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Measuring Barriers to the Widely Implementation of Energy-efficient Appliances: An Estimation of Subjective Discount Function

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LIST OF ABBREVIATIONS

SDR	Subjective discount rate
PAYS	Pay as you save
EE-appliance	Energy-efficient appliance
NEB	Non-energy benefit
PV	Photovoltaic
PCA	Principal component analysis
AC	Air conditioner
TPES	Total primary energy supply
OECD	Organization for Economic Co-operation and Development
GHG	Greenhouse gas
NDC	Nationally Determined Contribution
GDP	Gross domestic product
FIT	Fit-in tariff
MPL	Multiple price list

LIST OF UNITS OF MEASUREMENT

°C	Celsius degree
Mtoe	Millions of tonnes of oil equivalent
GW	Gigawatt
kW	kilowatt
JP¥	Japanese Yen
kWh	kilowatt hour
CN¥	Chinese Yuan
US$	United States Dollar

1 INTRODUCTION

1.1 Residential Energy-efficient Appliances and Sustainability

The enormous consumption of energy is threatening our living circumstances. Global temperature, compared to the pre-industrial level, has increased for approximately 1.0°C, and human activities are believed to be the main reason for that (IPCC, 2018). In order to maintain our influence on nature in a retrievable level, Paris Agreement suggested to actively avoid the increase of average temperature to less than 2°C compared to the pre-industrial level. 3 years after the Paris agreement, however, it seemed even more difficult to achieve this goal. More emission reduction strategies, considering the development of the world, should be adapted to catch up with the growing emission.

1.1.1 Household department's global potential

The residential sector, referring to household use of energy, shows great potential in reducing emissions. Globally, the residential sector represented 25% of the total final energy use among all sectors and was responsible for 17% of CO_2 emission (IEA, 2018). In some developed countries and areas, for example, the residential sector produced 25% of emissions in the EU and 21% in the United States (EIA, 2019). Emissions from the residential sector are about half of the total energy use of the

industrial sector, which represents 54% of global total final energy consumption (IEA, 2018), but the potential of voluntary actions from the residential sector cannot be ignored.

One of the differences between industrial and residential sectors when talking about emission reduction is whether it can be regulated mandatorily or not. Examples like the Clean Air Act passed in 1963 in the United States and emission standards published in each country are efforts that governments have tried to set a minimum standard to mitigate emission. Pablo-Romero et al. (2017) summarized two major reasons that the residential sector has great potentials. The first reason was based on the statistical data from IEA. 480 Mtoe of energy use, which was 3.4% of global total energy use, could be saved globally in the residential sector. The second reason was that the emission of residential energy use could hardly displace cross-boundary, therefore it is easier to observe compare to industrial use.

Besides reasons proposed by Pablo-Romero et al. (2017), a third reason that the residential sector has great potential lies in the differences between mandatory regulations and voluntary behaviors. Actions from governments and industries can ensure customers to buy appliances at least reach the minimum requirement, but there still have gaps between outdated and latest appliances and between appliances with

minimum efficiency level and those with top efficiency. Depending on consumers' subjective purchase decisions, the amount of energy use can vary enormously. The government may use encouragement policies like subsidies or loans to promote the consumption of appliances with better energy efficiency. Carlsmith et al. (1990) estimated that for the United States, energy efficiency would increase by 12% in 1990-2010 if no policies related to energy were introduced. With a full promotion of energy-efficient policies, the increase would rise to 26%. Yet, the failure of the Green Deal in the UK indicates that policies focusing on monetary incentives are insufficient to greatly enhance the purchase of energy-saving products. More studies on consumer behaviors should be conducted.

1.1.2 Energy-efficient household appliances (EE-appliances)

In this research, energy-efficient household appliances (EE-appliances) refer to all appliances that help reducing energy consumptions for residential use. When talking about the E-home appliance, major electronic appliances appeared in the residential scenario such as refrigerators, air conditioners, heating systems, lighting systems, boiler fall into this definition. Besides these frequently mentioned electronic appliances, appliances that help reduce the energy consumption of a house, such as thermal insulation windows, floors and materials are also included as E-home appliances. The

adoption condition of mentioned E-home appliances in China and Japan will be discussed in the next section. Questions related to the purchase of E-home appliances will be asked in the questionnaire, but a specific type of E-home appliance won't be mentioned. Details for the given conditions of E-home appliances will be specified in Chapter 2.3.

1.2 Energy policy & Energy structure

1.2.1 Energy policy

1.2.1.1 Japan

Japan is one of the Organization for Economic Co-operation and Development (OECD) member countries, representing 3% of the world total primary energy supply (TPES) and is responsible for 2.7% of the global greenhouse gas (GHG) emissions (IEA, 2018). In 2013, the total GHG emission in Japan is 1.48 billion tons of CO_2 equivalent. It is the fifth-largest energy-consuming country after China, United States, India and Russia. Japan submitted its Nationally Determined Contribution (NDC) after the Paris Agreement and set its target to reduce GHG emissions 26% in 2030 compared with the 2013 level. The government set the target to reduce around 40% based on 2013 emission level in residential sector till 2030 (閣議決定, 2016). The residential sector generated 0.19 billion tons of CO_2 equivalent GHG in 2017 and counted for 14.9% of total energy

use (METI, 2019). Compared with the EU and the United States, the proportion of energy use in the residential sector was relatively small in Japan. However, residential energy use in Japan has doubled since the oil shock happened in 1973. To achieve the ambitious goal proposed by the Japanese government, more possible solutions in the residential sector should be discussed.

1.2.1.2 China

China produces the most GHG emission in the world due to its large population and fast-speed development in the past 4 decades. It accounted for 21.5% of the world's TPES and consumed 21% of global total final energy use (IEA, 2018). Although the energy consumption per capita in China is relatively lower than many of OCED countries, the rapid industrialization and urbanization inevitably generated a huge amount of emissions. China submitted its NDC, setting its targets to reduce CO_2 emission per unit of GDP by 60%-65% in 2030 from the 2005 level (Department of Climate Change, 2015). Based on the data provided by China Energy Statistical Yearbook 2017, the residential sector in China consumed 379.5 Mtoe of energy and counted for 13.4% of total energy use (NBS, 2017). With industrialization, residential consumption tripled since 1995. It is 7 times higher than the consumption in 1980, the year after the economic reform. Emission reduction of China, considering its magnitude,

will have an enormous effect on global climate change.

1.2.2 Energy structure

1.2.2.1 Japan

Revising the current energy structure to increase more clean energy use is one of the major adaptation strategies to prevent global warmings. The energy composition in Japan changed after the 2011 Tohoku earthquake. In 2010, nuclear power provided 11.2% of domestic total energy supply, and the ratio of energy self-sufficiency reached to a 20.2% level (METI, 2019). After the disaster, a dramatic decline in nuclear power has led to a rebound reliance on fossil fuel energy. In 2017, 87.7% of energy supply in Japan relied on fossil fuels, 6.5% higher than 2010, as showed in Figure 1 (METI, 2019). Renewable energy use increased from 4.4% to

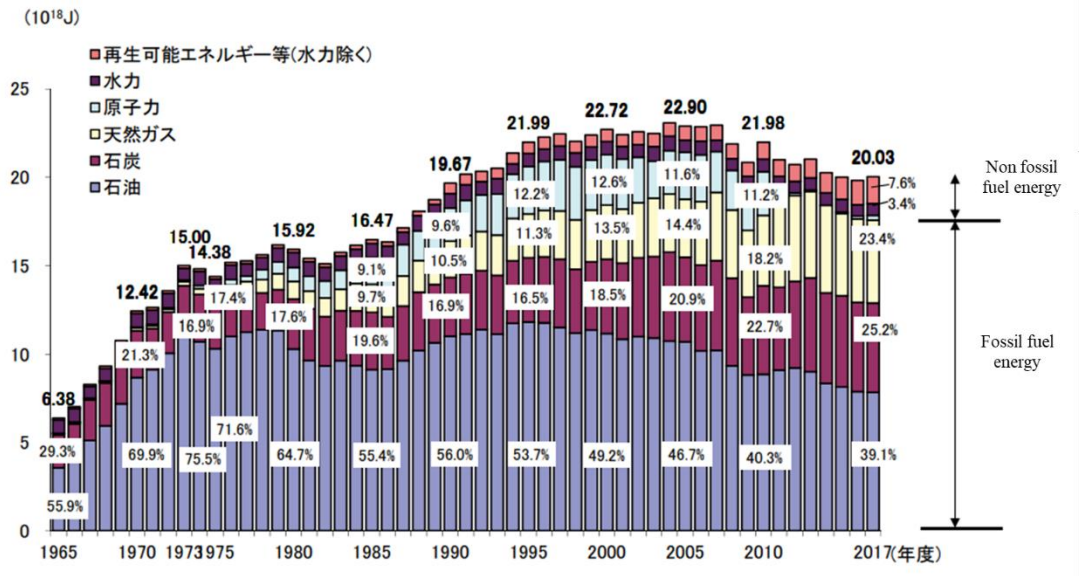

Figure 1 Change of the Energy Structure in Japan 1965-2017

7.6% of total energy supply but failed to fully cover the gap of nuclear power.

In 2017, Japan has installed 7 GW of photovoltaic systems, counting both commercial and residential sectors (IEA PVPS, 2018). For all types of residential dwellings, 7.5% adopted photovoltaic systems (METI, 2019). For the target set by the Japanese government in 2030, nuclear power and renewable energy will provide 20% and 24% powers for the electricity, respectively. Oshiro et al. (2017) assessed Japan's 2030 targets, and the result showed it is feasible to achieve those targets even if nuclear power remains constrained. The NDC targets of Japan itself, on the other hand, are criticized by researchers as insufficient to control global warming under 2° C (Kuramochi et al., 2017). Mitigation strategy such as energy saving in the residential sector, considering its potential, should be strengthened.

1.2.2.2 China

In 2016, around 83.2% of primary energy supply in China was produced by fossil fuels. The use of raw coal and crude oil as sources of energy continued to decrease in the past decade and the reliance on natural gas increased (NBS, 2017). China is one of the world-leading contributors to renewable energy and installed the largest amount of photovoltaic systems in the world. In 2017, China installed 53 GW of photovoltaic systems and counted for 54% of the global market. For the total capacity of installation,

China has installed 131 GW of PV systems, 2 times higher than the second-largest contributor (IEA PVPS, 2018). This also surpassed China's NDC target to produce 100 GW of PV power by the end of 2020. Nevertheless, the PV per capita, considering its large population, was still relatively small.

As a developing country still in the process of industrialization and urbanization, there is a gap in living conditions, as well as energy structure, between rural and urban areas of China. In 2011, rural area residential energy consumption represented 40.4% of total residential consumption (NADS RUC, 2016). Besides fossil fuels, renewable biofuels were widely used in rural compared to urban areas. Firewood, straw and marsh gas are the main resources for rural biofuels. Private straw burning caused a huge amount of GHG emissions and received more constrained from the government since 2015. Such biofuels generated as the byproducts of agricultural activities provided a new clean energy source for rural China.

1.3 Current EE-appliances & Subsidies

The energy efficiency of household appliances has greatly increased from 2000 to 2010, and gradually slowed down between 2010 and 2018. Table 1 (Agency for Natural Resource and Energy, 2011, 2019a) shows the energy efficiency and energy cost change of several electronic appliances over time in Japan. Appliances bought in 2010

compared to those in 2000, can save about 36% of energy use. The latest version of listed appliances saved 8% more energy use than those did in 2010.

Table 1 Change of the Energy Efficiency of EE-appliances. Electricity price is set to JP¥ 24/kWh

	Energy efficiency (kWH/ year)			Anuual Cost (¥ /year)		
Appliance	2000	2010	2018	2000	2010	2018
Refrigerator (401-450L)	760	306	312	18240	7344	7488
Refrigerator (501L~)	-	378	302	-	9072	7248
Air Conditioner	1017	872	801	24408	20928	19224
Lignting system	108	24	18.8	2592	576	451.2
Colar TV	120	87	55	2880	2088	1320

Retrofit of the thermal insulation of dwellings also showed energy-saving potential. The retrofit includes replacement of windows, floors, ceilings, walls, etc. to more thermal insulated materials based on needs. A complete retrofit, shown in Figure 2 (轟木, 2011), can reduce 50% of energy consumption heating and cooling.

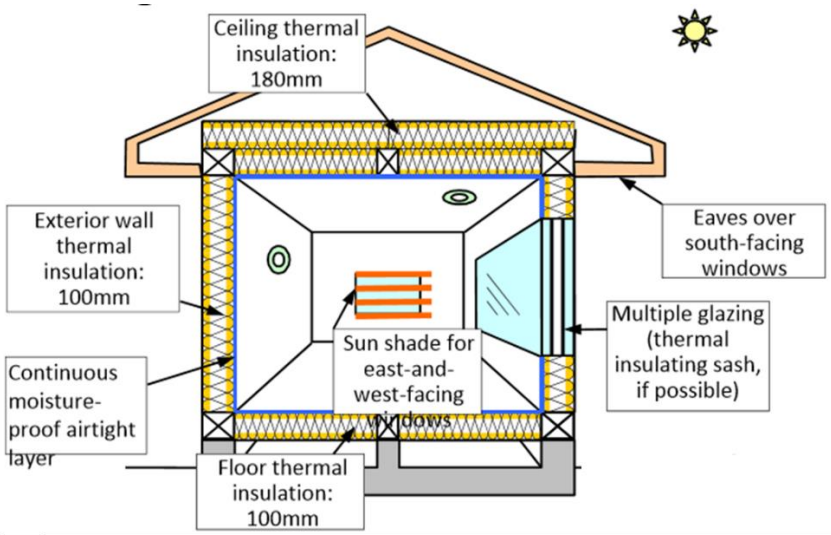

Figure 2 Available thermal insulation retrofits for a dwelling.

