	(0.012)	(144.981)
Number of households	7502	7502	7291	7291	3354	3354
Household fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1 Model 1 includes all samples. Model 2 excludes any HH that migrated from one province to another in between the year 2000 to 2014. Model 3 excludes the migrated HH as well as the HH who are capable to produce by themselves. Outcomes include only purchased amounts, self-producing amounts are not included.

For almost all panels and commodities, there are no significant differences found in our falsification test. The only exception is on chicken/duck meat real expenditure. Household from treated provinces is found to spent IDR 495 more than household from control provinces to buy chicken/duck meat per week even in the before-before period (the year 2000). This finding is not only limited to our full model specification, but also consistency reported in both subsample model 2 and model 3. However, the significant differences are only limited to monetary expenses, whereas the physical quantity changes are positive without any significant in all models.

One of the plausible explanation is people are trying to cope with the increase in chicken/duck meat price while maintaining their physical quantity consumption amount. Back in figure 1 and figure 4, we were able to observe both constant growth in fresh fish and chicken/duck meat price trend for both treatment and control group provinces. However, chicken/duck meat price increased were steeper than fresh fish. Also, the pattern of growth of chicken/duck meat price in control provinces is quite different in comparison to treatment provinces and much lower, this could lead to the expenditures differences found in placebo period between groups.

In general, the fishery levies abolition policy is found to positively impact on the consumption quantity of fresh fish, salted/smoked fish, and chicken/duck meat. However, only fresh fish and chicken/duck meat consumption quantity is robustly found to be increased in all model specification. In real expenditure-wise, only chicken/duck meat and eggs commodities are found to be persistently increased in all model. Based on market price trend, fishery levies abolition policy had reduced the average retail fish price among the treatment provinces, and this posed a positive impact on the physical quantity of fish consumption. Treatment household is also spent a relatively less amount of money in fish commodities and shifted their consumption to chicken/duck meat, which is relatively more expensive, and eggs.

Although more enormous impacts are found on chicken/duck meat consumption, we cannot derive this as the causal impact from the fishery levies, as this finding might be confounding to the reduction of chicken/duck meat price in treatment group provinces right before the fish levies abolition policy implemented. Furthermore, chicken/duck meat monetary consumption is also doesn't pass our placebo test in the period before. Therefore, the interpretation of the definite increase in real expenditure needs to examine carefully and should not be solely regarded as the impacts of fish levies abolition.

One of the plausible explanation to the findings of why household rather spend more to chicken/duck meat instead of fish were due to conventional norms of Indonesian households that regard fish as an inferior good due to its characteristics of cheap and readily available. Note that this argument is without taking account of those high values fish species that are more export-oriented. In such a case, both substitution effects and income effects resulted from the fish price reduction will drive and accelerate the households to spend more on chicken/duck meat.

However, our findings show that fish quality consumption doesn't reduce or stay constant when household able to consume the same amount of fish at a relatively lower price. We found that people still increase their consumption quantity of fish while reducing monetary expenditure (in model 1 and model 2 or almost keeping in constant in model 3). Further research is still needed to validate this argument, as our analysis approaches did not distinguish the differences between wealthier and poor households nor their consumption preferences.

3.4 Conclusions and Policy Implications

In contrast to the argument of Thilsted et al., (2016) that forecasting the rise in fish price, we discover the fish price in Indonesia is decreasing throughout the years even after the implementation of government policy in encouraging the fish production. Based on the estimation results, it can be concluded that the fishery levies abolition policy in 2010 had a improve in nutrition consumption (in terms of real expenditure) among Indonesian.

Contradicting to our initial expectation, fresh fish and salted/smoked fish expenditure went down among the treatment groups. Instead of fish, we found a stronger impact on the chicken/duck meat expenditure. Treated households experienced an increase in their chicken/duck meat consumption after the policy implementation. Such an increase in chicken/duck meat consumption is robust, or in precisely, further enlarged when we restrict the sample size to the provinces that have similar household median real expenditure in IDR per week. The plausible explanation is the income effects from fish price decrease had driven the household to spend the extra money saved from the reduction to chicken/duck meat and eggs commodities.

Although the physical quantities we computed from retail price might be less precise, we still able to find some weak evidence of an increase in the average fish consumption. In contrast to the IDR 4,133 real expenditure reduction in fresh fish, treated households are found to be consuming more fresh fish and chicken/duck meat per capita compare to controlled households in whole sample analysis. In overall, fishery levies abolition policy in 2010 is generating a positive impact in improving the animal protein nutrition consumption among the treated household.

This study suggests the indirect impacts could be found from one commodity levies abolition to the other commodity. We discovered the positive externality is generated by fishery levies abolition to the overall food commodities nutrition consumed by households. On one hand, policymakers are encouraged to consider the large-scale regulation that is similar to this kind of fishery levies abolition to improves the overall nutrition intakes by the local people as cost-effectiveness. On the other hand, we would also like to raise the awareness for careful assessment for any other type of large-scale regulations in future, as the indirect impact might exist and leads to the unnecessary negative outcomes.

Nevertheless, the fish consumption quantity among Indonesian are found to be hard to encourage solely through price reduction unlikely what is found in French, (2003) and Afshin et al., (2017). In particularly, if the Indonesia government would like to encourage the fish consumption, there would be a need to organize some promotion programs such as national fish-eating campaign days, educating the local people about health-beneficial that can be obtain through consuming fish.

Findings from this study are subjects to some limitations. Data limitation restricted us to explore the true changes in physical quantities changes resulted from the indirect impact of fishery levies abolition policy. As the data we have is only the last week consumption amount, it may not be appropriate to said one household doesn't consume certain commodities items, since there is a possibility where some household purchase a bulk quantity in the week before. The fish and chicken/duck meat commodities are not closely related to each other. Therefore, the price reduction of fish might not affect the price of chicken/duck meat. Our findings on the large increased in chicken/duck meat real expenditures might not suitable to be interpreted as sole effects from fishery levies abolition policy.

4 Long-term impacts of fetal origin exposure to tobacco smoke on the individual

4.1 Introduction

Environmental exposure to tobacco smoke (ETS) is a contemporary social obstacle to sustainable development. According to WHO (2015), there are 6 million people die of tobacco use annually, whereas 600,000 of them are dying from the effects of secondhand smoke (SHS). SHS is not an emerging terminology that found recently, Steinfeld firstly reported it in 1972 with its adverse impacts on non-smokers. Henceforth, dozens of attention had been paid on SHS, and researchers further proposed that ETS could be exerted through four ways: firsthand smoke, secondhand smoke, thirdhand smoke, and transgenerational effects. Tremendous findings on the relationship between SHS and diseases grabs the attention of various parties and policymakers to effectively addressing these public health threats.

Nevertheless, to what extent the control over tobacco smoke shall be emphasized is questionable. Most of the arguments on the size of control surround on SHS and the relatively new concept, thirdhand smoke (THS). The vagueness beliefs to the later required the regulators to incessantly prohibit smoking in all public spaces regardless of that spaces are open-air or not. However, to efficiently tackle the issue on extents of governs while considering the public welfare maximization, the causality of ETS to those negative impacts are waiting to be answered. One of the foremost questions that are rather overlooked is laid on fetal origin and earlier life ETS impacts on one's long-term socio-economic outcomes.

Among the limited studies of ETS about its economic implications, show the significantly higher inpatient costs during the first five years of an infant's life period if maternal smoking occurs. Beal et al. (2017) estimate the economic burden of two diseases, namely lung cancer and intellectual disability (ID), that resulted from ETS. The former study focus on the impact of maternal smoking, which is the active smoking of the mother during the pregnancy period. In contrast, the later one is investigating the impact of ETS and its transgenerational effects. Nevertheless, both of these studies are only limits to health impact and cost. There are no such long-term studies on how does ETS could generate impacts on one later life performance and socio-economic welfares.

On the other hand, Northrup et al. (2016) reported that once THS is a deposit, nicotine will be accumulated in the dust, surfaces, and air, due to its strong ability to adsorb to the surface and penetrate materials, it is not easily removed by vacuum or cleaning. Such a leftover of THS substances is found to exist weeks & months even after the cleaning process is done once smokers moved out of the apartment (Matt et al., 2011). In the case of active smokers in a household, THS could be transmitted during indoor smoking or through the residual leftover on the active smoker's clothes, which is then resuspended to floor or indoor furniture. This would affect mostly on infants and small kids who are still in crawling stages and have more hand-to-mouth gesture.

One thing to be highlighted here is although we noticed the differences caused by SHS and THS, due to the difficulties of distinguishing their existences, we are going to categorize both of them as passive smoking or ETS. Unlike the previous literature that mainly focuses only on paternal or maternal smoking consequences or either paternal or maternal as active smoker while the other one is non-smokers, we are going to consider the cases of all household member smoking status to capture the both of the effects of SHS and THS.

This paper aims to fill in the gaps by assessing the long-term impact of an earlier life ETS to one later life. As we try to distinguish the effects of the firsthand smoker, maternal smoking observations are excluded from our data analysis. Due to the nature of sample size limitations, we only try to access lifetime outcome of the earlier life ETS in aggregation with fetal origin hypothesis in comparison to never exposure groups. By assessing this impact, we would like to provide policy implications on the extent of the control over tobacco smoke in public space and provide parental behavior suggestions.