The installation of residential PV systems generates powers that can either sell to power companies or save for own use. Typical residential PV systems are under 10 kW and are set on rooftops. In Japan, residential PV systems have generated over 54,000 GW of energy, worthen JP¥ 2.2 trillion (Agency for Natural Resource and Energy, 2019b).

1.3.1 Japan

Currently, various subsidy policies can apply to residential appliances replacement and retrofits. Replacement of appliances such as air conditioner and refrigerator with a five-star energy label certified by Energy Conservation Center Japan (ECCJ) were subsidized. Subsidy for a five-star label refrigerator and an air conditioner, respectively, are JP¥ 7,000 and JP¥ 4,000 (EIC, 2019).

Subsidies for newly built dwellings and retrofit of old buildings are separated. Zero Energy House program (ZEH) provides JP¥ 0.7 million subsidies for both newly built detached houses and apartments. The program for retrofit subsidized existing dwellings for thermal insulation retrofit. It provided a subsidy equivalent to one-third of the retrofit cost, with a maximum of JP¥ 120,000 and JP¥ 15,000 for detached house and apartment, respectively (SII, 2019).

Japan applied the Feed-in-Tariff (FIT) policy for 10 years since 2009. With this

policy, power companies had to set a contract with residential PV users to buy powers from residents at a fixed price. This policy has terminated in 2019. Subsidies for PV systems were JP¥ 70,000/kWh in 2009 and were JP¥ 20,000/kWh in 2019 (SII, 2019).

1.3.2 China

China launched a new round of appliances replacement campaign in 2019. The campaign encouraged consumers to replace the latest EE-appliances including refrigerator, air conditioner, TVs and other 12 kinds of appliances. Based on the energy efficiency level of the chosen product, 8%-13% of the product price will be subsidized, with a maximum of CN¥ 800 (around JP¥ 12,000) per product (Huang, 2019).

For the rural areas in China, the government provided a one-time subsidy per house since 2012 to help rural areas constructing thermal insulation reform, but reports specifying the subsidy level were not found (NADS RUC, 2016). The retrofit subsidy in urban areas was designed in a different standard. Depending on the floor size of the dwelling, a CN¥ 20/m2 (around JP¥ 300/m2) was available for urban residents (Ministry of Finance, 2012).

Residential PV received a CN¥ 0.2/kWh subsidy (JP¥ 3/kWh) from the Ministry of Finance in 2019 (National Energy Administration, 2019). The purchase and installation of residential PV systems received no subsidies.

1.4 Barriers of implementation

1.4.1 Japan

The effectiveness of Japan's current subsidy policies should be discussed separately. A subsidy policy called Eco-point has been introduced during 2009-2011. Consumers were rewarded by Eco-point, a credit that could use as cash, to replace their outdated appliances. The government stated that 2.7 Mtoe of CO2 emission was reduced during 2009-2011 due to the adoption of Eco-point. Nevertheless, the later result from the Board of Audit of Japan (2012) suggested that the emission eventually increased by 1.7 Mtoe. Mito et al. (2014) simulated the increase of new refrigerators and found the introduction of eco-point was not a significant reason. With more people replacing their appliances, the average year of use for these appliances should decrease. However, an investigation held in 2018 (AEHA, 2018) found that the average use years for 4 appliances in Table 2 were longer compared to 2008.

Table 2 Change of average use years of 4 household appliances between 2008 and 2018, with replacement reasons.

Appliance		Average use years	Reason for replacement (%)			
			For a better product	Malfunction	Moving to new place	Others
Refrigerator	2008	10.4	14.6	68.2	8.6	8.6
	2018	12.2	11.6	62.7	7.4	18.3
Washing Machine	2008	8.7	8.4	76.8	6.9	7.9
	2018	10.9	7.5	77.7	4.7	10.1
Air Conditioner	2008	10.5	13.9	59.2	14.2	12.7
	2018	13.6	11.5	69.1	4.5	14.8
Color TV	2008	9.5	20.4	69.1	3.3	7.2
	2018	9.6	33.4	56.7	4.9	5

The energy efficiency standard for buildings was revised in 2015 to replace the previous version designed in 1999. Buildings with better energy efficiency increased. 53% of residential dwellings under 300m^2 fulfilled the energy-efficient standard in 2018. It is not sure whether the increase of certified buildings was caused by subsidies or by the revision of the standard. For those dwelling under 300m^2 and failed to fulfill the standard, the retrofit cost was over JP¥ 0.8 million. Taking the subsidy program into consideration, the payment for each household is still very high. This may become a major obstacle that prevents more dwellings from retrofits.

While commercial use of PV increased in 40% of annual growth since 2012, the adoption of residential PV systems slowly increased from 5.9% in 2013 to 7.5% in 2018 (METI, 2019), with a 5% increase per year. The expensive installation fee is one of the reasons that prevent more household for adoption. With the termination of FIT, the residential PV sector will face more challenges to increase its energy supply. New incentives for the residential market should be found to cope with Japan's 2030 targets.

The adoption of EE-appliances including residential PV systems in Japan has encountered barriers considering the low adoption rate of residential PVs and long use years of household appliances, Efficiency of residential dwellings, with higher efficiency standard, may continue to increase. However, the cost of retrofit may prevent

residents to take actions.

1.4.2 China

In 2009-2011, China proposed a subsidy policy for rural areas and a replacement policy for the whole country. The subsidy for rural areas was 13% of the purchase price, and the subsidy for all residents was 10% of the purchase price (NADS RUC, 2016).

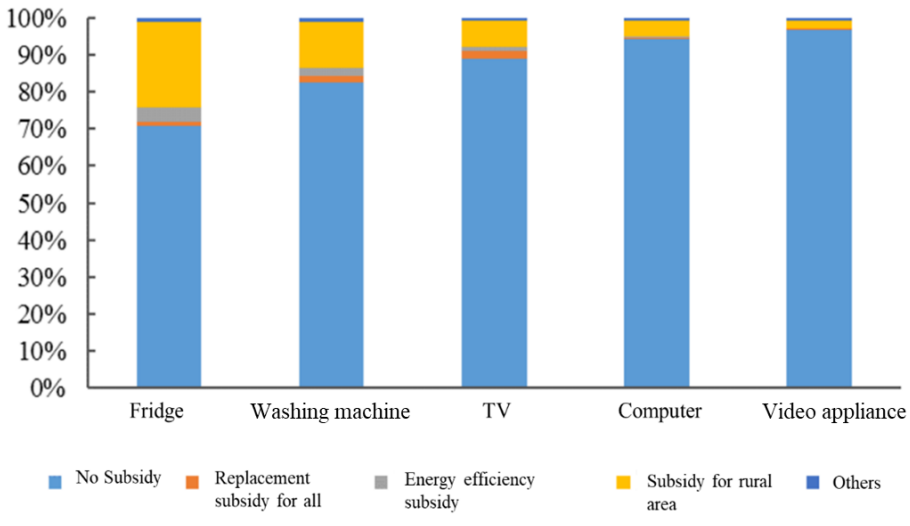

Figure 3 The usage of subsidies in buying EE-appliances

Residents in a rural area could use both policies if applied. Figure 3 shows that only 10%-20% of respondents utilized at least one subsidy in rural areas (NADS RUC, 2016). Data about the utilization in the urban area was not found. Research on the effectiveness of replacement subsidy suggested that the average use years for 4 appliances shown in Table 3 would decrease (Lu and Matsumoto, 2012). Yet, no statistical data in recent years could be found to examine Lu and Matsumoto's result.

Table 3 Average use years for 4 appliances before and after the implementation of the subsidy. figure translated from Japanese.

	Average year of use after subsidy implemented (years)	Average year of use before subsidy implemented (years)
Refrigerator	10.5	13
Washing Machine	10.5	13
Air Conditoner	11.5	14
Color TV	9.5	12

There is a gap in thermal insulation retrofit between urban and rural areas. The official document reported that 40% of urban residential dwellings have achieved energy efficiency standard in China, 2017 (MOHURD, 2017). On the other hand, the research on rural areas showed that 80% of respondents have never changed windows in their households, and 80% of using windows were single layer glasses. Most of the household didn't have thermal insulation retrofit, and only 3% of the retrofit was subsidized by the government (NADS RUC, 2016). In general, the adoption rate of residential retrofit in China is still low compared to that in Japan.

Residential PV has experienced quick development in the past 5 years. In 2015, only 20,000 households installed an on-grid PV system. The number increased to 500,000 households in the next 2 years (CPIA, 2018). In 2019, 40% of newly installed PV systems were residential PVs. Despite the quick development, the adoption rate among all residential households is still very small.

1.5 Subjective discount rate (SDR) & purchase behavior

Investment in EE-appliances seems to be a cost-effective decision for consumers considering the potential of energy savings. However, the low adoption rate of EE-appliances indicates the existence of the barrier, called the energy efficiency gap that inhibited consumers from taking energy-efficient actions (Elgar, 2006, Qiu et al., 2014). Socioeconomics believed that misplaced incentives, referring to fewer alternatives provided by manufacturers, and the insufficient and inaccurate information are some reasons for the gap (Brown, 2001). However, such situations were less likely to happen over time, since more alternative appliances were provided on the market, with the energy-efficient label and more strict efficiency standards.

Behavioral economics explains this gap by evaluating the subjective discount rate (SDR) of individuals. The subjective discount rate also refers to time-preference, and it represents the change of the monetary value of an individual over time (Wilson and Dowlatabadi, 2007). Given an example for SDR, if one is receiving rewards in the future, assumed as JP¥ 10,000 after 2 years, the equivalent current value of this reward accepted by this person is the subjective monetary value of the future reward, and the discount ratio of the value change between now and future is called SDR (Doyle, 2013). Some demographic characteristics, such as income, education, and race were reported

to have a significant influence on SDR (Hausman, 1979, Newell and Siikamäki, 2015).

1.5.1 Discount function and purchase behavior

SDR was used to explain purchase behaviors related to energy-efficient appliances, as the reward from energy-saving always comes in the future. Hausman (1979) studied the individual discount rate for air conditioners and found the average discount rate within the lifespan of ACs was 25%. Summarized by Train (1985) as a literature review, studies were indicating an average SDR of 32% for thermal insulation retrofit, 58% for refrigerator and 43% for blue-ray players (Dube et al., 2014). A study focusing on consumers who already adopted residential PVs found that people who bought PVs have a different SDR (7%) compare to those who rent PVs (21%) (Rai and Sigrin, 2013). A summary of these studies can refer to Table 4 (Rai and Sigrin, 2013).

Table 4 Summary of SDR studies related to EE-appliances (Hausman, 1979; Newell and

Siikamäki,2015; Coller and Williams, 1999; Dube et al., 2014; Rai and Sigrin, 2013; Train, 1985)

Author	Year	N	Subjects	Method	Average SDR	Findings
Hausman	1979	1985	US	Real data estimation	25%	Discount rate of ACs, and income substantially influence SDR
Newell and Siikamäki	2015	1217	US	Choice based	19%	Education, race and house size affect SDR
Coller and Williams	1999	199	US University Students	Choice based	17%	Subjects have lower interest rate when delaing with real reward than that of hypothetical
Dube et al.	2014	1000	US	Choice based	43%	Discount rate of Blue-ray player. Impatient for delay
Rai and Sigrin	2013	365	US PV users	Likert-Scale Choice	7% of buyer 21% of renter	Discount rate of PVs. People who buy PVs have lower discount rate than those who rent PVs.
Train	1985	Not mentioned	US	Not mentioned	58%	Disount rate of refrigerator. Summarized by Train
Train	1985	Not mentioned	US	Not mentioned	32%	Disount rate of retrofit. Summarized by Train

Taking Hausman's result on ACs as an example, if an individual receives JP¥1,000 as energy-saving one year later, the current worth of this savings will be JP¥750 with a 25% discount rate. With the existence of SDR, an individual's current value of future rewards decreased over time, therefore future rewards are less preferred compared to the high initial payment of EE-appliances.

Some studies, though not directly related to energy-efficient appliances, focused on the measurement of discount function models. Differed from measuring SDR case by case mentioned above, studies on the discount function suggested that there was a "stable decision criterion" acted as the parameter of the individual's SDR (Doyle, 2013). A traditional behavioral economic model for SDR suggested that people's future value discount at a constant rate, while many other models were suggested to better interpret

consumer's behavior. However, few studies about energy-saving behaviors have attempted to apply these discount functions. More details about discount functions will be touched in Chapter 2.

1.6 Green Deal and Pay as you save (PAYS)

People with high SDR, as mentioned above, will have less interest in spending the high initial pay to purchase EE-appliances. To mitigate the gap between initial payment and the long payback time, a policy called Green Deal was officially launched by the UK government in 2013. The idea of the Green Deal is that users do not have to pay the initial fee of EE-appliances while enjoyed the satisfaction of using more energy-efficient products. This mechanism is called pay as you save, also referred to as on-bill repayment. The Green Deal was inspired by the KfW Programmes for Energy Efficient Refurbishment launched in 2009 in Germany (Schröder et al., 2011). A similar policy called Property Assessed Clean Energy Now (PACEnow) started in 2008.