In terms of maternal ETS, a systematic review by Leonardi-Bee et al. (2008) summarized that, in 44 studies, maternal ETS is significantly associated with 22% increase in the risk of low birth weight[6] (LBW), but it does not consistently impact on the small for gestational age (SGA) or prematurity deliver. By adjusting to the maternal smoking behavior, Meaney et al. (2014) found paternal smoking during the perinatal period is causing a risk of miscarriage by the odds ratio of 2.22. From mental health and behavioral perspectives, Liu et al. (2013) report that maternal ETS may impacts child behavioral development, in particular, the externalizing behaviors of the child in China. Whereas in the U.S., Beaver et al. (2010) report that postnatal ETS leads to an increase in the neuropsychological risk of infants, and thus lead to antisocial behavior among males. Polanska et al. (2017) prove that ETS during 1st and 2nd trimester of pregnancy affects the language ability of children by age 1 and 2, the negative impact is higher with 2nd trimester ETS. Whereas, the cognitive ability is negatively related to ETS at 2nd trimester, and motor ability is negatively associated with ETS at all three trimesters.

From the perspectives of prenatal and postnatal ETS impacts, Burke et al. (2012) show prenatal or postnatal ETS leads to an increase in incidence of wheeze and asthma in children and young people by 20% from 79 studies. Similar findings also reported by Skorge et al. (2005) by studying the 11-year community cohort study for respondents range from 15 to 70 years old in Norway, they found passive smoking during prenatal and postnatal was associated with asthma and some other respiratory symptoms. Yet, none of these findings goes beyond the medical health field.

Lastly, in terms of postnatal, Kopp et al. (2016) shows ETS is exacerbating chronic diseases from 286

[6] Less than 2500g.

studies. Chiswell & Akram (2017) shows ETS increases the risk of anesthetic complications and some adverse surgical outcomes in children. In overall, a systematic review of Kusel, Timm & Lockhart (2013) states ETS contributed to adverse health impacts in non-smokers, increase the risk of meningococcal carriage, cognitive impairment, medical attend rate among children, LBW, and future smoking initiation.

Meanwhile, the established findings in maternal smoking or paternal smoking literature, such as impacts to long-term fertility of female offspring (Camlin et al., 2016), increase in child adiposity and blood pressure (Oken et al., 2005), adverse impact to the immune system of offspring (Ng & Zelikoff, 2007) were not yet studied in the circumstances of ETS.

Indonesia is picked up for this study for several reasons. First, there is a comprehensive Indonesia Family Life Study(IFLS) panel database in 5 different years from 1993, 1997, 2000, 2007, 2014, which can provide us the complete picture of household smoking situations and continuos outcomes from infants up until young adulthood. Second, given the worldwide recognition of the adverse impacts of tobacco, many countries had ratified the Framework Convention on Tobacco Control (FCTC) as an effort to restrict tobacco usage. However, Indonesia is the only Asia-Pacific country who are not yet participating in FCTC up until 2017. This situation leads to the domination of the cigarettes industry, low priced cigarettes, overwhelming tobacco advertisements7, publicly opened tobacco sponsorship in Indonesia. Therefore, the number of fitted observations for this study is more easily accessed in the data. Third, as we are going to focus only on ETS, the high prevalence smoking rate of 76.2% among males in Indonesia and a low rate of 3.6% among females is matched with our requirement of samples.

The structure of the remaining parts of the paper is arranged as following: data and methodology, result and discussion, and conclusion and policy implications.

4.2 Data and Methodology

4.2.1 Data

This paper is utilizing IFLS data conducted by RAND with five different waves. They are particularly studied in the year 1993, 1997, 2000, 2007, 2014. This rich panel data set enables us to trace the consequences of fetal origin hypothesis. We start to construct the data from the household roster. The table of the number of households and detailed individual observation is reported in Table 4.1. Each wave of IFLS consists of several different questionnaires that are conducted to the different respondents within a household. The main questionnaires modules include (1) Control book for tracing, (2) Household roster and characteristics, (3)

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[7] Exceptional can be found in some city or Kabupaten as the result of establishment of regional laws (Peraturan Daerah) about non-smoking areas (Kawasan Tanpa Rokok).

Household economy, (4) Adult information (age > 15), (5) Ever-married women information, (6) Child information, (7) Anthropometric record.

Table 4.1: Number of observations from each IFLS waves

	IFLS1	IFLS2	IFLS3	IFLS4	IFLS5
Year	**1993**	**1997**	**2000**	**2007**	**2014**
No. of Ind	33,081	33,930	43,649	50,584	58,549
Detail Ind. info	14,406	19,892	25,470	29,032	34,271
No. of HH	7,224	7,608	10,291	13,056	15,349

We first identified the observation with father and mother that are living in the same household. With the information of the individual with mother information, data is merged with the women questionnaire and adult questionnaire to obtain detailed information on women's birth delivery information. Next, for each of these individual residual households, we match the dataset with our main interest explanatory variable, smoking behavior section.

For any household with one or more than one household member that is smoking will take count as ETS of the young adult later as long as the smoking behavior occurs in between the pregnant period up until five years olds. Since we are concern about the ETS issues from both SHS and THS, any households with members that are not answered to the adult questionnaire on the smoking behavior section are discarded. This is because we are not able to identify the total number of smokers in a household and the period of ETS for a person. During this process, a large number of observations are dropped due to the rules of IFLS that randomly select adults/child/married women in a household if the specific households have more than two qualified members to participate in the questionnaires. One may suspect that this will lead to sample selection biases in our study, yet, due to the nature of random selections of the respondent that implemented by IFLS crews, this issue should not be severe. Moreover, our interest is to compare the ETS households and non-ETS households. It is noteworthy to know that chances to be excluded from the study are equal between these two groups, no matter it is due to the random selections or some specific time of interviews that naturally left out certain work forced individuals.

As alternatives to the dummy indicator of ETS and non-ETS households, we also conduct the analysis using "intensity of smokes" in a household. This variable indicates the ratio of household members smoking within the households. It is calculated by dividing the smoker's member over all household member in each year and taking the average value of it over the mother's pregnancy period up until the kids turn into five years old. The distribution of the density of intensity of smokers in each household of our selected samples is illustrated in Figure 4-1. In Figure 4-1, we only include the household with smokers exists to shows the distribution among the "Treated" group.

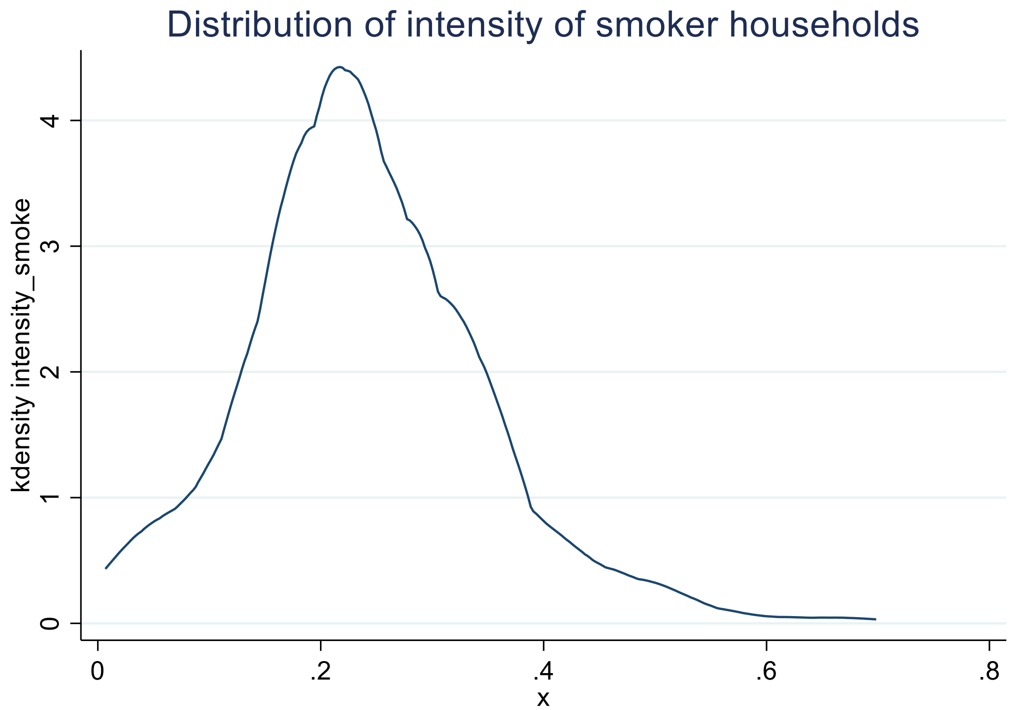

Figure 4-1: Distribution of density of intensity of smokers in households of our selected samples.

As for the outcome variables, we further match the dataset longitudinally across the waves to observe the short-term, medium-term, and long-term outcomes. The included variables are stillbirths rate, birthweights, elementary, junior high school and high school education outcomes (test score for Indonesian language, English, and Maths), smoking behavior, age starts to smoke, current salary, unemployment period, time and risk preferences. Among these outcome variables, birthweights, current salary, unemployment period, time, and risk preferences are mostly missing, and we have to give up in using them as our outcome variables.

All these data cleaning and rearrangement processes resulted in 4,610 individual observations with full household member smoking behavior information, by considering ETS and non-ETS, it yields 3,508 treated observations and 798 control observations coming from 3,771 households. Table 4.2 reports the t-test results of some household characteristics.

Table 4.2: Descriptive statistics and t-test of ETS and non-ETS groups

	Non ETS		Constant ETS		
Variables	No. obs	Mean	No. obs	Mean	Diff
Education expenditure	680	17889.65	3071	21213.79	-3324.13
Total HH expenditure	576	43173.46	2664	103525.8	-60352.3
Food expenditure	659	166443	3014	195210.7	-28767.7***

Nonfood expenditure	558	169067.5	2581	213752.2	-44684.8
Farm asset	715	4710978	3218	6011967	-1300989
Non-farm asset	715	2059381	3218	1213378	846002.8
Other asset	715	20300000	3218	13700000	6571085***
Current housing	715	6246593	3218	5629043	617549.8
Log of Farm asset	715	-5.66	3218	-4.19	-1.46**
Log of Non-farm asset	715	-14.21	3218	-14.88	0.67
Log of Other asset	715	10.56	3218	11.47	-0.91*
Log of Current housing	715	3.53	3218	2.55	0.98

Notes: Due to a large portion of zero values, logs are taken after plus with 0.0000001 to keep the observations. One to three asterisk mark represents the significant mean differences at 10%, 5%, and 1%, respectively.

4.2.2 Methodology

With the recognition to there could be a lot of confounders existing while studying the issue of ETS, and the best attempts to address this issue, this paper utilizes double-selection lasso regression and double machine learning methods (Belloni et al., 2014; Chernozhukov et al., 2018). These two methods are the improvement over the traditional lasso regression, where the selection of penalty term or turning parameter is improvised. Lasso regression is commonly used in a machine learning context. It is extremely helpful when we had a large number of samples and a large number of variables, which may be even greater than our number of observations. Lasso posed the penalty terms that reduced the number of X to avoid multicollinearity and allowed some X to be excluded from the model. The selection of X is completely data-driven by the minimization of the residual sum of squares errors. In order to simplify the discussion under methodology, the actual steps to perform these two methods are described as following. Please refer to the original paper for the mathematical equations.

For double-selection lasso regression (Belloni et al., 2014):

(i) Running linear lasso of the outcome variable, Y, on a series of control variables, X, to obtain the selected $\widehat{x_y}$. In this paper, we tuned our penalty parameter by using cross-validation (CV) methods.

(ii) Running linear lasso of the treatment variable, D, on the same series of control variables, X, to obtain the selected $\widehat{x_d}$

(iii) Run an OLS regression of outcome variable on treatment variable, D, and the union of selected X variables, which is $\widehat{x_y}$ & $\widehat{x_d}$

This method utilized the advantages of the lasso to fine-tune the X variables to be included in the model. Unlike the traditional lasso, that minimized the covariates to be held by one time, it runs twice to ensure the factors that influence both outcome and treatment variables are controlled. Thus, the coefficient of treatment variable will tell us the extent of influences our main interest variables posed on the outcome.

For double machine learning methods (Chernozhukov et al., 2018):

(i) Split data into K folds. In this paper, we applied K=10

(ii) Use K=1 dataset to perform followings:

(1) Run lasso of Y on X to obtain $\widehat{x_y}$

(2) Regress Y on $\widehat{x_y}$, to obtain the coefficients of $\widehat{\beta_{k1}}$.

(3) Run lasso of D on X to obtain $\widehat{x_d}$

(4) Regress D on $\widehat{x_d}$, to obtain the coefficients of $\widehat{\gamma_{k1}}$.

(iii) Use other data that not included in K=1 dataset, to calculate:

(1) Residuals of Y, $\tilde{Y} = Y - \widehat{x_y}\widehat{\beta_{k1}}$

(2) Residuals of D, $\widetilde{D} = d - \widehat{x_d}\widehat{\gamma_{k1}}$

(3) Run separate lasso of Y on X to obtain $\widehat{x_y}$

(4) Regress Y on $\widehat{x_y}$, to obtain the coefficients of $\widehat{\beta_{k\prime}}$.

(5) Run separate lasso of D on X to obtain $\widehat{x_d}$

(6) Regress D on $\widehat{x_d}$, to obtain the coefficients of $\widehat{\gamma_{k\prime}}$.

(iv) Use K=1 dataset to calculate:

(1) Residuals of Y, $\tilde{Y} = Y - \widehat{x_y}\widehat{\beta_{k\prime}}$

(2) Residuals of D, $\widetilde{D} = d - \widehat{x_d}\widehat{\gamma_{k\prime}}$

(v) Using full data, regress $\tilde{Y}$ on $\widetilde{D}$ to obtain the estimated coefficients of $\widetilde{D}$

This method utilized two fundamental criteria to avoid overfitting issues and correlation of error terms to the covariates. They are the samples splitting in step (i) which splitting all samples into K folds for the out-of-sample calculation, and not estimating coefficients for selected X in step (v) to avoid the plausible biases arise from model-selection. The regression of residuals of the outcome variable on the residuals of the treatment variable is also known as partialing-out methods, origin from the Frinsh-Waugh-Lovell theorem.

Besides these, we also illustrated two different approaches to compute penalty terms and the coefficients selected by the models for three outcomes to justify our selection of CV for all the remaining models. We compare two approaches: (i) plugin default that chooses the smallest value of the penalty term without computing the minimized loss function during the lasso process, and (ii) CV methods. For CV methods, the original datasets are divided into equal sizes K-folds. The fitted model formed from the training data, K fold, will be tested by K-1 fold data to test its prediction properties to minimize the loss function in the lasso model.

Note that we also follow the practices to include all raw covariates and all second-order terms, which includes of squares of continuous variables, and first-order interactions for all covariates (Chernozhukov et al., 2018). This yields our potential control variables to 1,351 from originally 39 raw control variables. We also include indicators of missing values in our data. We try to run both versions using all potential control variables and only the 35 raw control variables, and the results are consistent in the coefficient negative or positive sign, the only differences lay on small changes of coefficients and significance. For the sake of brevity, we only report the results that include all second-order terms.

4.3 Results and Discussions

Table 4.3 reports the outcomes of ETS and its relationship to birth weight, smoke initiation, and the age begins to smoke using double selection lasso, double machine learning methods, and computation of penalty term of plugin and CV. In general, we can see that the control variables selected by tuning the lambda using CV are quite different from those chosen by plugin default. It is worth to note that CV increases the precisions by repetitively computing the distinct value of lambda using the K-fold methods to minimize the loss function of the lasso. While the findings using both plugin and CV methods usually yield the same negative or positive sign of coefficient with only the difference in the degree of the coefficient.

Birthweight and age to begins smoking don't significantly associate with the ETS, while the smoke initiation is positively significant. By using double selection lasso methods with CV, it is reported with 4.7% higher chances among individuals who exposed to tobacco smoke in their early life to smoke after they grow up. With double machine learning methods with CV that further reduce the correlation of residuals with covariates, it is reported with 4.3% higher chances that ETS will associate with smoking initiation. Although the coefficient is found to be negative for age begins to smoke, it is not significant in all specifications of models.

Table 4.3: Main result table for birthweight, smoke initiation and age begins to smoke

Double Selection Lasso

	(1)	(2)	(3)	(4)	(5)	(6)
	Birthweight	Birthweight	Smoke Initiation	Smoke Initiation	Age begins to smoke	Age begins to smoke
ETS	0.026	0.031	0.053***	0.047***	-0.277	-0.254
	(0.039)	(0.040)	(0.015)	(0.015)	(0.226)	(0.224)
X_potential	1351	1351	1351	1351	1351	1351
X_selected	3	3	13	37	8	10
Methods for λ computation	Plugin	CV	Plugin	CV	Plugin	CV
N	2311	2311	4180	4180	1255	1255

Double Machine Learning

	(7)	(8)	(9)	(10)	(11)	(12)
	Birthweight	Birthweight	Smoke Initiation	Smoke Initiation	Age begins to smoke	Age begins to smoke
ETS	0.022	0.022	0.052***	0.043***	-0.227	-0.231
	(0.039)	(0.039)	(0.015)	(0.015)	(0.219)	(0.223)
X_potential	1351	1351	1351	1351	1351	1351
X_selected	8	36	54	153	41	65
Methods for λ computation	Plugin	CV	Plugin	CV	Plugin	CV
N	2311	2311	4180	4180	1255	1255

Notes: One to three asterisk mark represents the significant mean differences at 10%, 5%, and 1%, respectively. X_potential denotes the number of potential covariates. X_selected denotes the number of covariates selected for the model. Robust standard error in parentheses.