1.6.1 PAYS as energy benefits (EB)

Mechanisms of the Green Deal and pay as you save will be explained. The institution from the UK government authorized certified business owners to provide service. People who are interested in household retrofit contacted business owners to assess the possible energy saving actions for their dwellings, and calculate the potential

energy saving from the retrofit. A contract based on the level of energy-saving will be signed between residents and business owners, and then retrofit will be conducted funded by the government. After finishing the retrofit, residents pay their energy bills in the same amount as they did before, and the exceeding part from energy saving will be used to pay for the retrofit until all charges are paid (Figure 4). When finishing the payment, residents can benefit from the reduction of energy costs. The content of retrofit including a partial or complete revision of dwellings, implementation of new boiler, lighting systems and temperature control systems, based on the needs of the residents (Schröder et al., 2011).

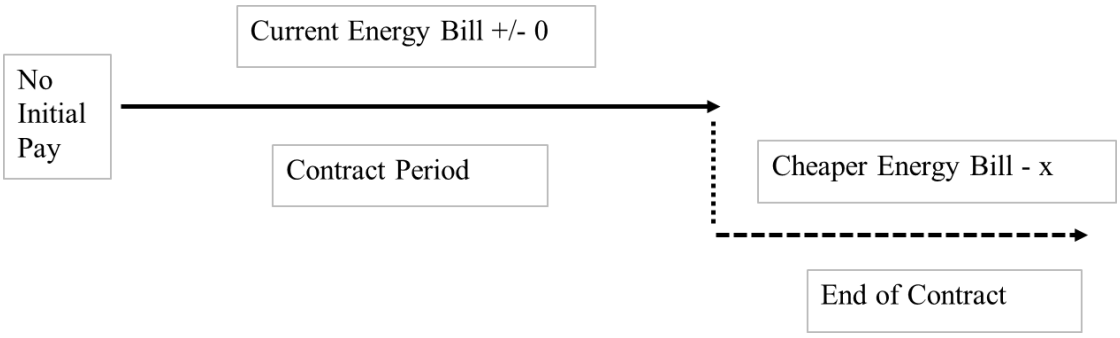

Figure 4 The scheme of pay as you save (PAYS)

1.6.2 Failure of the Green Deal

The Green Deal was repealed in 2015 and was regarded as an inefficient policy for energy saving. Contradictions focused on the "Golden Rule" that ensured the whole policy. The "Golden Rule" set the maximum amount of loan based on the assessment

of the dwelling's energy-saving potential. However, such potential was measuring under ideal conditions. For institutions like bank or energy companies that provide fund support, there is no guarantee the contract dwelling will keep the original energy usage level, so the payback time varies based on real situations (Chandler, 2015). There is also a risk that residents escaped from the repayment duty, thus fund providers may seek a higher interest rate for the loan considering these uncertainties. Consumers, on the other hand, would certainly expect a low-interest rate to finish the payback faster. The Green Deal eventually provided a 7% fixed interest rate for the loan contract, a level that neither fund provider nor consumers felt convinced (Dowson et al. 2012). A survey showed that only 7% of British people were interested in such a plan when the interest rate of the loan was above 6% (Kloke, 2014).

The eventual participation rate for the Green Deal was 0.006%. PACEnow launched in the United State had higher participation of 0.5% (Kloke, 2014). The low adoption rate in both countries indicated these policies failed to be attractive to people. Currently, Japan is considering the implementation of similar policies, while China has no agenda on this. A revision to create more incentives for a PAYS policy should be studied to avoid the failure of the Green Deal.

1.7 Health benefit

1.7.1 Health effect as non-energy benefits (NEB)

Non-energy benefits (NEB) refers to those indirect benefit that can be obtained through the improvement of energy efficiency, additional to the direct monetary benefit from energy-saving (Röbbel, 2011). Health improvement is one major NEB of introducing EE-appliances to the household. First, researches in both developed and developing countries have shown that a better indoor thermal insulation condition can significantly reduce the indoor mortality rate during extreme weather (Wilkinson et al. 2001, Onozuka and Hagihara, 2015). Improvement of thermal insulation can also reduce the risk of respiratory disease and asthma (Ikaga et al., 2011). Such insulation improvement can be reached by replacing windows and adding insulation materials to ceilings and walls. An additional NEB of a retrofit is the reduction of noise exposure from outdoor, which reduces stress and risks of mental illnesses (Guite et al., 2006). Replacement of electronic appliances in developing countries, such as coal stoves, will also reduce the risk of illness from indoor air pollutions.

1.7.2 Incentives to reduce payback time

While PAYS provides a direct benefit to users by avoiding high initial payment, the uncertainty of PAYS and the long payback time make PAYS less attractive to

potential users. Taking the NEB of health into account may better implement a policy related to EE-appliances. The reduction of illness and mortality risk will make people cost less on medical services and the loss due to absence from work (Ikaga et al., 2011). With a simulation, Ikaga et al. predicted that the improvement of thermal insulation will create NEB that reduced 40% of payback time when the retrofit was paid in a one-time payment. A combination of PAYS and NEB will, by prediction, mitigate the subjective discount of potential users, therefore penetrate the barrier of EE-appliances implementation.

1.8 Research Objectives

1.8.1 Originality of this research

As discussed in the previous sections, studies on the time preference of EE-appliances usually focused on the correlation between SDR and demographic characteristics. The study of discount functions and applying existing discount functions to EE-appliances purchase behavior are topics that few studies have been touched. While studies on the PAYS and NEB have been conducted separately, no researches have put them together to seek the possibility of their policy implications.

1.8.2 Research objectives

The main objective of this research is to use subjective discount rate, and

parameters of discount function to predict respondents' purchase behaviors on EE-appliance. Additionally, this research also wants to measure changes in respondents' purchase decisions when PAYS and NEB are introduced. More respondents are assumed to purchase the given EE-appliances if options of PAYS and information of NEB are provided. Whether PAYS and NEB are significant factors to the increment remains unclear and will be analyzed in this research. The parameter generated from the discount function can be a new indicator for us to predict consumers' purchase behaviors. Due to the difference in demographic characteristics, the result in Japan and China can be different, and policy implications will be discussed based on their results.

This chapter has explained the reason why the potential of residential energy saving in China and Japan is large, and what are those barriers that prevent wide adoption of EE-appliances. The measurement of SDR will help us calculate the value of PAYS and NEB of each respondent so that their impact on purchase decisions can be quantified. Chapter 2 will explain the method of this research, following by the result presented in Chapter 3. Discussions in Chapter 4 will look for the possible policy indicated by the result, and conclusions will be made in Chapter 5.

2. METHOD

2.1 Structure of questionnaire survey

2.1.1 Define research subjects

Questionnaire surveys were conducted for one time in China and Japan. A research company, NTTCom Online Marketing Solutions Corporation, distributed questionnaire as an online survey and ensured sample data were chosen in a random way to reduce sample bias. Respondents who finished the survey got coupon tickets as a compensation for cooperation. Contents of questionnaire surveys were designed and arranged by Zhaoying Zhou and Prof. Yoshikuni Yoshida, while the layout of surveys was adjusted by the research company. For both countries, each respondent will be randomly placed in one of four groups. The difference between the four groups will be explained in Section 2.1.3.

In both China and Japan, the gender of respondents was equally distributed. There was no living area limitation for sample collection, so answers from any prefecture in China and Japan will get an equal chance to be included as samples. However, due to the geographic distribution of the population, there might be some prefectures that recorded no samples. Age was an important variable for sample screening. As the research contains questions related to purchasing decisions, young

teenagers, who are usually regarded as financially dependent on their family and are not able to make a big purchase decision for the whole family, were excluded from sample collection. For the same reason, respondents who answered "student" for their occupation were excluded from sample collection.

Also, questions were asked to check if respondents made rational choices for their time preference. Those who made irrational choices for time preference, considering the accuracy of analysis, were excluded from the sample. The definition of "irrational choice" of time preference will be explained in detail in Section 2.2.3. The predicted sample size for all four groups in each country was 1,000 respondents. We eventually received 1,124 qualified samples for China and 1,053 samples for Japan.

2.1.2 Composition of questions

The questionnaire gave to respondents was divided into three sections: demographic information, subjective discount rate, and purchase decisions. Each section contained the following questions. Contents in the questionnaire for each group, if not specifically mentioned, were the same. The questionnaire used in China was translated from Japanese by Zhaoying Zhou. Details of each part and the layout of questions can refer to appendix A.

Demographic information: respondents' demographic information was

collected as independent variables for analysis. We collect information including gender, age, living prefecture, occupation, family member, education, household type, family annual income, illness, sports time, sleeping condition, paying loan, environmental awareness and health awareness. There were 34 questions related to demographic information in this questionnaire.

Subjective discount rate (SDR): This part includes 5 sets of questions, with 6 sub-questions in each set. For each set of questions, the respondent needed to choose between a near term reward with less money and a delayed reward with more money. The 5 sets of questions provided 5 different delayed time. A set of questions contained 6 sub-questions with different given interest rates. The first sub-questions for each set were asked as a test question. If a respondent gave an irrational answer to the first question, the survey for this respondent would be terminated. In each set, values of given rewards would change based on respondents' answers. Such variation was achieved by programming done by NTTcom. Respondent's subjective discount value of a given reward in a defined delay time can be calculated after finishing a set of sub-questions. The total amount of questions related to time preference for each respondent is 30. The parameter of each respondent's subjective discount function will be elicited using the result of SDR. Details related to SDR will be explained in section 2.2.

Purchase decisions: Respondents would read a description text of a given energy-efficient appliance. The price, energy efficiency level and service life were specified in the text, while the product type of this appliance was intentionally unspecified. Additional information about the payment method and non-energy benefit (NEB) of the purchase decision were given to respondents. Respondents were required to answer 4 questions with different additional information, and the different decisions among questions will be observed. Details of purchase decisions will be explained in section 2.3.

The whole questionnaire had 68 questions. Respondents were asked to finish all given questions to be counted into samples. Given choices for each question can be found in appendix A.

2.1.3 Differences among groups

Respondents in each country will be randomly placed into 1 of 4 groups. The same questions related to demographic information will be asked to all groups. Questions about the SDR were different among groups. Group 1 and Group 2 stated that respondents received monetary rewards by winning a lottery, while Group 3 and Group 4 received rewards by making wise investment decisions. Using Japan as an example, Japanese respondents placed in Group 1 and Group 3 will make decisions

between JP¥ 10,000 in Time A and an alternative choice in Time B. Respondents in Group 2 and Group 4 did so in a JP¥ 100,000 level. Respondents from China received payoffs in Chinese currency. For the convenience of calculation, the questionnaire used in China didn't equally exchange Japanese yen to Chinese yuan, instead CN¥ 1,000 and CN¥ 10,000 were used. The amount of annual energy saving, and the price of EE-appliances provided in purchase decision questions were based on the indicated reward in SDR questions. The amount of annual energy saving equaled the indicated reward, and the price of EE-appliances was five times the annual energy saving. Figure 5 is a brief flow chart that also explains the differences among groups.

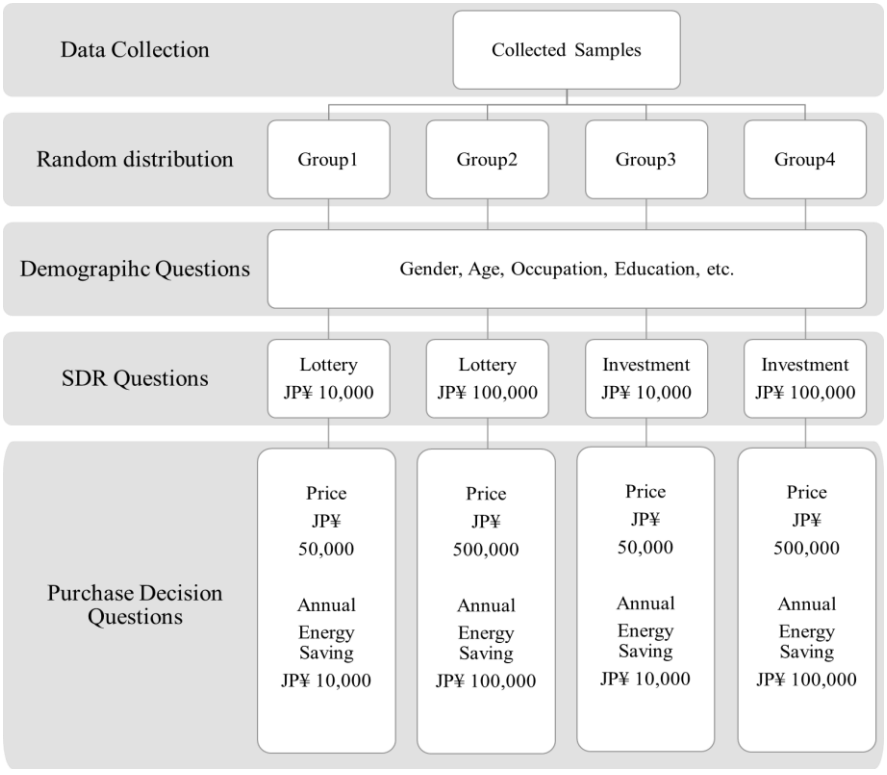

Figure 5 A summary of how respondents were distributed, with a flow chart explaining differences among groups.