Table 4.4 reports the result using the exact same specifications in Table 4.3, with treatment variable now change to intensity of smokers exists in the household. Similarly, there is no relationship found on birthweight with the intensity of smokers. Smoke initiation is found to be strongly correlated, while higher precisions in the estimation using CV methods have a slightly lower coefficient than those estimated using the plugin method. In addition, the age of one begins to smoke is now found to be significantly associated with the intensity of smokers. By using the CV method, it is reported that when one has more family members who smoke during their fetal period up to five years old, he or she may start smoking at 2.45 to 3.06 years old younger than those who have relatively less intensity level of exposure to smokers.

Table 4.4 Main result table for birthweight, smoke initiation and age begins to smoke using the intensity of smokers

Double Selection Lasso

	(1)	(2)	(3)	(4)	(5)	(6)
	Birthweight	Birthweight	Smoke	Smoke	Age begins	Age begins

			Initiation	Initiation	to smoke	to smoke
Intensity of smokers	0.010	-0.012	0.198***	0.187***	-2.440***	-2.454***
	(0.146)	(0.148)	(0.043)	(0.043)	(0.577)	(0.576)
X_potential	1351	1351	1351	1351	1351	1351
X_selected	2	24	10	87	2	16
Methods for λ computation	Plugin	CV	Plugin	CV	Plugin	CV
N	2466	2466	4480	4480	1342	1342

	Double Machine Learning					
	(7)	(8)	(9)	(10)	(11)	(12)
	Birthweight	Birthweight	Smoke Initiation	Smoke Initiation	Age begins to smoke	Age begins to smoke
Intensity of smokers	-0.002	-0.029	0.208***	0.202***	-2.293***	-3.062***
	(0.146)	(0.138)	(0.043)	(0.043)	(0.570)	(0.765)
X_potential	1351	1351	1351	1351	1351	1351
X_selected	9	93	35	162	21	90
Methods for λ computation	Plugin	CV	Plugin	CV	Plugin	CV
N	2466	2466	4480	4480	1342	1342

Notes: One to three asterisk mark represents the significant mean differences at 10%, 5%, and 1%, respectively. X_potential denotes the number of potential covariates. X_selected denotes the number of covariates selected for the model. Robust standard error in parentheses.

Table 4-5 reports the main outcome result of the double selection lasso model and double machine learning model for education outcomes in elementary school, junior high school, and high school. These are the test score for the national examination, which is known as Evaluasi Belajar Tahap Akhir Nasional (EBTANAS) up until the year 2002, or Ujian Akhir Nasional (UAN) for the year 2003 to 2004, or Ujian Nasional (UN) for the year 2005 onwards. Meanwhile, column 10 & 11 for Table 4-5 are referring to the dummy of ever fail or repeat a grade during the school life.

Language scores are found to be negatively significantly associated with ETS under double selection lasso model. ETS is correlated to 0.144 lower in the Indonesian language test score during elementary school, but such a negative relationship is faded in junior high and high school. Whereas English language test score is found to be negatively associated with ETS by 0.148 in junior high school which is also quickly catch up once one is enrolled in high school. Persistent negatively relationship is found for the Indonesian language test score in elementary school with 0.13 lower score when double machine learning model is exercised, but not in the English score.

Table 4.5: Main result table for education outcomes

Double Selection Lasso Educational Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
		Elementary			Junior High			High School			
	Indonesian	English	Maths	Indonesian	English	Maths	Indonesian	English	Maths	Fail a grade (dummy)	Repetition of school (dummy)
ETS	-0.144**	0.064	-0.039	-0.083	-0.148**	-0.081	0.011	0.098	0.088	0.006	0.030
	(0.060)	(0.188)	(0.080)	(0.062)	(0.073)	(0.085)	(0.085)	(0.093)	(0.117)	(0.016)	(0.022)
X_potential	1351	1351	1351	1351	1351	1351	1351	1351	1351	1351	1351
X_selected	19	3	26	31	36	41	8	19	32	11	10
N	2668	516	2679	2441	2423	2432	1402	1414	1348	4141	4141

Double Machine Learning Educational Outcomes

	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
		Elementary			Junior High			High School			
	Indonesian	English	Maths	Indonesian	English	Maths	Indonesian	English	Maths	Fail a grade (dummy)	Repetition of school (dummy)
ETS	-0.130*	0.011	-0.015	-0.078	-0.105	-0.116	0.062	0.095	0.184	0.008	0.029
	(0.067)	(0.217)	(0.083)	(0.069)	(0.097)	(0.090)	(0.080)	(0.094)	(0.156)	(0.016)	(0.022)
X_potential	1351	1351	1351	1351	1351	1351	1351	1351	1351	1351	1351
X_selected	117	35	73	114	114	167	110	69	85	42	50
N	2668	516	2679	2441	2423	2432	1402	1414	1348	4141	4141

Notes: One to three asterisk mark represents the significant mean differences at 10%, 5%, and 1%, respectively. X_potential denotes the number of potential covariates. X_selected denotes the number of covariates selected for the model. Robust standard error in parentheses.

Table 4.6: Main result table for education outcomes using intensity of smokers

Double Selection Lasso Educational Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Elementary			Junior High			High School				
	Indonesian	English	Maths	Indonesian	English	Maths	Indonesian	English	Maths	Fail a grade (dummy)	Repetition of school (dummy)
Intensity of smokers	-0.381**	-0.335	-0.196	-0.253	-0.625***	-0.504*	0.180	-0.018	-0.051	0.081*	0.190***
	(0.178)	(0.563)	(0.233)	(0.180)	(0.233)	(0.258)	(0.251)	(0.284)	(0.340)	(0.047)	(0.068)
X_potential	1351	1351	1351	1351	1351	1351	1351	1351	1351	1351	1351
X_selected	19	9	39	55	57	68	24	24	16	17	14
N	2848	553	2862	2618	2599	2609	1502	1513	1445	4440	4440

Double Machine Learning Educational Outcomes

	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
	Elementary			Junior High			High School				
	Indonesian	English	Maths	Indonesian	English	Maths	Indonesian	English	Maths	Fail a grade (dummy)	Repetition of school (dummy)
Intensity of smokers	-0.400**	-0.723	-0.056	-0.141	-0.533**	-0.488*	0.230	-0.473	-0.104	0.072	0.169***
	(0.180)	(0.576)	(0.146)	(0.172)	(0.245)	(0.265)	(0.245)	(0.575)	(0.354)	(0.044)	(0.064)
X_potential	1351	1351	1351	1351	1351	1351	1351	1351	1351	1351	1351
X_selected	101	28	91	159	161	175	115	109	136	70	58
N	2848	553	2862	2618	2599	2609	1502	1513	1445	4440	4440

Notes: One to three asterisk mark represents the significant mean differences at 10%, 5%, and 1%, respectively. X_potential denotes the number of potential covariates. X_selected denotes the number of covariates selected for the model. Robust standard error in parentheses.

Table 4.6 reported the result of education outcome using the intensity of the smokers in each household. Unlike the ETS and non-ETS household outcomes, the intensity of smokers posed some significant negative relationship on the language test score. In particular, it shows about 0.38 lower scores in Indonesian language tests in elementary school, and 0.63 lower scores for English language tests in junior high school using double selection Lasso methods. Double machine learning shows a robust result of 0.40 lower scores in Indonesian language tests in elementary and 0.53 lower scores in English language tests in junior high school. Maths scores in junior high school are also reported to be negatively associated with the exposure to the high intensity of smoking family members, with a range of 0.49 to 0.50 lower with a different model.

Last but not least, we also observed greater changes (in the range of 16.9% to 19%) of repetition of school in both models and an 8% higher chance of failing a grade under the double selection model.

4.4 Conclusions and Policy Implications

Given the comprehensive 21 years panel data, this paper study the association of ETS during earlier life to one's later life. Our paper is contributing to the literature of ETS by comprehensive ETS information since we only took account the sample with all household member smoking behavior were recorded in the survey. We define ETS as a combination and not limited to SHS or THS in the household. At the same time, the situation in Indonesia of more than 76.2% males prevalence of tobacco smoke enables us to distinguished the maternal smoking influence during the prenatal or perinatal period with the sole ETS. This brought a meaning that all the mothers with child's ETS are also passive smokers as the result of other household members are smoking. It also distinguished our study with maternal smoking as, in that case, the transmission of nicotine could occur through a genetic, biological channel, or maternal breastfeeding.

In this paper, we found that ETS in early life is associated with smoking initiation, which is a very intuitive result. Our main findings are pointed on the negative language test scores outcome of the early life ETS individual in their adolescent age. While further developing the model and examining the intensity of smokers (ratio of smokers among family members), those who have a greater degree of exposure are found to have higher chances to start smoking, at about two years old younger than those who have relatively less exposure. These findings were consistent with the previous literature findings, and even proving the negative effects is continually occurred until one in their junior high school. Although with the slightly different in the definition of ETS, previous literature shows the adverse impacts on the language abilities of children at their first two years of life if they were ETS during the maternal pregnancy period (Eskenazi & Castorina, 1999; He et al., 2018; Polanska et al., 2017). While Eskenazi & Castorina (1999) raise the issue without clear evidence, He et al. (2018) showing the exists of such negative influences among rural households in China, while Polanska et al. (2017) showing child psychomotor development were affected by ETS.

Our findings further confirmed the associations of ETS to language ability through the study of test scores in the national exam in elementary school and junior high school. Even at the age of junior high school, individuals who are ETS are still vulnerable and less competitive to their counterparts who are not exposed to tobacco smoke. The sub-analysis using the intensity of smokers further showing the higher ratio of smokers among family members are associated with one's lower Indonesian language test score in elementary school exams, lower English language test score in junior high school exam and even lower maths score. This intensity of smokers also related to higher chances of school repetition.

This finding alarmed the need for Indonesia policymakers or regulators to imposed stricter rules on public areas smoking to prevents the negative influences to the next generations. Since the year 2009, Indonesia central government imposed a national law, Raperda Kawasan Tanpa Rokok Topang UU 36/2009, about the non-smoking area (Kawasan tanpa rokok, KTR). However, the complication of law implementations in Indonesia allows each provincial government to slowly adapt to this UU and reform the local law for the execution cause a lot of delays while the prevalence rate of the smoking population doesn't seem to be slow down throughout the year. Amalia et al., (2019) also reported the ineffectiveness of this KTR law in influencing the smoking behavior among Indonesian. Therefore, we would like to urge the policymakers for law reform and general household to be reconsidered before they get to smoke at home, which may exert bad influences on the next generations.

Last but not least, we also would like to highlight some limitations of this study and hoping the future research could take these aspects into consideration. First of all, this study cannot be regards as a causal impact study, as smoking behavior are suffered from self-selection biases. Although we try to prove that the smoker's households are quite similar to the non-smoker's households in general, there is still some significant difference in the characters which we are not able to deny. While this study may not be able to address causality issues, our findings are still demonstrated a strong association relationship and predictive value of early life ETS to individual long term outcomes. Secondly, this study is based on a secondary household survey panel data, most of the information including the smoking behavior as such start smoking day and others are all on a self-report recall basis, we are not able to recheck the truthfulness of the data, and may subject to some amount of recall biases. Thirdly, this study may have limited external validity issues as the situation in Indonesia is too special, compares to other countries, as such, the high prevalence of male smoking rates and also those culture norms issue. To validate the applicability of the findings in this paper, some further research in other countries settings or causality studies are needed.

5 Conclusion

With all the three case studies discussed above, I would like to draw the attention back to the SDG issues. Back to the point of how individual households can proactively respond or already responded to the call of actions towards SDGs, under Goal 12, it is more intuitive and direct that household can maintain sustainable consumption, and do not over-consume on the expense of future generations. Apart from this, households can also rationally contributed to other SDGs goals by having an environmentally friendly choice, consume a proper healthier diet, or having a good lifestyle habit.

In Case study 1, we see that natural material residential buildings are mitigating the spike increase in electricity demands in Indonesia throughout the year 2007 to 2011. However, based on the actual statistics, natural material residential buildings are shown to be decreased over the years. A proactive household may consider reforming their residential housing using some vernacular structure and building materials to mitigate the high rise of electricity needs. Such awareness of household may need to be increased with the efforts of policymakers or developers.

In Case study 2, the causality of government fish levies abolition policy with its impact on household fishery and other animal protein consumption is studied. This sheds light on policymakers on how to influences or directs the household food consumption towards desirables' nutritious, rich diets. The findings show that income and substitution effects resulted from fish price reduction are turning households to increase their consumption in both fish and chicken. This situation is ideal where it can help to accomplished SDGs goal 2 and goal 3.

In Case study 3, the harmful good, tobacco consumption in households was studied. We look at how tobacco consumption creates an undesirable situation of early life exposure to tobacco smoke and examine its relationship to one later life performance or behavior. Given the negative influences are found, it is reasonable for a household to refrain from tobacco consumption. However, this seems to be challenging as the high prevalence of smoking rates among Indonesian, and it commonly occurs in all quantile households, probably due to the social norms and cultures. In this situation, the intervention from policymakers for desirables outcomes is highly required, as such, provides education to develop awareness.

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Appendix

For Chapter 2

I. Justification of factors selected as other determinants that affect household electricity consumption

As noted in the introduction, among socioeconomic indicators, income is consistently reported as the primary factor determining residential electricity consumption in both developed and developing countries (Esmaeilimoakher et al., 2016; Huebner et al., 2016; McLoughlin et al., 2012; Romero-Jordán et al., 2016; Thogersen & Gronhoj, 2010; Wallis et al., 2016). It has been widely discussed that wealthier households are expected to have a greater tendency to purchase luxurious and large equipment and home appliances, which contribute to higher electricity demands (Kroon et al., 2013; Tyler, 1996; Zhang et al., 2016). However, in developed countries, people also become more environmentally aware as income increases, so their energy-saving behavior would negatively contribute to the total household electricity consumption (Han et al., 2013).

As observed by Wiesmann et al. (2011), income has a much lower impact on electricity consumption when other control variables are considered. When income data for developing countries are not available or accurate, various proxy variables of household wealth or factors that are directly affected by income can be used to collectively capture the effects of income (Romero et al., 2013). As this issue applies to our case of the SUSENAS core and module surveys, we used several proxy variables for household wealth to determine the influence of income including the monthly rental rate for housing, a dummy indicator for being a recipient of the food subsidy program known as RASKIN, the monthly food expenditures, and monthly non-food expenditures. It should be noted that the approximate estimations for the housing rental rate were obtained from the homeowners in our sample. To ensure comparability, all monetary variables were converted into the 2011 real value in Indonesian Rupiah (IDR) and logarithmically transformed.

The second major category consists of household demographic factors that typically include family size, the number of infants and school children, the number of elderly persons, and the characteristics of the household head, such as age, educational attainment, and occupation. In the literature, these variables are considered to represent lifestyle, behavior, and the amount of time spent at home(Bartusch et al., 2012; Bedir et al., 2013; Brounen et al., 2012; Fritzsche, 1981; Huang, 2015; Laicane et al., 2015; Swan & Ugursal, 2009; Tso & Guan, 2014; Wallis et al., 2016; Wiesmann et al., 2011; Yohanis et al., 2008).

Major building-related indicators such as building age, number of rooms, number of stories and house type (detached or not) (Chong, 2012; Huebner et al., 2016; Kuusela et al., 2015; Wiesmann et al., 2011) could not be included due to the data being unavailable. Thus, we used total floor area as an indicator related to building category.

II. Data source detail information

In the SUSENAS dataset, there are two typical types of surveys: (i) the core survey for households and individuals and (ii) the module surveys. The first survey occurs every year to collect demographic information. In contrast, the module surveys can be further categorized into three types that are conducted successively every three years: (a) sociocultural and educational, (b) housing and health, and (c) household consumption and expenditure.

To work on our analysis, the core and module surveys were merged by household ID, and household population weights were incorporated into all analyses to ensure their national-level representability. The urban and rural classification of each household in this study is that of the SUSENAS by default following guidelines from the BPS. This classification is made based on a list of criteria such as population density, the proportion of agricultural households[8], access to urban facilities, the availability of public facilities and the proportion of land used for purposes other than housing at the village level.

The total number of observations in the dataset is 125,981 cross-sectional repeated households (57,578 for 2007 and 61,101 for 2011) spread across approximately 4,300 census blocks in every kabupaten (city) in Indonesia. After the data cleaning process, which includes removing inconsistent and incomplete observations as well as households with zero electricity consumption, the final number of observations used in our data analysis was 118,679. The inconsistency occurs due to some household failed to complete the module surveys, while the

[8] In BPS terminology, the indicator "agricultural household" is used when the major occupation of a household is in the agriculture industry.

incomplete observations apply to those households failed didn't answer any of the core information that we used in our analysis.

As reported by Sulistiyo, Banchongphanith, and Kaneko(2011), household electricity un-subscriber (HEUS) user groups, whose usage cannot be tracked, are common, and we assume that these HEUS users are among the households with zero consumption. Since we are unable to differentiate their usage and to ease the interpretation, we chose to exclude these zero-consumption groups from the analysis in this study.

III. Detail methodology discussion

i. BD Decomposition

As explained, BD decomposition (Oaxaca, 1973) allows us to decompose the electricity consumption increment between year 2011 and 2007 to each determinant mentioned in section 3. The detailed steps in decomposing the changes in electricity consumption are as follows:

a) Separate the sample into urban group and rural group, calculate the differences in electricity consumption between year 2011 and 2007 of each group.
b) With equation (2), we consider these differences are the result of difference in intercept, difference in slope, β, and difference in observed X variables. In which, we consider difference in intercept and difference in slope as coefficient effect, and the latter one as characteristic effect.
c) We further quantified the contribution of each X, our selected list of determinant variables, to each coefficient effects and characteristic effects in percentage form.

BD decomposition allows us to quantify the changes occurs in between two years into two main separated effects and further quantify them into particular changes in each determinant. This methodology posed an advantage by enabling us to separate the differences of electricity consumption throughout year into changes imposed by physical quantities in X and changes due to the slope intensity changes in reaction to unit of change in X, whereas in our main interest context, X is different building types of residential housing in Indonesia.