2.2 Environment awareness and health awareness

Many previous studies used their questions to measure awareness. Schlegelmilch et al. (1996) created questions from environmental knowledge, environmental attitudes, and recycling behavior perspectives. Ham et al. (2015) reviewed previous studies including Schlegelmilch et al., and measured environmental awareness from cognitive, affective and conative perspectives. Some researchers (Dunlap et al., 2000) focused more on people's feelings of environments, and developed a measurement scale called "New Environmental Paradigm". Considering the balance of contents and the comprehensiveness of the observation, Schlegelmilch's idea was adopted to design questions.

Questions related to environmental awareness, 12 in total, were asked to observe the respondent's knowledge, attitudes, and actions to various environmental issues. 4 questions were about their knowledge of environmental issues, from the cause of global warming to their actual energy consumption. 2 questions were asked for their attitudes toward environment conservation obligation, and 6 for the energy-saving behavior they have conducted every day. There were 11 questions asking the respondent's self-evaluation of physical and mental health conditions, nutritional balance and health-related behaviors.

For each question, a statement (e.g. I know what is the Paris Agreement) will be given to the respondent, and respondents need to answer a typical 5-items Likert scale ranging from strongly agree to strongly disagree. Descriptions of these questions can be found in Appendix A.

Most results related to demographic information obtained through the survey were used directly or transformed into dummy variables, except for environmental and health awareness. This research observed respondents change of purchase decisions on the given energy-efficient appliance when introducing them additional non-energy, health benefits. Therefore, an observation of respondent subjective understanding of environment and health issues was conducted, and results were transformed to numerical data by the principal component analysis (PCA).

2.2.1 Principle component analysis (PCA)

Principal Component Analysis was conducted to transform original variables. Proposed by Karl Person (1901), principal component analysis is a widely used statistical approach to reduce the dimension of correlated variables by creating a new set of uncorrelated factors (Wold et al., 1987). Based on the research results, observation may include a large number of variables and variables can be highly correlated with each other. Such correlations among variables contain redundant information that can

be sacrificed for the simplicity of the observed data. Principal components generated through this analysis are new interpretations and a combination of original variables and are uncorrelated with each other. The 1st principal component represents most of the variation of the original data set and the first few principal components retain important information of the original data.

Questions related to environmental and health awareness will be asked in the 5-items Likert scale. Answers of strongly agree will be recorded as 1, and strongly disagree will be valued as 5. An analysis add-in "Analyse-it" in Excel was used to conduct PCA calculations.

2.3 Subjective discount rate (SDR) and discount functions

2.3.1 Literature Review & Calculation functions

As mentioned in Chapter 1, few studies have tried to use discount functions to measure the purchase behaviors of energy-saving products. Traditional behavioral economics assumes that individual's discount rate is fixed over time. This assumes that the individual is completely rational to make decisions. In that case, the discount function of the individual will be an exponential function as Figure 6 shows. Any two points on the exponential function will have the same ratio of change. The Equation 1 will be

$$V = P \cdot F(t) = P \cdot exp \cdot (-\alpha \cdot t) \quad (1)$$

Where V is the discounted value regarding the delayed reward P and discount rate $F(t)$. After the delayed period t the delayed reward will be received. α is the parameter that determines the discount function.

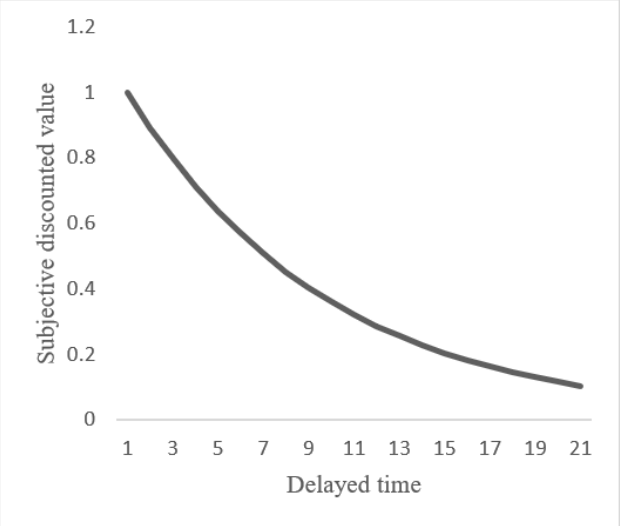

Figure 6 Shape of an Exponential discount function.

Researchers then found out that in reality, people usually didn't follow such constant change of subjective values. For example, if people are asked to choose between one apple today and two apples tomorrow, both answers are possible. However, when people are asked to choose one apple a year later and two apple a year and one day later, few people will choose to get one apple (Thaler, 1981). Harvey (1994), after reviewing previous studies on both humans and animals, found that with the increase of delayed time, the discount rate turned to be smaller, violate the traditional

exponential discounting pattern. Ainslie (1974) proposed a hyperbolic function to describe the decrease of SDR over time, said our behaviors and decision making, rather than being rational, frequently involved impulsiveness. People always overvalue current rewards, but not for the rewards happened long after. A hyperbolic function to explain this phenomenon will be

$$V = F(t) \cdot P = \frac{1}{1+\alpha \cdot t} \cdot P \quad (2)$$

Where *V* is the discounted value regarding reward *P* and discount rate *F(t)*. *F(t)* is the discount rate regarding delayed time *t* and parameter α. The shape of a hyperbolic discount function is showed in Figure 7.

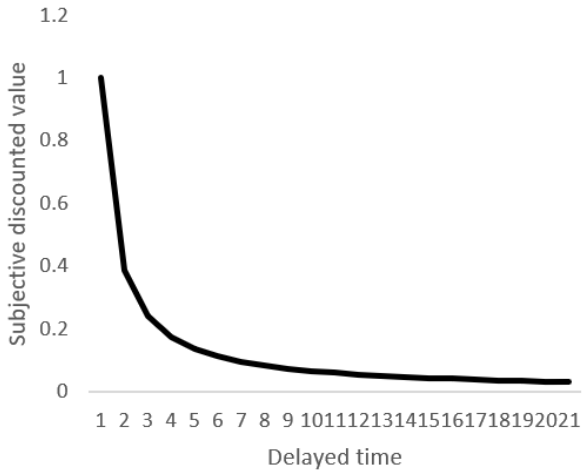

Figure 7 Shape of a hyperbolic discount function.

As Figure 7 shows, when using Equation 2, subjective value of a reward declined quickly in the near future, and as delayed time increases, the decline of subjective value slows down.

Ainslie's hyperbolic function explained the impulsiveness of human actions. However, just like people are not always rational, they are not always impulsive either. Besides, there is a possibility that some people hardly discount their future value over time, which should also be represented. Green et al. (1994) introduced a new function trying to cover as many possible behaviors as possible. This function, called hyperboloid discount function, will be

$$V = F(t) \cdot P = (1 + \alpha \cdot t)^{-\frac{\beta}{\alpha}} \cdot P \quad (3)$$

Where *V* is the discounted value regarding reward *P* and discount rate *F(t)*. *F(t)* is the discount rate regarding delayed time *t*. is the parameter indicating the rate of discounting, explained by Green et al. (1994). When becomes larger, the decrease of value overtime becomes larger. β / α is the parameter indicating the sensitivity of delay. By using Green's function, when β / α is close to 1, the function turns to hyperbolic. When the value of β / α is larger than 1, the function gradually turns to an exponential function. When β / α is close to 0, then the function hardly discounts. Figure 8 are examples of hyperboloid discount function with the change of and β / α.

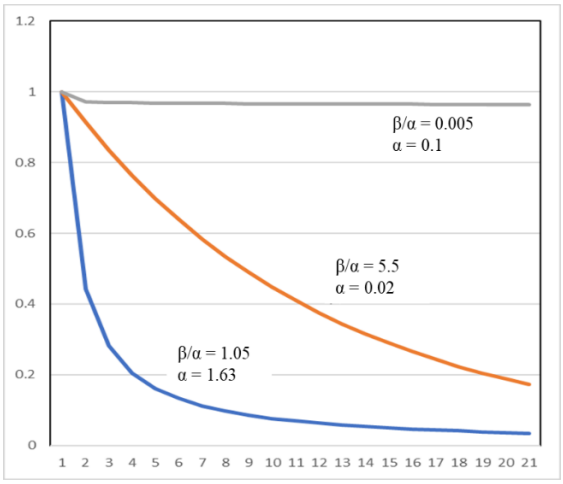

Figure 8 Hyperboloid discount functions with the change of β/α and α

Kawashima (2008) compared among these three discount functions and found that the hyperboloid discount function proposed by Green et al. (1994) had better fitness to explain discounting behaviors. Few pieces of research related to the purchase decision of EE-appliances used functions mentioned by Green et al. (1994) and Kawashima (2008). Haq and Weiss (2018) used exponential functions to elicit SDR of efficient energy but didn't observe respondents' purchase behavior. Hayashi (2010) used hyperbolic function to estimated consumers' SDR but didn't apply it to purchase behavior either. Kuga (2016) from Yoshida laboratory compared among discount functions and used hyperboloid function to estimate SDR. The result of the individual's SDR was used by Kuga to simulate purchase decisions of residential PV systems, refrigerators and LED lighting systems. This research, considering previous studies' results on discount function, used the hyperboloid discount function proposed by Green et al. (1994).

2.3.2 Source of monetary reward

Previous studies have changed types of given rewards to find how this will lead to the change of respondents' SDR. Johnson and Bickel (2002) compared the differences of SDR between real rewards and hypothetical rewards. Respondents were asked to answer questions with both hypothetical rewards and real rewards with a different range of money (from US$ 10 to US$ 250). The sample size of this study is 6 participants. The result from Johnson and Bickel (2002) suggested that there was no difference in SDR when providing real and hypothetical rewards. Coller and Williams (1999) had a different result with larger rewards and more samples. Respondents were distributed into 6 groups, while 5 were informed to receive real rewards and 1 group was informed with hypothetical rewards. Each group had 35 respondents and the indicated reward was US$ 500 or above. The result suggested that respondents who chose between real rewards had a lower discount rate compared to those who choose between hypothetical rewards.

As the questionnaire survey was conducted through an online survey this time, it will be hard to provide real rewards to respondents. Therefore, instead of surveying real and hypothetical rewards, this research observed the difference of SDR when the stated rewards come from different sources. Two different sources of monetary rewards,

lottery and investment payback, were used in this research. If groups given lottery rewards had different SDR compared to those given investment rewards, then a clarification of the source of rewards will be necessary when researching SDR in the future.

Taking Group1 in Japan as an example, the description for lottery rewards was, "By luckily winning a lottery, you will receive a reward of JP¥ 10,000 now. Now you have another option to receive JP¥ x (different among questions) amount of money y years (different among questions) later. Which one you will choose?".

The description for investment rewards was, "By making wise investment choice by yourself, you will receive a reward of JP¥ 10,000 now. Now you have another option to receive JP¥ x (different among questions) amount of money y years (different among questions) later. Which one you will choose?".

This research assumed that respondents would value rewards earned by their investment choice more than those earned by lottery since more individual efforts were included in investment actions.

2.3.3 Delayed time between observations

When observing SDR, many previous studies related to EE-appliances only observed one or two periods of delays to estimate SDR (Coller and Williams, 1999; Rai

and Sigrin, 2013; Schleich et al., 2019; Enzler et al., 2014). Green et al. (2004) suggested to use 8 periods of delays with unequal intervals of delays. Kuga (2016) based on previous studies (Green et al., 2004; Fujita and Yoshida, 2013), suggested an original design for the delayed time that combined delays with equal intervals and with unequal intervals together. This research adopted the design propose by Kuga (2016), and the design of delayed time is showed in Table 5. All respondents were asked to finish all sets of questions related to SDR.

Table 5 A combination of equal and unequal interval of delay.

Questions	Choice A	Choice B	Interval of delay
Set 1	Receive now	Receive 1 year after	1 year
Set 2	Receive1 year after	Receive 1.5 years after	0.5 year
Set 3	Receive 1 year later	Receive 2 years after	1 year
Set 4	Receive 3 years after	Receive 4 years after	1 year
Set 5	Receive 3 years after	Receive 6 years after	3 years

2.3.4 Questionnaire design for SDR

By finishing 5 sets of questions related to SDR, discount rates of different delayed time of each respondent can be elicited. This section will explain how the sub-questions in each set look like.

A revision of the multiple price list (MPL) was conducted. Table 6 is an example of MPL. The advantage of MPL is that MPL is clear and easy to understand by respondents. However, this is also a disadvantage when researchers want to elicit SDR as accurately as possible. By understanding the layout of MPL, respondents may report

answers that are higher than their real SDR (Anderson et al., 2006). The revision of MPL rearranged questions into 6 sub-questions, starts from a screening question. An example of sub-questions in question set 1 is given here.

Sub-question 1: Respondents were asked to choose between A: JP¥ 10,000 now and B: JP¥ 10,000 a year later. Respondents who chose answer B were regarded as irrational, and the survey would be terminated.

Sub-question 2: Respondents were asked to choose on a 50% interest rate level. If choice A at a 50% was preferred, then the SDR of this question was above 50%. An additional question asking the respondent's interest rate ranged from 100% to 500% would be asked. If choice B was preferred, then the SDR of this question was below 50%. The interest rate given in sub-questions 3 − 6 would be adjusted based on the previous answers. Figure 9 is a flow chart specifying adjustments that helps better understanding this mechanism. If the final answer in sub-question 6 was JP¥ 14,500, then the subjective value of the respondent would be the average of JP¥ 15,000 and JP¥ 14,500.

Table 6 A multiple price list used to measure SDR

	A	B			
No. of the question	Receive it now (JP ¥)	Receive it 1 year later (JP ¥)	Interest rate (%)	Answer	
1	10000	10000	0	A	· B
2	10000	10100	1	A	· B
3	10000	10200	2	A	· B
4	10000	10300	3	A	· B
5	10000	10400	4	A	· B
6	10000	10500	5	A	· B
7	10000	10600	6	A	· B
8	10000	10700	7	A	· B
9	10000	10800	8	A	· B
10	10000	10900	9	A	· B
11	10000	11000	10	A	· B
12	10000	11200	12	A	· B
13	10000	11400	14	A	· B
14	10000	11600	16	A	· B
15	10000	11800	18	A	· B
16	10000	12000	20	A	· B
17	10000	12200	22	A	· B
18	10000	12400	24	A	· B
19	10000	12600	26	A	· B
20	10000	12800	28	A	· B
21	10000	13000	30	A	· B
22	10000	13500	35	A	· B
23	10000	14000	40	A	· B
24	10000	14500	45	A	· B
25	10000	15000	50	A	· B
26	10000	20000	100	A	· B
27	10000	30000	200	A	· B
28	10000	40000	300	A	· B
29	10000	50000	400	A	· B

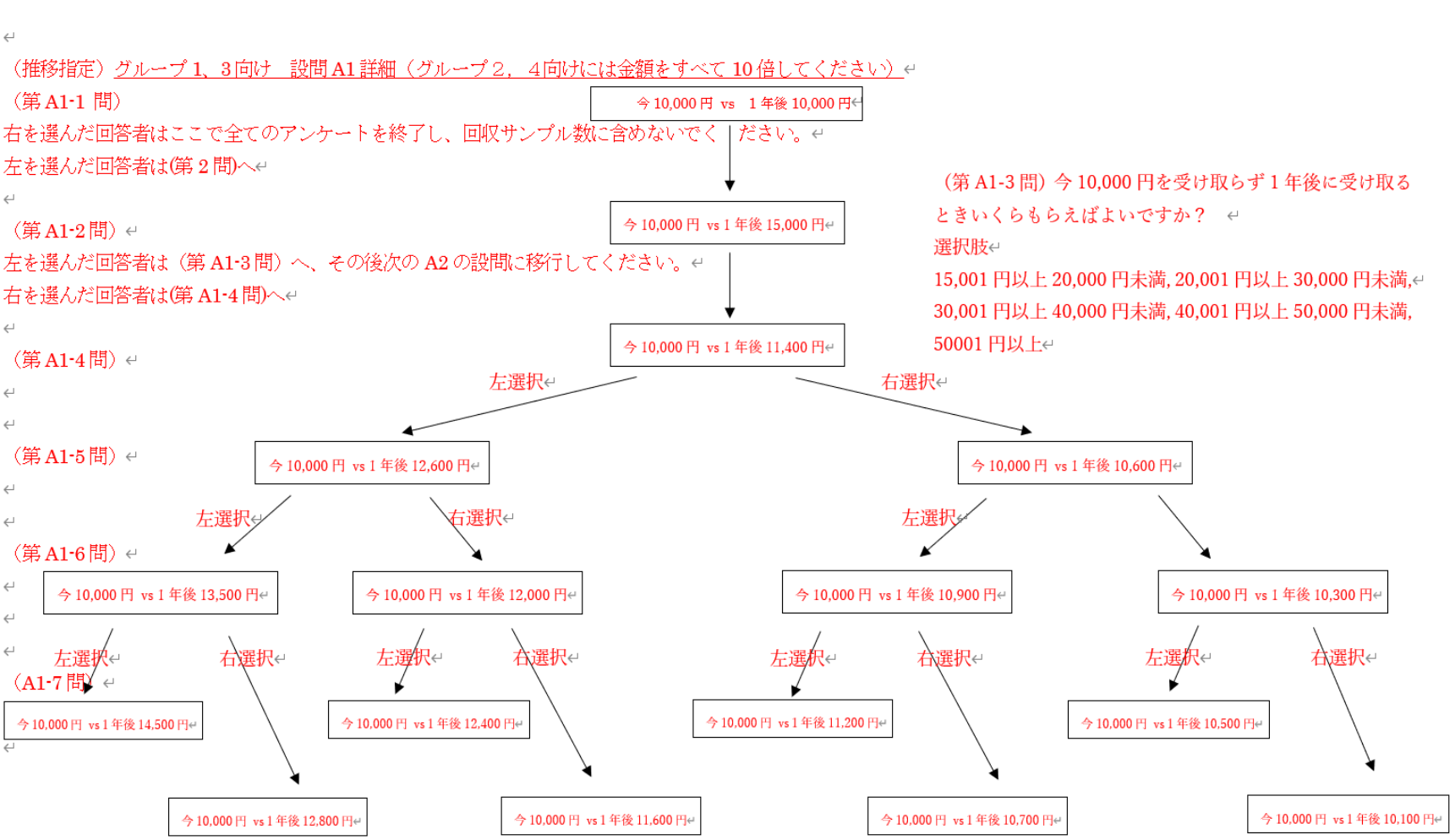

Figure 9 Flow chart of 6 sub-questions

2.3.5 Calculation

For each respondent, 5 answers of subjective values regarding different delayed time were observed through mentioned procedures. The hyperboloid function, Equation (3), will be used for calculation. For each answer, the subjective current value was V_i regarding the accepted reward P_i and the delayed time t_i.

$$V_i = F(t)_i \cdot P_i = (1 + \alpha \cdot t)^{-\frac{\beta}{\alpha}} \cdot P_i \quad (4)$$

β / α and α can be estimated using least square method. The function will be,

$$\sum_{i=1}^{5} V_i = \sum_{i=1}^{5} (V_i - V)^2 \quad (5)$$

where V is the value respondents can receive now and V_i is the value respondents accepted to receive after a delay time of t.

An excel add-in "Solver" was used to find the minimum value of Equation (5). Result of Equation (5) was defined as the object of the calculation and was set to minimum. β / α and α were defined as variables regarding the result. As Equation (5) get to its minimum, the output of β / α and α were parameters that determine respondents SDR.

With the result of parameters β / α and α, the change of subjective values overtime can be measure using Equation (3). For example, if an EE-appliance's service

of life is 10 years, and respondent can save JP¥ 10,000 per year for energy bills. The accumulation of subjective value will be the net present value (NPV) of the energy saving in the next 10 years. The equation will be,

$$\sum_{t=1}^{10} V(t) = \sum_{t=1}^{10} F(t) \cdot P = \sum_{t=1}^{10} (1 + \alpha \cdot t)^{-\frac{\beta}{\alpha}} \cdot P \quad (6)$$

where P is the saved energy cost per year.

$$npv\ of\ 10yrs = \sum_{t=1}^{10} V(t) - P_s \quad (7)$$

where P_s is the price of the EE-appliance.

If the result of Equation (7) is positive, then it means subjectively this respondent values the save on energy bills over the price of the EE-appliance, therefore subjectively the respondent gain benefit from this purchase decision. Contrarily, a negative result of Equation (7) indicates that such purchase decision is subjectively a loss of benefit for the respondent.

The average SDR can be elicited through the Equation (8),

$$\overline{SDR} = (10\ P - \sum_{t=1}^{10} V(t))^{0.1} - 1 \quad (8)$$

Where P is the annual saved energy cost.

2.4 Purchase decision observation

2.4.1 NPV and real purchase decision

Net present value, in this research, measured the subjective feeling of monetary

gain and loss over time. Comparing the net present value of each respondent with observations of respondent's purchase decision, the correlation between NPV and purchase decision can be measured.

For each group, 4 questions were asked to observe respondents' purchase decisions of an energy-efficient appliance. Each question had different additional information about payment methods and health benefits. The description of the energy-efficient appliance kept the same in all questions.

Description of the appliance

"There is now a new energy-efficient product on sale. By introducing this appliance, you can save x amount of money per year. The price of this appliance is 5x, with no extra cost. The service life of this appliance is 10 years. All the information is 100% guaranteed."

The product type of appliance was intentionally unspecified because of two reasons. First, this research focused on respondent's general purchase attitudes toward all kinds of household appliances that reduce energy consumption. Specifying a certain kind of appliance will substantially influence respondent's purchase decision if the respondent had already owned this appliance. Second, non-energy benefit was introduced into this observation, while only part of existing appliances, such as thermal

insulation floor and central air conditioning system, had a non-energy benefit effect. Mentioning specific appliance with and without non-energy benefit, considering the first reason, will generate unnecessary confusion to respondents.

As mentioned in Figure 5, the price and energy cost savings were different among groups. Using a questionnaire in Japan as an example, in Group 1 and Group 3 this appliance cost 50,000 JPY, and the annual savings on energy cost is 10,000 JPY. The appliance costs and savings are 10 times higher in Group 2 and group 4, which are 500,000 JPY and 100,000 JPY, respectively. Despite the differences in the product price and amount of savings, the payback time for respondents in all groups is 5 years, which means all respondents get extra benefits for this purchase action from the 6th to the 10th year.

2.4.2 Payment method & Health Benefit (NEB)

The 1st question asked if the respondent would purchase this appliance by one-time payment or not. No additional information about the health benefit was given in the first question.

The 2nd question asked if the respondent would purchase this appliance by PAYS or not. The mechanism of PAYS was fully explained to respondents. Interest for PAYS was set to 0 in the question. Same as the 1st question, there was no information about

the health benefit.

The 3rd question and the 4th question used the same payment method as the 1st and the 2nd, respectively. Health benefit was introduced in these questions. Respondents would read additional information, telling them that the introduction of this appliance improves the thermal insulation performance of the whole dwelling. This improvement would help reduce the risk of hypertension, heart disease and other illness caused by dramatic temperature change. With the prevention effect of such illnesses, the mortality rate of related disease would decline from 1 in 1,000 people to 1 in 10,000 people.

When using PAYS instead of one-time payment as the payment method, the NPV of PAYS should be calculated separately. With PAYS, respondents would avoid initial payment of the EE-appliance, and for the first five years there was no energy benefit. The function for NPV of PAYS will be,

$$npv\ of\ PAYS = \sum_{t=6}^{10} V(t) = \sum_{t=6}^{10} (1 + \alpha \cdot t)^{-\frac{\beta}{\alpha}} \cdot P \qquad (9)$$

Since there is no initial payment, the value of Equation (9) will always be positive. The NPV of one-time payment, considering the initial pay of EE-appliances, is equal to Equation (7).

2.4.3 Calculation of purchase decisions

Binary logistic regression was used to measure the probability (y) of respondents' dichotomous purchase decisions. The parameter (β) of each predictor represents the contribution of that independent variable (X) on the purchase decision, as shown in Equation (10),

$$y = \ln[p/(1-p)] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_i X_i \quad (10)$$

where y = 1 means a "yes" answer for the purchase decision questions, 0 means a "no" answer. p is the probability that y = 1, and 1-p is the probability that y = 0. *i* is the number of individual variables, and β_0 is the y-intercept. The calculation was done by computer, using "Stata" as the calculation software.

3. RESULT

3.1 Questionnaire survey

3.1.1 Demographic profile

This research collected 1124 and 1053 valid samples in China and Japan, respectively. Table 7 is a summary of gender, age and sample size in China and Japan. Gender of respondents tended to be equal, yet in China female respondents were slightly more than males. Juveniles were excluded from samples, and people in 40s represented the largest proportion (33.4% / 33.3%) of samples in both China and Japan. Regarding respondents over the 70s, more samples were collected in Japan (65 samples) than in China (18 samples). Age structure and the accessibility of technology in senior people are believed to be reasons for this difference.

Groups 3 and 4 had a larger sample size compared to Group1 and 2 in both countries because the main purpose of Group1 and 2 was to compare with Group3 and 4 to examine the difference between lottery reward and investment reward.

Figure 10 and Figure 11 indicate the geographic information of respondents. In Japan, 37% of responses were collected from Tokyo (16%), Kanagawa (10%), Kyoto (3%) and Osaka (8%). In China, 39% of responses were from Beijing (13%), Shanghai (15%), Guangzhou (8%) and Shenzhen (3%), the top 4 cities as of economic

development.

Table 7 Summary of gender, age and samples in each group in China and Japan

	China	Japan
Sample size	1124	1053
Gender(Male/Female)	49.6%/50.4	50%/50%
10s	0	0
20s	108 (9.6%)	48 (4.6%)
30s	263 (23.4%)	298 (28.3%)
40s	375 (33.4%)	351 (33.3%)
50s	286 (25.4%)	166 (15.8%)
60s	74 (6.6%)	125 (11.9%)
70s+	18 (1.6%)	65 (6.2%)
Group1	131 (11.7%)	109 (10.4%)
Group2	126 (11.2%)	108 (10.3%)
Group3	428 (38.1%)	417 (39.6%)
Group4	439 (39.1%)	419 (39.8%)

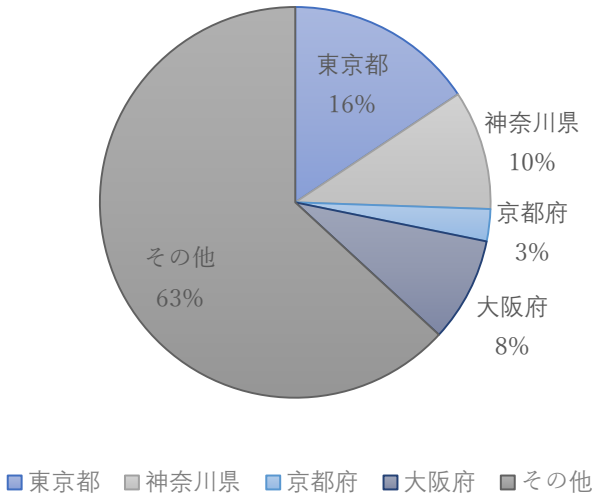

Figure 10 Geographic information of the source of samples in Japan.