This advantage is best suited to our objective as we presume building types housing stock is changed throughout year as the preferences of people for residential building may change throughout year due to increase in income and circumstance of local community as elaborated in section 2. Furthermore, we also presume the coefficients of different building types to be varies with time and region due to dynamic changes of surrounding environment in parallel to tremendous urbanization taken place in Indonesia.

ii. FFL Decomposition

FFL (unconditional quantile) decomposition allows us to assess the quantile effects of different building types on household electricity consumption. The fundamental of FFL lay on the idea of re-centered influence function which can be estimated as following:

$$RIF\left(Y_{tji};\ Q_\tau\right) = Q_\tau + \frac{\tau - I(Y_{tji}\ \leq\ Q_\tau)}{f(Q_\tau)} \qquad (E1)$$

where Q_τ is the specific quantile, in our study is 10^{th}, 50^{th} and 90^{th} quantile, f is the marginal density function of Y, I(·) is the indicator that equal to one when Y_{tji} is less than Q_τ, t denotes A: 2011, B: 2007, j denotes C: urban, D: rural, and i denotes household. Note that the true value of RIF is never been observed, therefore, unknown value in E1 is all estimated using the sample estimator values. By adding the influence function (second term of E1) to the quantile statistic (first term of E1) with conditional on interest X, we are able to obtain the estimated conditional electricity consumption distribution of interest. The detailed steps in decomposing the changes in electricity consumption using FFL are as following:

a) Recover the average partial effect of small change in value of X on the unconditional τ quantile using RIF as in equation (E1).
b) Similarly, steps (a) to (c) explained under BD decomposition section are repeated with the equation (2) are now replaced equation (3), in other words, outcome Y is replaced with the RIF values estimated using (E1) for each quantile, year, region groups.

This FFL decomposition is crucial and posed a huge advantage as it enable us to estimate the changes in electricity consumption distribution in 10^{th}, 50^{th}, and 90^{th} quantile imposed by changes in building types. In other words, FFL decomposition can be view as a generalization of OB decomposition that allow one to decompose the changes in two distributions, unconditional quantile in our case.

We didn't consider panel data regression in this circumstance due to two main reasons. First, our data are not panel households. Second, although panel data regression posed the merits of fixed effects that can help us to remove the unobservable household fixed effects, it is not aligned with our research objectives. As mentioned in our introduction and background section, current distribution of housing stock in Indonesia is quite complex due to several aggregating effects from income growth, urbanization, community preference, and local government consideration. Therefore, our targets here are two folds: (i) to understand the current distribution of building types by region-wise and quantile-wise in terms of electricity consumption, and how does these distribution of housing stock had been changed throughout year by quantifying it using the characteristics effects of BD and FFL equations (ii) to what extend each of these building types associated to the electricity consumption by quantifying it using coefficient effects of BD and FFL equations.

IV. OLS Table

	2007			2011		
VARIABLES	**(1) All**	**(2) Urban only**	**(3) Rural only**	**(4) All**	**(5) Urban only**	**(6) Rural only**
Region areas	0.128***			0.178***		
	(0.007)			(0.007)		
<u>Dwelling's characteristic factors</u>						
Dwelling's types (Clay Tile I base)						
Natural Material	-0.281***	-0.110***	-0.372***	-0.320***	-0.275***	-0.368***
	(0.021)	(0.039)	(0.025)	(0.018)	(0.029)	(0.022)
Zinc	-0.171***	-0.134***	-0.211***	-0.126***	-0.117***	-0.135***
	(0.008)	(0.010)	(0.011)	(0.007)	(0.010)	(0.010)
Clay Tile II	-0.066***	-0.070***	-0.094***	-0.035***	-0.011	-0.075***
	(0.009)	(0.017)	(0.011)	(0.010)	(0.018)	(0.011)
Concrete	-0.005	-0.008	-0.054*	-0.017	-0.021	-0.009
	(0.013)	(0.015)	(0.032)	(0.013)	(0.015)	(0.025)
Other Types	-0.165***	-0.075***	-0.253***	-0.101***	-0.020	-0.195***
	(0.021)	(0.032)	(0.028)	(0.018)	(0.035)	(0.021)
Log of floor wide (m^2)	0.137***	0.138***	0.112***	0.160***	0.176***	0.120***
	(0.005)	(0.006)	(0.008)	(0.006)	(0.008)	(0.008)
Dwelling's ownership	0.034***	0.065***	-0.050**	0.047***	0.012***	0.020
	(0.008)	(0.010)	(0.015)	(0.008)	(0.011)	(0.013)
Constant	-0.652***	-0.765***	0.059***	1.865***	1.622***	2.678***
	(0.090)	(0.121)	(0.138)	(0.085)	(0.122)	(0.115)
Household demographic factors fixed	Yes	Yes	Yes	Yes	Yes	Yes
Household wealth factors fixed	Yes	Yes	Yes	Yes	Yes	Yes
Observations	57,578	25,261	32,317	61,101	28,000	33,101
R-squared	0.536	0.570	0.343	0.553	0.568	0.379

Notes: Column (1) to (3) are the OLS result of panel 1 to 3 (all samples, urban area households, rural area households) for 2007, whereas column (4) to (6) is for year 2011. Outcome variable is log of electricity consumption per capital measured in Rupiah. Household demographic factors includes of family size, household head education level, number of child aged 0-4, number of schooling children aged less than 18, and household head job sector dummies. Household wealth factors includes of log of dwelling's monthly rental, RASKIN food program subsidy receivers, log of monthly non-food expenditure and log of monthly food expenditure. Robust standard errors in parentheses. *, **, and *** indicate significance level of 10%, 5% and 1% respectively.

Table A 1: OLS result table with 3 panels

V. Unconditional Quantile Regression Table

	Urban 2007			Rural 2007		
VARIABLES	10th	50th	90th	10th	50th	90th
Dwelling's characteristic factors						
Dwelling's types (Clay Tile I base)						
Natural Material	-0.237***	-0.084**	-0.049	-0.487***	-0.344***	-0.147***
	(0.079)	(0.045)	(0.053)	(0.049)	(0.025)	(0.033)
Zinc	-0.124***	-0.153***	-0.104***	-0.290***	-0.214***	-0.067***
	(0.023)	(0.015)	(0.021)	(0.020)	(0.014)	(0.021)
Clay Tile II	-0.232***	-0.124***	0.136***	-0.112***	-0.128***	-0.042**
	(0.050)	(0.023)	(0.023)	(0.023)	(0.016)	(0.019)
Concrete	-0.035	0.037	0.076*	-0.183***	-0.060**	0.193***
	(0.026)	(0.023)	(0.040)	(0.047)	(0.035)	(0.074)
Other Types	-0.274***	-0.009	-0.048	-0.612***	-0.238***	0.135***
	(0.081)	(0.045)	(0.056)	(0.058)	(0.029)	(0.042)
Log of floor wide (m^2)	0.060***	0.131***	0.223***	0.137***	0.084***	0.117***
	(0.014)	(0.016)	(0.014)	(0.015)	(0.010)	(0.015)
Dwelling's ownership	0.048***	0.100***	0.034	-0.011	-0.025	-0.096***
	(0.023)	(0.016)	(0.021)	(0.028)	(0.019)	(0.029)
Constant	1.915***	-1.794***	-1.463***	2.191***	-0.848***	-1.844***
	(0.272)	(0.173)	(0.290)	(0.261)	(0.170)	(0.280)
Household demographic factors fixed	Yes	Yes	Yes	Yes	Yes	Yes
Household wealth factors fixed	Yes	Yes	Yes	Yes	Yes	Yes
Observations	25,261	25,261	25,261	32,317	32,317	32,317
R-squared	0.147	0.413	0.250	0.101	0.287	0.179

Notes: Column (1) to (5) is the quantile regression of urban area households of 2007, column (6) to column (10) is the quantile regression of rural area household respectively. Outcome variable is log of electricity consumption per capital measured in Rupiah. Household demographic factors includes of family size, household head education level, number of child aged 0-4, number of schooling children aged less than 18, and household head job sector dummies. Household wealth factors includes of log of dwelling's monthly rental, RASKIN food program subsidy receivers, log of monthly non-food expenditure and log of monthly food expenditure. Robust standard errors in parentheses. *, **, and *** indicate significance level of 10%, 5% and 1% respectively.