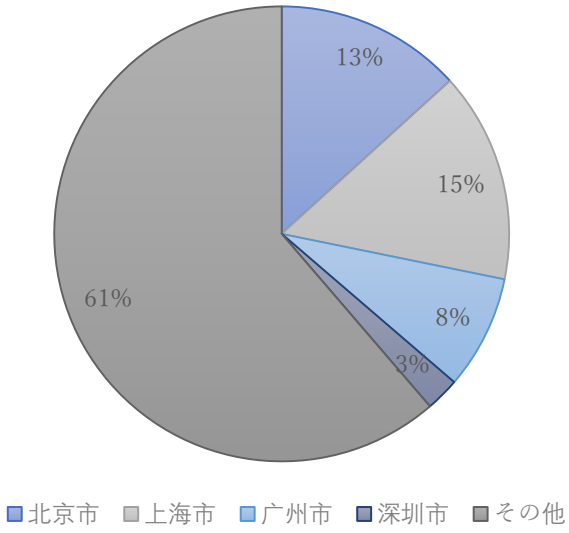

Figure 11 Geographic information of the source of samples in China**.**

Most respondents' occupation was permanent employee (Table 8). There is a significant difference on housewife/ house husband between Japan (20%) and China (2%).

Table 8 Occupations of respondents in China and Japan.

Occupation	Japan	%	China	%
Manager & Above	18	2%	39	3%
Permanent Employee	400	38%	748	67%
Part-time job	130	12%	23	2%
Permatemp	37	4%	112	10%
Temperary Employee	19	2%	5	0%
Freelancer	82	8%	53	5%
Side job	1	0%	4	0%
Housewife/House husband	213	20%	28	2%
Student	0	0%	0	0%
Unemployeed	141	13%	38	3%
Others	12	1%	74	7%

Table 9 Education level, dwellings, families and loan in China and Japan.

	China				Japan			
	Group1	Group2	Group3	Group4	Group1	Group2	Group3	Group4
N	131	126	428	439	109	108	417	419
Education								
High School unfinished	1%	4%	3%	3%	3%	1%	2%	3%
High School degree	9%	7%	12%	8%	27%	28%	23%	27%
vocational college	19%	25%	20%	25%	10%	10%	11%	13%
Associate degree	/	/	/	/	11%	11%	10%	11%
Undegraduate & Above	71%	64%	66%	65%	50%	50%	54%	47%
Dwelling type								
Detached House (Owned)	18%	17%	19%	23%	50%	56%	55%	53%
Detached House (Rent)	2%	0%	2%	3%	5%	2%	3%	2%
Apartment (Owned)	69%	79%	73%	68%	17%	19%	18%	16%
Apartment (Rent)	11%	4%	6%	6%	28%	23%	24%	28%
Others	0%	1%	0%	0%	0%	0%	0%	0%
Family Type								
単身	15%	10%	9%	12%	20%	18%	19%	16%
夫婦2人	24%	21%	23%	23%	17%	23%	20%	25%
未婚の自分と親との2世代世帯	4%	7%	5%	5%	20%	17%	21%	21%
既婚の自分(夫婦)と親との2世代世帯	2%	3%	4%	4%	1%	2%	2%	2%
自分(夫婦)と子供の2世代世帯	47%	48%	48%	48%	38%	35%	30%	31%
自分(夫婦)と子供と孫との3世代世帯	2%	2%	2%	2%	0%	0%	0%	1%
自分(夫婦)と親と子供との3世代世帯	6%	8%	8%	7%	3%	5%	6%	2%
その他	1%	0%	0%	0%	2%	1%	2%	1%
Loan								
Paying Loan	24%	25%	20%	17%	23%	32%	22%	25%
Used to have loan	21%	16%	15%	12%	14%	18%	19%	16%
Never have loan	55%	60%	65%	71%	63%	50%	58%	59%

Data about education level, dwelling type, family type, and loan were collected, and present in Table 9. There is no associate degree in China, and among groups, respondents in China had higher education levels than respondents in Japan. 23%-28% of respondents in Japan held a high school diploma, which many of them (19%-25%) in China chose to finish a vocational college to learn some skills. The dwelling type was also very different between China and Japan. More than half (50%-56%) of

Japanese respondents bought their own detached house, while most (68%-73%) of Chinese respondents lived in their own apartment. Such difference relies on the difference in population density. The proportion of single respondents (16%-20%) and single respondents living with parents (17%-21%) in Japan was much higher than in China (9%-15%, 4%-7%, respectively). In both China and Japan, more than half of respondents said they have never pay for a loan. Social cultures in China and Japan, based on the differences in their results, were quite different.

Table 10 Average income, illness, sports time and sleep time.

	China				Japan			
	Group1	Group2	Group3	Group4	Group1	Group2	Group3	Group4
N	131	126	428	439	109	108	417	419
Average Income (million JP￥)	3.06	3.02	3.19	3.25	4.68	5.15	4.96	4.66
Average Illness (%)	69%	61%	63%	63%	35%	39%	42%	42%
Average Sports time (h/week)	3.22	3.15	2.96	3.22	0.89	1.28	1.23	1.27
Average Sleep Time (h/day)	6.89	6.96	6.93	6.98	6.50	6.51	6.48	6.35

The mean value of income, illness, sports and sleep time are shown in Table 10. To avoid confusion, incomes in China have transformed into million JP￥. Illness here is a subjective, self-diagnose result. A list of physical and mental illnesses was given, and respondents chose all illnesses they believed applied. Among all groups, respondents in Japan had a higher average income level than respondents in China. While the average sports time and sleep time of Chinese respondents were higher, they also self-diagnosed for a higher average proportion of illness, compared to respondents

in Japan.

The principal component analysis was conducted to extract components with a higher contribution to the variation. Table 11 and Table 12 shows principal components of environmental awareness and health awareness in China and Japan. For both environment and health awareness, the first component contributes the most to the variation of results. Interpretation of Comp1 in both results will be a general environment consciousness and a general health consciousness. In both countries, a negative coefficient for Comp1 was observed. The Likert scale used in PCA analysis valued “strongly agree” as 1 and “strongly disagree” as 5. Therefore, the bigger the score respondents got for Comp1, the higher their environment and health consciousness were.

Table 11 Principal components of Chinese respondents.

	Principal Components					
	Environment					
	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5	Comp 6
1. 地球温暖化問題についてよく知っている	-0.22	0.52	-0.22	0.21	-0.27	0.10
2. 二酸化炭素が温室効果ガスのひとつで化石燃料が人為的な排出の原因であることを知っている	-0.28	0.41	0.14	0.37	-0.23	-0.19
3. 地球温暖化対策としてのパリ協定について知っている	-0.20	0.55	-0.18	-0.31	0.39	0.09
4. 1ヶ月の自宅の電力消費量を把握している	-0.29	-0.09	0.16	0.37	0.75	-0.02
5. 個人の省エネ努力は政府や企業の努力と同等、もしくはより重要だと思う	-0.32	-0.04	0.38	-0.08	-0.04	-0.07
6. 先進国は途上国より大きい環境への責任を負うべきだと思う	-0.26	0.14	0.46	-0.46	-0.02	0.39
7. シャワーを使うときには、節水ヘッドを使ったり、使用時にまめに栓を閉じるようにしている	-0.28	-0.07	-0.37	-0.36	0.11	-0.64
8. 省エネのためには個人の習慣を変える必要があると思う	-0.36	-0.15	-0.02	0.14	-0.32	-0.08
9. 省エネのため、冷房の設定温度は28度を目安にしている	-0.25	-0.16	-0.56	0.18	0.06	0.49
10. 使っていない部屋の照明を消している	-0.33	-0.25	0.19	0.29	-0.03	-0.07
11. 商品を選ぶ時、環境ラベル（エコラベル）があるものや省エネ性能が高い商品を優先する	-0.34	-0.17	-0.06	-0.26	-0.14	-0.14
12. 可能な限り、外出時に自転車や公共交通機関を使う	-0.28	-0.30	-0.13	-0.18	-0.11	0.34
Contribution	37%	11%	8%	6%	6%	5%
Cumulative contribution	37%	48%	57%	63%	69%	74%
	Health					
	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5	Comp 6
1. 現在、肉体的には健康である	-0.31	0.42	-0.12	0.12	-0.33	0.13
2. 現在、精神的には健康である	-0.33	0.22	-0.15	0.47	-0.38	0.07
3. １日3回規制正しく食事をしている	-0.28	-0.19	-0.37	0.30	0.36	-0.68
4. 塩分、糖質、油分を摂りすぎないようにしている	-0.30	-0.34	-0.28	-0.37	0.16	0.30
5. 食事では栄養バランスを考えている	-0.33	-0.32	-0.19	-0.25	-0.15	0.26
6. 定期的に、何らかの運動を行っている	-0.30	-0.22	0.02	-0.24	-0.53	-0.31
7. 帰宅後には手洗いをするようにしている	-0.25	-0.34	0.05	0.56	0.24	0.42
8. 睡眠時間は充分だと思う	-0.32	0.39	-0.01	-0.20	0.39	0.05
9. 睡眠の質は高いと思う	-0.32	0.43	-0.04	-0.22	0.27	0.02
10. 室内の冷暖の変化について敏感だと思う	-0.26	-0.06	0.72	0.09	0.10	0.03
11. 健康を考えて、室温をいつも適切に設定している	-0.32	-0.12	0.43	-0.12	-0.03	-0.29
Contribution	37%	14%	9%	7%	6%	6%
Cumulative contribution	37%	51%	59%	67%	73%	79%

Table 12 Principal components of Japanese respondents.

	Principal Components					
	Environment					
	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5	Comp 6
1. 地球温暖化問題についてよく知っている	-0.34	-0.37	0.00	-0.03	0.08	-0.20
2. 二酸化炭素が温室効果ガスのひとつで化石燃料が人為的な排出の原因であることを知っている	-0.32	-0.37	0.09	0.20	0.20	-0.28
3. 地球温暖化対策としてのパリ協定について知っている	-0.30	-0.50	0.06	-0.10	0.06	-0.10
4. 1ヶ月の自宅の電力消費量を把握している	-0.25	0.04	0.23	0.01	-0.87	-0.12
5. 個人の省エネ努力は政府や企業の努力と同等、もしくはより重要だと思う	-0.35	0.04	0.02	0.30	-0.07	0.37
6. 先進国は途上国より大きい環境への責任を負うべきだと思う	-0.33	0.06	-0.03	0.29	0.13	0.51
7. シャワーを使うときには、節水ヘッドを使ったり、使用時にまめに栓を閉じるようにしている	-0.27	0.34	0.15	-0.22	-0.08	-0.09
8. 省エネのためには個人の習慣を変える必要があると思う	-0.33	0.35	-0.01	0.20	0.18	0.10
9. 省エネのため、冷房の設定温度は28度を目安にしている	-0.24	0.16	0.02	-0.71	0.24	0.07
10. 使っていない部屋の照明を消している	-0.23	0.45	0.11	0.21	0.20	-0.60
11. 商品を選ぶ時、環境ラベル（エコラベル）があるものや省エネ性能が高い商品を優先する	-0.31	-0.03	-0.16	-0.37	-0.10	0.19
12. 可能な限り、外出時に自転車や公共交通機関を使う	-0.13	0.05	-0.94	0.05	-0.17	-0.19
Contribution	41%	11%	8%	7%	6%	6%
Cumulative contribution	41%	52%	60%	67%	74%	79%
	Health					
	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5	Comp 6
1. 現在、肉体的には健康である	-0.28	-0.40	0.30	-0.28	0.40	-0.12
2. 現在、精神的には健康である	-0.31	-0.42	0.25	-0.29	0.10	-0.16
3. １日3回規制正しく食事をしている	-0.28	-0.02	0.41	0.03	-0.63	-0.01
4. 塩分、糖質、油分を摂りすぎないようにしている	-0.37	0.22	0.12	0.28	-0.17	-0.13
5. 食事では栄養バランスを考えている	-0.40	0.22	0.14	0.18	-0.08	-0.08
6. 定期的に、何らかの運動を行っている	-0.24	-0.04	0.10	0.67	0.50	0.28
7. 帰宅後には手洗いをするようにしている	-0.22	0.30	0.13	-0.41	0.05	0.81
8. 睡眠時間は充分だと思う	-0.29	-0.29	-0.54	-0.02	-0.24	0.16
9. 睡眠の質は高いと思う	-0.31	-0.33	-0.46	0.10	-0.11	0.14
10. 室内の冷暖の変化について敏感だと思う	-0.26	0.40	-0.29	-0.29	0.25	-0.23
11. 健康を考えて、室温をいつも適切に設定している	-0.32	0.34	-0.16	-0.11	0.12	-0.34
Contribution	35%	13%	10%	9%	7%	7%
Cumulative contribution	35%	48%	58%	66%	74%	81%

3.1.2 Subjective discount rate

Each respondent's value of parameters, β/α, net present value, and the subjective discount rate were elicited. Table 13 shows the average value of each group's results. All groups in China have a higher mean value of parameter β/α than groups in Japan, which means a higher proportion of respondents with exponential discounts. All groups in China have a higher mean value of SDR than groups in Japan, thus the NPV of both one-time payment and PAYS have lower mean value than groups in Japan.

Table 13 Mean value of α, β/α, net present value and the subjective discount rate.

Mean value	China				Japan			
	Group1	Group2	Group3	Group4	Group1	Group2	Group3	Group4
β/α	40.80	25.09	15.54	22.08	5.63	9.13	13.06	7.43
α	2E+57	9E+18	8E+18	7E+18	8E+18	8E+18	7E+18	8E+18
NPV of One-time payment	-0.95	-0.68	-1.19	-0.43	1.03	2.41	1.35	1.98
NPV of PAYS	1.68	1.79	1.53	1.89	2.83	3.51	2.93	3.27
SDR	18%	17%	18%	16%	7%	2%	7%	4%

3.1.3 Purchase decisions

Table 14 shows the purchase decisions made by respondents from China and Japan. For all groups in China, the purchase willingness increased when PAYS was provided as a payment method. However, when PAYS was provided to all groups in Japan, the purchase willingness either remained unchanged or decreased. For respondents in Japan, PAYS didn't seem like an attractive payment method. In general, respondents in China had a higher intention to purchase the given EE-appliance in all

given conditions.

Table 14 Purchase decisions of respondents from China and Japan, when different information for each question was provided.

China	Group 1		Group 2		Group 3		Group 4	
	Yes	No	Yes	No	Yes	No	Yes	No
One-time payment	72%	28%	71%	29%	76%	24%	75%	25%
PAYS	86%	14%	83%	17%	84%	16%	83%	17%
One-time payment + NEB	73%	27%	75%	25%	76%	24%	71%	29%
PAYS + NEB	82%	18%	87%	13%	86%	14%	81%	19%

Japan	Group 1		Group 2		Group 3		Group 4	
	Yes	No	Yes	No	Yes	No	Yes	No
One-time payment	61%	39%	55%	45%	61%	39%	54%	46%
PAYS	52%	48%	56%	44%	54%	46%	52%	48%
One-time payment + NEB	56%	44%	52%	48%	61%	39%	55%	45%
PAYS + NEB	52%	48%	56%	44%	57%	43%	55%	45%

3.2 Binary logistic regression analysis

The correlation between purchase decision and independent variables including discount parameter, discount rate, and demographic data was examined using binary logistic regression. Table 15 is the regression result of Group 3 and Group 4 in both countries. For all groups in China and Japan, β/α had a significant positive correlation ($p< 0.01$ in Japan Group 4, $p< 0.05$ in China Group 3, Japan Group 3, $p< 0.1$ in China Group 4) with purchase decisions of EE-appliance. Also, the value of NPV-PAYS in all groups, and NPV-Onetime in China Group3, Japan Group3 and Japan Group4 had a significant positive correlation with purchase decisions. In China Group4 and Japan

Group4, if the discount function of a respondent was a hyperbolic function, there was a significant negative effect on purchase decisions. HealthDummy variables in the table refer to purchase decision questions that contained information about NEB. Therefore, the result of HealthDummy in all groups showed that when additional information about health effects was provided, respondents were more willing to purchase the EE-appliance. The payment method is a dummy variable, in which 0 represents a one-time payment and 1 represents PAYS. In Japan Group3 and Group4, a negative coefficient of PAYS was observed. When the payment method PAYS was provided to respondents in Japan, their purchase willingness decreased, consisted of the result in Table 14. Env-Comp1 indicated that respondents in all groups with higher environmental consciousness would have higher purchase willingness.

Regressions with fewer dependent variables included only NPV-PAYS, NPV-One time, Payment method, Hyperbolic, β/α, and HealthDummy were conducted to examine the fitness of Table 15. The significance of most variables was aligned with Table 15. However, the pseudo r squares between the two regression results indicate that the results in Table 15 had better model fitness than the results in Table 16.

An additional regression analysis analyzing purchase decisions with different payment methods was conducted. NEB (HealthDummy) had positive correlations

with the purchase decision in a one-time payment scenario but was not significant in the PAYS scenario (Tables 17, 18).

Table 15 Result of binary logistic regression.

VARIABLES	China Group3	China Group4	Japan Group3	Japan Group4
NPV-PAYS	0.368***	0.154**	0.238***	0.306***
	(0.101)	(0.0779)	(0.0504)	(0.0533)
NPV-Onetime	0.128***	-0.0339	0.191***	0.261***
	(0.0439)	(0.0359)	(0.0284)	(0.0312)
Payment method	-0.0642	0.274	-0.718***	-0.454**
	(0.207)	(0.196)	(0.186)	(0.211)
Hyperbolic	-0.174	-1.418***	0.716	-0.935*
	(0.289)	(0.317)	(0.528)	(0.567)
β/α	0.00315**	0.00215*	0.00295**	0.00432***
	(0.00151)	(0.00115)	(0.00119)	(0.00136)
Age	-0.0432***	-0.00719	0.0199***	-0.00755
	(0.00947)	(0.00933)	(0.00681)	(0.00697)
HealthDummy	0.404***	0.270**	0.363***	0.352***
	(0.147)	(0.137)	(0.118)	(0.116)
Gender	-0.744***	0.321**	0.327**	0.850***
	(0.173)	(0.158)	(0.161)	(0.168)
Income	0.0458	0.0306	0.0219	-0.00113
	(0.0452)	(0.0344)	(0.0232)	(0.0257)
IncomeDontwannaanswer	1.220	0.923	-0.470**	-0.689***
	(0.976)	(0.943)	(0.224)	(0.218)
Env-Comp 1	0.168***	0.124**	0.185***	0.183***
	(0.0494)	(0.0519)	(0.0357)	(0.0344)
Env-Comp 2	-0.0930	-0.170**	-0.0604	0.0231
	(0.0783)	(0.0794)	(0.0556)	(0.0542)
Env-Comp 3	0.240***	0.354***	0.00526	-0.0184
	(0.0834)	(0.0876)	(0.0535)	(0.0537)
Env-Comp 4	0.140	0.0370	-0.0729	0.0160
	(0.103)	(0.0955)	(0.0600)	(0.0616)
Env-Comp 5	-0.0855	0.165*	-0.242***	-0.128**
	(0.102)	(0.0959)	(0.0659)	(0.0639)
Env-Comp 6	0.241**	-0.253***	-0.164**	-0.0839
	(0.0984)	(0.0932)	(0.0774)	(0.0727)
Health-Comp1	0.175***	0.106*	-0.0260	0.0401
	(0.0573)	(0.0556)	(0.0391)	(0.0375)
Health-Comp2	-0.161**	-0.267***	0.0883*	0.103*
	(0.0731)	(0.0726)	(0.0530)	(0.0580)
Health-Comp3	0.0302	-0.00814	-0.104*	-0.129**
	(0.0954)	(0.0867)	(0.0585)	(0.0608)
Health-Comp4	0.0461	0.106	-0.193***	-0.0448
	(0.101)	(0.0984)	(0.0631)	(0.0574)
Health-Comp5	0.343***	0.150	-0.117*	0.169***
	(0.102)	(0.108)	(0.0636)	(0.0649)
Health-Comp6	-0.0659	0.195*	0.0344	0.00878
	(0.108)	(0.104)	(0.0669)	(0.0714)
Constant	5.758***	3.206***	1.772**	-1.382*
	(1.125)	(0.989)	(0.731)	(0.736)
Pseudo R2	0.2018	0.1511	0.1662	0.1735
Observations	1,588	1,556	1,528	1,548

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 16 A control group for Table 15.

VARIABLES	China Group3	China Group4	Japan Group3	Japan Group4
NPVPAYSDummy	0.389***	0.107	0.231***	0.253***
	(0.0940)	(0.0682)	(0.0437)	(0.0450)
NPVOnetimeDummy	0.122***	-0.0423	0.181***	0.219***
	(0.0381)	(0.0310)	(0.0247)	(0.0262)
hyperbolic	-0.365	-1.271***	0.633	-0.780
	(0.231)	(0.276)	(0.435)	(0.492)
PaysorOnetime	-0.194	0.295*	-0.669***	-0.373**
	(0.181)	(0.175)	(0.167)	(0.188)
β/α	0.00230*	0.00138	0.00321***	0.00334***
	(0.00131)	(0.00104)	(0.00103)	(0.00125)
HealthDummy	0.327**	0.233*	0.305***	0.298***
	(0.132)	(0.127)	(0.108)	(0.106)
Constant	1.266***	1.045***	0.0858	-0.399***
	(0.122)	(0.106)	(0.0994)	(0.109)
Pseudo R2	0.0377	0.0284	0.0456	0.0572
Observations	1,596	1,576	1,532	1,552

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 17 Binary logistic regression of China. Purchase decisions based on different payment method were separately studied.

VARIABLES	China Group3 One time	China Group4 One time	VARIABLES	China Group3 PAYS	China Group4 PAYS
NPV-Onetime	0.158***	-0.00203	NPV-PAYS	0.381***	0.0782
	(0.0481)	(0.0396)		(0.110)	(0.0858)
Hyperbolic	-0.329	-1.663***	Hyperbolic	0.0853	-1.415***
	(0.395)	(0.465)		(0.459)	(0.461)
β/α	0.00111	0.00352**	β/α	0.0111**	0.000670
	(0.00167)	(0.00172)		(0.00513)	(0.00162)
Age	-0.0558***	-0.00904	Age	-0.0342**	-0.00723
	(0.0130)	(0.0125)		(0.0151)	(0.0145)
HealthDummy	0.527***	0.445**	HealthDummy	0.296	0.0895
	(0.200)	(0.190)		(0.233)	(0.212)
Gender	-0.908***	0.611***	Gender	-0.678**	-0.0491
	(0.233)	(0.219)		(0.278)	(0.248)
Income	0.0171	-0.0108	Income	0.0908	0.0863
	(0.0597)	(0.0447)		(0.0743)	(0.0609)
IncomeDontwannaanswer	1.525	1.624	IncomeDontwannaanswer	1.157	-0.210
	(1.415)	(1.296)		(1.594)	(1.493)
Env-Comp 1	0.158**	0.0794	Env-Comp 1	0.220***	0.188**
	(0.0680)	(0.0737)		(0.0794)	(0.0786)
Env-Comp 2	-0.0768	-0.0338	Env-Comp 2	-0.121	-0.389***
	(0.107)	(0.110)		(0.128)	(0.125)
Env-Comp 3	0.266**	0.536***	Env-Comp 3	0.230*	0.180
	(0.112)	(0.125)		(0.138)	(0.131)
Env-Comp 4	0.271*	0.0187	Env-Comp 4	-0.0154	0.101
	(0.140)	(0.134)		(0.167)	(0.147)
Env-Comp 5	0.0328	0.0518	Env-Comp 5	-0.221	0.338**
	(0.141)	(0.133)		(0.159)	(0.153)
Env-Comp 6	0.200	-0.251**	Env-Comp 6	0.393**	-0.308**
	(0.129)	(0.128)		(0.171)	(0.147)
Health-Comp1	0.199**	0.123	Health-Comp1	0.133	0.0591
	(0.0777)	(0.0773)		(0.0918)	(0.0867)
Health-Comp2	-0.226**	-0.439***	Health-Comp2	-0.0911	-0.0890
	(0.0984)	(0.104)		(0.119)	(0.112)
Health-Comp3	-0.165	-0.216*	Health-Comp3	0.321**	0.242*
	(0.130)	(0.119)		(0.158)	(0.140)
Health-Comp4	-0.161	0.274**	Health-Comp4	0.355**	-0.0828
	(0.139)	(0.139)		(0.164)	(0.151)
Health-Comp5	0.451***	0.386***	Health-Comp5	0.264	-0.118
	(0.140)	(0.149)		(0.168)	(0.167)
Health-Comp6	-0.291*	0.153	Health-Comp6	0.223	0.268*
	(0.149)	(0.148)		(0.174)	(0.155)
Constant	6.782***	3.129**	Constant	4.925***	4.068***
	(1.508)	(1.335)		(1.812)	(1.579)
Pseudo R2	0.2351	0.1939	Pseudo R2	0.2607	0.174
Observations	790	776		792	756

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 18 Binary logistic regression of China. Purchase decisions based on different payment method were separately studied.