Table A 2: Unconditional Quantile Regression Table of Year 2007

VARIABLES	Urban 2011 10th	Urban 2011 50th	Urban 2011 90th	Rural 2011 10th	Rural 2011 50th	Rural 2011 90th
<u>Dwelling's characteristic factors</u>						
Dwelling's types (Clay Tile I)						
Natural Material	-0.529***	-0.190***	-0.173***	-0.602***	-0.344***	-0.113***
	(0.094)	(0.039)	(0.048)	(0.047)	(0.027)	(0.036)
Zinc	-0.173***	-0.103***	-0.072***	-0.250***	-0.157***	-0.000
	(0.022)	(0.014)	(0.023)	(0.017)	(0.014)	(0.022)
Clay Tile II	-0.167***	-0.061**	0.277***	-0.061**	-0.123***	0.019
	(0.055)	(0.025)	(0.028)	(0.024)	(0.018)	(0.021)
Concrete	-0.003	-0.003	0.053	-0.142***	0.027	0.139**
	(0.028)	(0.023)	(0.045)	(0.039)	(0.034)	(0.058)
Other Types	-0.269***	0.057	0.242**	-0.443***	-0.232***	0.116***
	(0.088)	(0.045)	(0.073)	(0.050)	(0.028)	(0.038)
Log of floor wide (m^2)	0.160***	0.142***	0.224***	0.149***	0.094***	0.122***
	1.692(0.016)	1.693(0.011)	1.694(0.020)	1.695(0.015)	1.696(0.011)	1.697(0.017)
Dwelling's ownership	0.060***	0.068***	0.005	0.063***	-0.003	-0.021
	(0.024)	(0.016)	(0.027)	(0.024)	(0.018)	(0.030)
Constant	2.607***	2.538***	-0.353	2.707***	2.648***	2.206***
	(0.270)	(0.166)	(0.339)	(0.229)	(0.156)	(0.255)
Household demographic factors fixed	Yes	Yes	Yes	Yes	Yes	Yes
Household wealth factors fixed	Yes	Yes	Yes	Yes	Yes	Yes
Observations	28,000	28,000	28,000	33,101	33,101	33,101
R-squared	0.140	0.377	0.267	0.123	0.248	0.165

Notes: Column (1) to (5) is the quantile regression of urban area households of 2011, column (6) to column (10) is the quantile regression of rural area household respectively. Outcome variable is log of electricity consumption per capital measured in Rupiah. Household demographic factors includes of family size, household head education level, number of child aged 0-4, number of schooling children aged less than 18, and household head job sector dummies. Household wealth factors includes of log of dwelling's monthly rental, RASKIN food program subsidy receivers, log of monthly non-food expenditure and log of monthly food expenditure. Robust standard errors in parentheses. *, **, and *** indicate significance level of 10%, 5% and 1% respectively.

Table A 3: Unconditional Quantile Regression Table of Year 2011

For Chapter 3

I. Supporting Figures

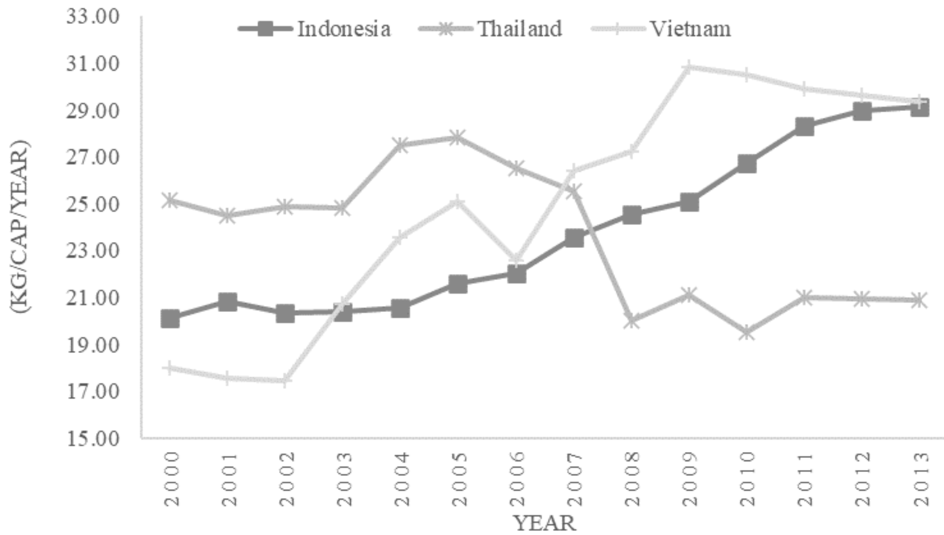

Figure A 1: Fisheries production in Indonesia, Thailand and Vietnam from 2000 to 2015

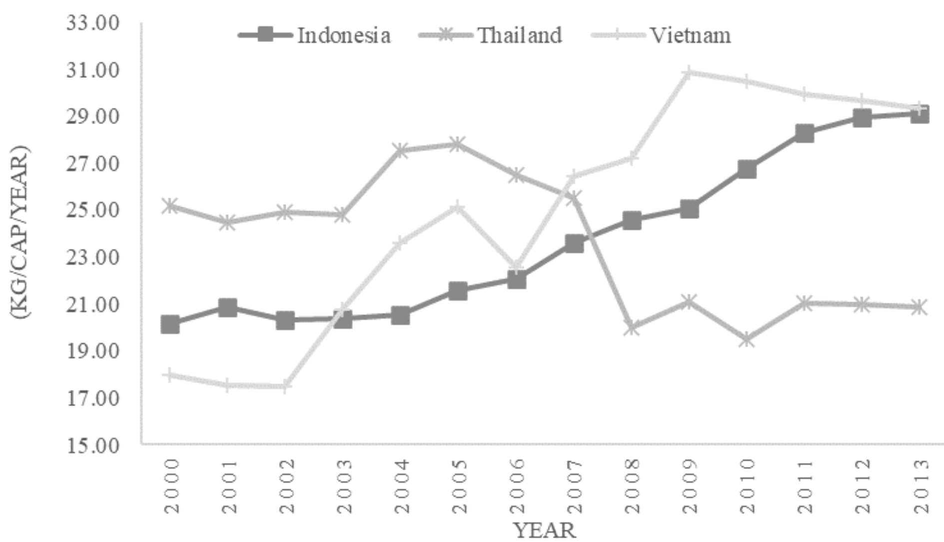

Figure A 2: Fisheries production in Indonesia, Thailand and Vietnam from 2000 to 2015

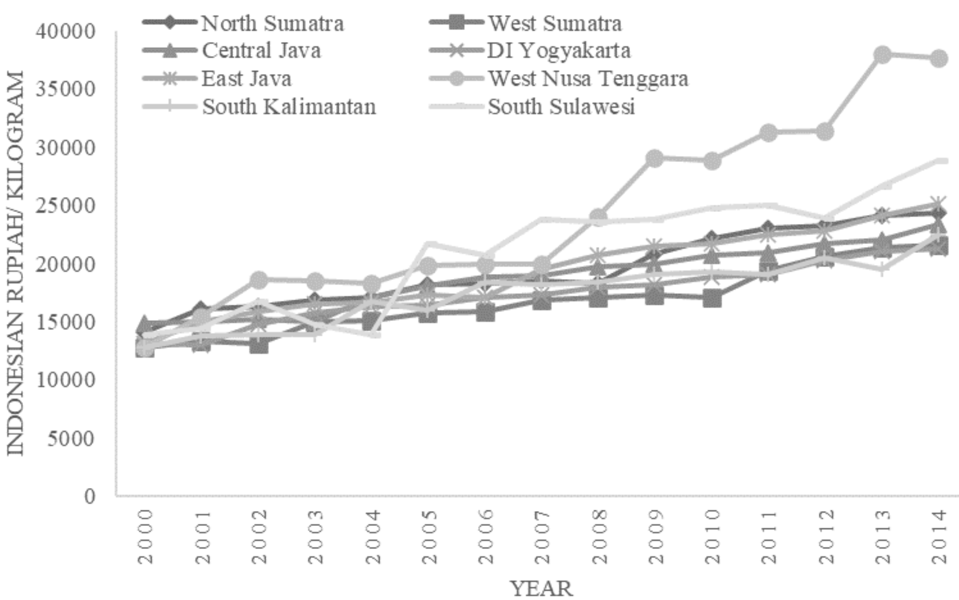

Figure A 3: Fresh fish price changes in control provinces

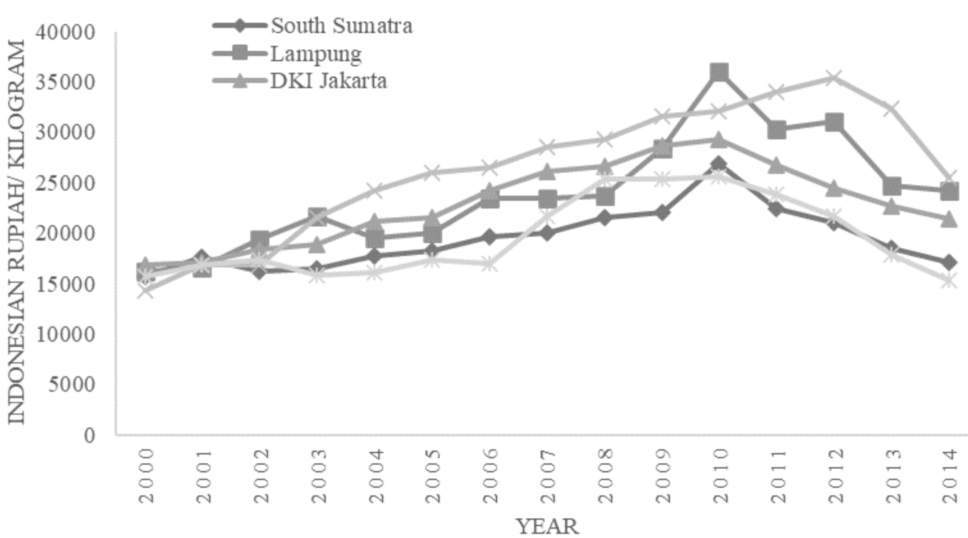

Figure A 4: Fresh fish price changes in treatment provinces

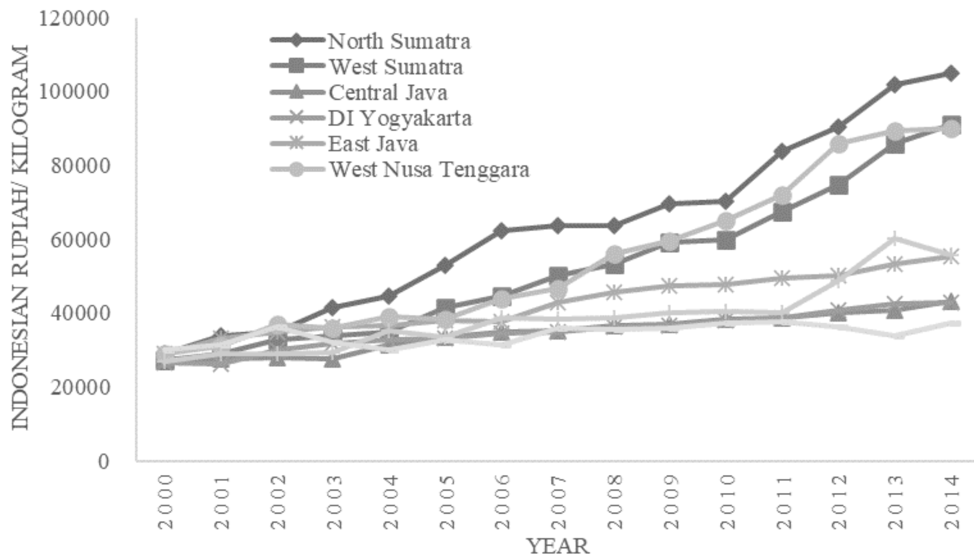

Figure A 5: Salted/Smoked fish price changes in control provinces

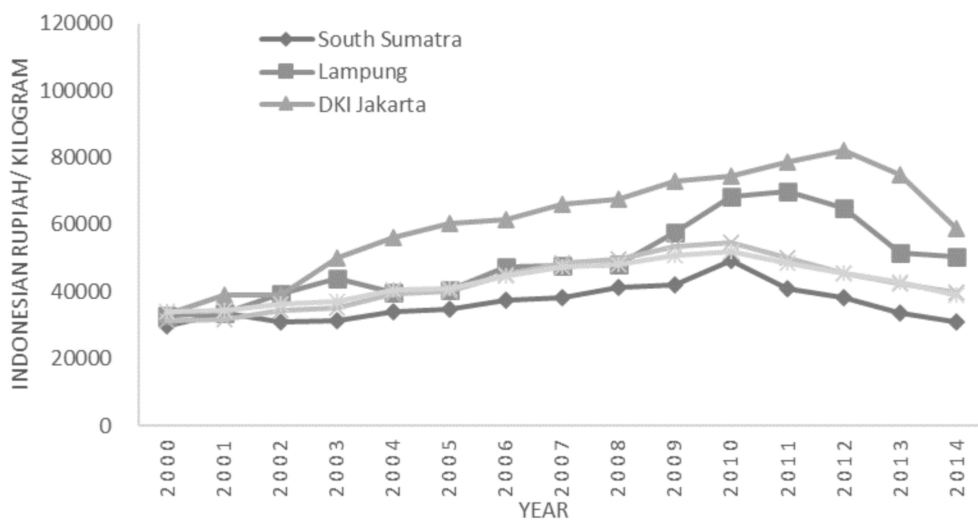

Figure A 6: Salted/Smoked fish price changes in treatment provinces

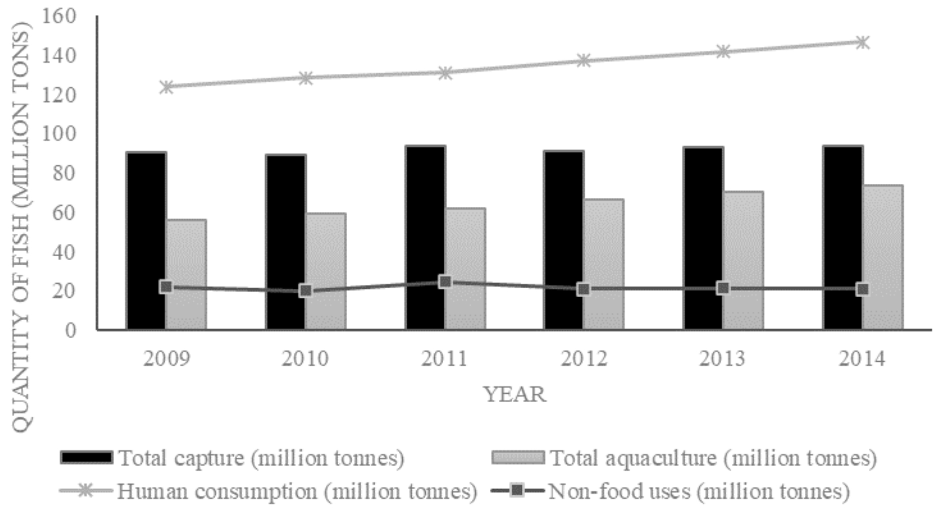

Figure A 7: World fisheries production and consumption from 2009 to 2014

II. Supporting Tables

Table A 4: Simple mean difference of dependent variables of interest

	Year 2007			Year 2014		
VARIABLES	Control Province	Treatment Province	T-stats sig.	Control Province	Treatment Province	T-stats sig.
(i) Consumption Quantity (Kilograms/capita in a week)						
Fresh Fish	0.103	0.071	(***)	0.123	0.124	
Salted/ Smoked Fish	0.015	0.014		0.014	0.018	(***)
Chicken/ Duck Meat	0.070	0.074		0.069	0.099	(***)
Eggs	0.099	0.098		0.095	0.101	(*)
(ii) Consumption Expenditure (Indonesian rupiah/capita In a week)						
Fresh Fish	1,993.236	1,687.839	(**)	4,121.208	3,248.028	(***)
Salted/ Smoked Fish	661.786	709.384		1,051.268	920.798	(**)
Chicken/ Duck Meat	1,294.946	1,950.681	(***)	2,828.873	4,478.468	(***)
Eggs	1,167.533	1,378.790	(*)	2,016.893	2,499.592	(***)
(iii) Consumption Probability						
Fresh Fish	0.598	0.516	(***)	0.561	0.469	(***)
Salted/ Smoked Fish	0.507	0.545	(**)	0.460	0.470	
Chicken/ Duck Meat	0.386	0.469	(***)	0.415	0.510	(***)
Eggs	0.674	0.746	(***)	0.670	0.723	(***)

Notes: Asterisk mark represent the significant mean differences in terms of t-statistics.

Table A 5: DiD on treatment and control province between year 2007 and 2014 for consumption probability

	Model 1	Model 2	Model 3
VARIABLES	Consumption Probability	Consumption Probability	Consumption Probability
Fresh Fish	-0.010	-0.014	-0.030
	(0.014)	(0.014)	(0.021)
Salted/ Smoked Fish	-0.028*	-0.034**	-0.037*
	(0.015)	(0.015)	(0.022)
Chicken/ Duck Meat	0.011	0.010	0.019
	(0.014)	(0.015)	(0.022)
Eggs	-0.019	-0.021	-0.003
	(0.014)	(0.014)	(0.019)
Number of Household	7502	7291	3354
HH FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Notes: Robust standard errors are reported in parentheses. Model 1 includes all samples. Model 2 excludes any HH that migrated from one province to another in between the year 2000 to 2014. Model 3 excludes the migrated HH as well as the HH who are capable to produce by themselves. Consumption probability is a binary variable created based on the consumption quantity of HH, it equal to zero when household report zero consumption.

Table A 6: Placebo period result on treatment and control province between year 2007 and 2014 for consumption probability

	Model 1	Model 2	Model 3
VARIABLES	Consumption Probability	Consumption Probability	Consumption Probability
Fresh Fish	-0.008	-0.010	-0.028
	(0.014)	(0.015)	(0.021)
Salted/ Smoked Fish	0.027*	0.031**	0.053**
	(0.015)	(0.015)	(0.022)
Chicken/ Duck Meat	0.015	0.012	0.039*
	(0.014)	(0.015)	(0.022)
Eggs	0.017	0.016	0.006
	(0.014)	(0.014)	(0.019)
Number of Household	7502	7291	3354
HH FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Notes: Robust standard errors are reported in parentheses. Model 1 includes all samples. Model 2 excludes any HH that migrated from one province to another in between the year 2000 to 2014. Model 3 excludes the migrated HH as well as the HH who are capable to produce by themselves. Consumption probability is a binary variable created based on the consumption quantity of HH, it equal to zero when household report zero consumption.