VARIABLES	Japan Group3 One time	Japan Group4 One time	VARIABLES	Japan Group3 PAYS	Japan Group4 PAYS
NPV-Onetime	0.198***	0.294***	NPV-PAYS	0.237***	0.288***
	(0.0312)	(0.0356)		(0.0541)	(0.0576)
Hyperbolic	1.529*	-1.516	Hyperbolic	0.144	-0.553
	(0.819)	(0.938)		(0.695)	(0.747)
β/α	0.00300*	0.00414**	β/α	0.00277	0.00434**
	(0.00173)	(0.00187)		(0.00170)	(0.00192)
Age	0.0150	-0.0235**	Age	0.0206**	-0.00437
	(0.00959)	(0.0100)		(0.00926)	(0.00937)
HealthDummy	0.522***	0.483***	HealthDummy	0.241	0.247
	(0.174)	(0.170)		(0.164)	(0.161)
Gender	0.233	1.099***	Gender	0.397*	0.590**
	(0.236)	(0.249)		(0.226)	(0.234)
Income	0.0394	-0.0545	Income	0.00493	0.0429
	(0.0353)	(0.0378)		(0.0319)	(0.0360)
IncomeDontwannaanswer	-0.715**	-0.884***	IncomeDontwannaanswer	-0.322	-0.485
	(0.334)	(0.320)		(0.313)	(0.304)
Env-Comp 1	0.153***	0.268***	Env-Comp 1	0.230***	0.112**
	(0.0518)	(0.0516)		(0.0505)	(0.0473)
Env-Comp 2	-0.0131	0.119	Env-Comp 2	-0.122	-0.0238
	(0.0822)	(0.0794)		(0.0775)	(0.0751)
Env-Comp 3	-0.0386	-0.00264	Env-Comp 3	0.0466	-0.0162
	(0.0790)	(0.0785)		(0.0753)	(0.0754)
Env-Comp 4	-0.0169	0.000976	Env-Comp 4	-0.128	0.0309
	(0.0890)	(0.0894)		(0.0837)	(0.0867)
Env-Comp 5	-0.0778	-0.0910	Env-Comp 5	-0.385***	-0.164*
	(0.0959)	(0.0952)		(0.0942)	(0.0891)
Env-Comp 6	-0.342***	-0.214**	Env-Comp 6	-0.0134	0.0396
	(0.116)	(0.106)		(0.108)	(0.103)
Health-Comp1	-0.0592	0.0122	Health-Comp1	0.00926	0.0500
	(0.0581)	(0.0551)		(0.0545)	(0.0522)
Health-Comp2	0.0742	0.149*	Health-Comp2	0.108	0.0847
	(0.0788)	(0.0844)		(0.0736)	(0.0803)
Health-Comp3	-0.154*	-0.0429	Health-Comp3	-0.0680	-0.274***
	(0.0863)	(0.0876)		(0.0826)	(0.0853)
Health-Comp4	-0.0923	-0.0165	Health-Comp4	-0.279***	-0.0809
	(0.0914)	(0.0832)		(0.0902)	(0.0808)
Health-Comp5	-0.233**	0.133	Health-Comp5	-0.0372	0.165*
	(0.0949)	(0.0949)		(0.0890)	(0.0898)
Health-Comp6	0.0877	-0.0596	Health-Comp6	-0.00946	0.0872
	(0.0988)	(0.104)		(0.0938)	(0.101)
Constant	1.865*	0.556	Constant	1.227	-3.255***
	(1.066)	(1.053)		(1.032)	(1.062)
Pseudo R2	0.2097	0.2197	Pseudo R2	0.1609	0.1525
Observations	764	774	Observations	762	770

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

3.3 Comparison between groups & countries

3.3.1 Lottery and Investment rewards

Comparison between groups receiving lottery rewards and groups with investment rewards (Table 19) indicates that the source of rewards, in this study, did not show significant impact on respondents' SDR. The p-value for all comparisons were above 0.05, therefore null hypothesis could not be rejected.

Table 19 t-test between lottery rewards group and investment rewards group.

t-Test: Two-Sample Assuming Unequal Variances: SDR

	China				Japan			
	Group1	Group3	Group2	Group4	Group1	Group3	Group2	Group4
Mean	0.18	0.18	0.17	0.16	0.07	0.07	0.02	0.04
Variance	0.01	0.01	0.01	0.01	0.03	0.02	0.02	0.02
Observations	127	399	117	394	102	383	100	388
df	202		227		145		157	
t Stat	-0.83		1.36		-0.26		-1.16	
P(T<=t) two-tail	0.41		0.17		0.80		0.25	
t Critical two-tail	1.97		1.97		1.98		1.98	

3.3.2 Differences between China & Japan

NPV presents future rewards in current value, accumulatively. When comparing groups with same group number in different countries, significant differences were observed in all comparisons.

Table 20 t-test result of NPV comparing groups between China and Japan.

	China			Japan				
	Mean	Variance	n	Mean	Variance	n	*t*	$p > \|t\|$
Group1	-0.95	6.45	127	1.03	12.30	102	-4.78	4E-06
Group2	-0.76	7.00	117	2.41	8.54	100	-8.44	6E-15
Group3	-1.19	6.07	399	1.35	10.26	383	-12.38	5E-32
Group4	-0.43	7.60	394	1.98	9.38	388	-11.57	1E-28

4. DISCUSSION

4.1 New variables measuring energy-efficient purchase behaviors

While the residential sector has great potential for energy saving, an individual's behaviors are always hard to predict. Barriers including high initial payment, lack of knowledge and information can prevent people from adopting energy-efficient technologies. Researches have tried to analyze incomes, environmental awareness, house size, and many other demographic characteristics to give more insights to policy implications. This research studied the relationship between one's subjective discounting pattern and real purchase behavior. The results of this study suggest that not only the subjective discount rate, which explains an individual's measurement of values but also the discount function that implies an individual's behavioral pattern, can help us predict purchase behaviors related to EE-appliances. Theoretically, when people have a higher discount rate, they tend to value current benefits more, thus are less likely to conduct energy-saving investment. However, few studies observed the discount rate and the purchase decision of EE-appliances independently to verify this assumption.

The use of SDR and discount function in data collection will help better estimate the effectiveness of EE-appliances implementation strategies. Rather than some demographic characteristics such as living area and occupations that rarely found a

significant correlation with the purchase of EE-appliances, questions observing peoples' SDR and parameters of discount function can be introduced into social survey and data collections as new variables to find potential users of EE-appliances.

To make such suggestion is feasible, it is necessary to conduct more researches between purchase behavior of EE-appliances and subjective discounting. For example, previous studies found that the subjective discount rate for various appliances varied from 10% to over 300% (Wilson and Dowlatabadi, 2007). This time the observed mean SDR in China ranged from 16% to 18%, while SDR in Japan ranged much lower from 2% to 7%. Whether such difference is an improvement of model estimation accuracy or is caused by other reasons remain unclear. In this research, 34 questions related to SDR and purchase decisions were asked, and those questions were highly similar to each other. To reduce the burden for respondents, a simpler question design that can precisely estimate SDR and parameters will be an enormous incentive for the wide implementation of data collection.

4.2 The effect of health benefit

Based on the regression result, this research suggests that providing additional information on health-related benefits can increase the purchase willingness of EE-appliances. The knowledge gap of the NEB should be measured, as it is unclear how

many people know what NEB is and how it is related to EE-appliances. Both China and Japan are facing the problem of an aging society. Seniors usually feel less easy to access the latest information and are more vulnerable to health risks. Therefore, policymakers, when considering policies related to NEB, should increase the accessibility of such information. The demographic data in this research shows that over 60% of Chinese respondents believed they have at least one physical or mental disease. This can explain why the general concern of health awareness has a positive effect on purchasing EE-appliance.

5. CONCLUSION

Emission reduction is an unignorable issue for a sustainable future. An individual's energy-saving actions can make significant contributions to mitigate global warming and policymakers started to put more resources to maximize the potential of residential energy efficiency. To find more predictors for consumers' behaviors, questionnaire surveys were conducted in both China and Japan.

Subjective discount rate and the discount function of each respondent were elicited and were used as independent variables to observe purchase decisions of energy-

efficient appliances. The effects of NEB information and PAYS in the decision-making process were also observed.

Results of surveys suggested subjective discount rate and discount function were useful predictors of respondents' purchase behaviors. NEB showed a positive effect on purchase decisions, while PAYS was insignificant in China and being negative in Japan.

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APPEDIX

本調査では回答者を 4 種類のグループに分けます。

【A 主観的割引パート】

グループ 1：「宝くじで 1 万円当たる場合」の設問に答えていただきます

グループ 2：「宝くじで 10 万円当たる場合」の設問に答えていただきます

グループ 3：「投資で 1 万円得る場合」の設問に答えていただきます

グループ 4：「投資で 10 万円得る場合」の設問に答えていただきます

【B 間接便益パート】

グループ 1 とグループ 3：設問 B1,B2, B3, B4 に答えていただきます

グループ 2 とグループ 4：設問 B5,B6, B7, B8 に答えていただきます

【C 個人属性パート】

全グループ共通です。

パート A【主観割引】
※これからお金の感覚に関するアンケートを答えていただきます。
※正解があるわけではありませんので、深く考えすぎずにご自身の直感でお答えください。

パート A は 4 つの回答者グループに分かれます。グループ 1 と 2 向けの設問 A1～A6 とグループ 3 と 4 向けの設問 A1～A6 があります。

● グループ 1 とグループ 2 向けの設問 A1～A6 ※以下、グループ 1 は 1 万円、グループ 2 は 10 万円です。
A1 あなたは（1 万円, 10 万円）の宝くじが当たりました。今すぐ当選金を受け取るか、それとも 1 年後右に提示される金額を受け取るかを選ぶことができます。どちらかを選択してください。※ただし 1 年後に確実に提示された額を受け取れ、100%信頼できるものとします。
A1 の設問は回答によって最大 6 問続きます。詳細はグループ 1,3 は P5 を参照ください。グループ 2,4 は P12 を参照ください。

A2 あなたは（1 万円, 10 万円）の宝くじが当たりました。今すぐ当選金を受け取るか、それとも 3 年後右に提示される金額を受け取るかを選ぶことができます。どちらかを選択してください。※ただし 3 年後に確実に提示された額を受け取れ、100%信頼できるものとします。
A2 の設問は回答によって最大 6 問続きます。詳細は P7 を参照ください。

A3 あなたは（1 万円, 10 万円）の宝くじが当たりました。当選金は 1 年後に受け取れます。1 年後に(1 万円,10 万円)を受け取るか、さらに半年後(今から 1 年半後)右に提示される額を受け取るかを選ぶことができます。どちらかを選択してください。※さらに半年待っても確実に提示された額を受け取れ、100%信頼できるものとします。
A3 の設問は回答によって最大 6 問続きます。詳細は P8 を参照ください。

A4 あなたは（1 万円, 10 万円）の宝くじが当たりました。当選金は 1 年後に受け取れます。1 年後に(1 万円,10 万円)を受け取るか、さらに 1 年後(今から 2 年後)右に提示される額を受け取るかを選ぶことができます。どちらかを選択してください。※さらに 1 年待っても確実に提示された額を受け

取れ、100%信頼できるものとします。
A4 の設問は回答によって最大 6 問続きます。詳細は P9 を参照ください。

A5　あなたは（1 万円, 10 万円）の宝くじが当たりました。当選金は 3 年後に受け取れます。3 年後に(1 万円,10 万円)を受け取るか、さらに 1 年後(今から 4 年後)右に提示される額を受け取るかを選ぶことができます。どちらかを選択してください。※さらに 1 年待っても確実に提示された額を受け取れ、100%信頼できるものとします。
A5 の設問は回答によって最大 6 問続きます。詳細は P10 を参照ください。

A6　あなたは（1 万円, 10 万円）の宝くじが当たりました。当選金は 3 年後に受け取れます。3 年後に(1 万円,10 万円)を受け取るか、さらに 3 年後(今から 6 年後)右に提示される額を受け取るかを選ぶことができます。どちらかを選択してください。※さらに 3 年待っても確実に提示された額を受け取れ、100%信頼できるものとします。
A6 の設問は回答によって最大 6 問続きます。詳細は P11 を参照ください。

● グループ 3 とグループ 4 向けの設問 A1～A6　　※以下、グループ 3 は 1 万円、グループ 4 は 10 万円です。
A1　あなたは自身で考えた資産の投資がうまくいって、(1 万円, 10 万円)の利益を得ました。今すぐその利益を受け取るか、それとも 1 年後右に提示される金額を受け取るかを選ぶことができます。どちらかを選択してください。※ただし 1 年後に確実に提示された額を受け取れ、100%信頼できるものとします。
A1 の設問は回答によって最大 6 問続きます。詳細はグループ 1,3 は P5 を参照ください。グループ 2,4 は P12 を参照ください。

A2 あなたは自身で考えた資産の投資がうまくいって、(1 万円, 10 万円)の利益を得ました。今すぐその利益を受け取るか、それとも 3 年後右に提示される金額を受け取るかを選ぶことができます。どちらかを選択してください。※ただし 3 年後に確実に提示された額を受け取れ、100%信頼できる

ものとします。
A2 の設問は回答によって最大 6 問続きます。詳細は P7 を参照ください。

A3　あなたは自身で考えた資産の投資がうまくいって、(1 万円, 10 万円)の利益を得ました。利益は 1 年後に受け取れます。1 年後に(1 万円,10 万円)を受け取るか、さらに半年後(今から 1 年半後)右に提示される額を受け取るかを選ぶことができます。どちらかを選択してください。※さらに半年待っても確実に提示された額を受け取れ、100%信頼できるものとします。
A3 の設問は回答によって最大 6 問続きます。詳細は P8 を参照ください。

A4　あなたは自身で考えた資産の投資がうまくいって、(1 万円, 10 万円)の利益を得ました。利益は 1 年後に受け取れます。1 年後に(1 万円,10 万円)を受け取るか、さらに 1 年後(今から 2 年後)右に提示される額を受け取るかを選ぶことができます。どちらかを選択してください。※さらに 1 年待っても確実に提示された額を受け取れ、100%信頼できるものとします。
A4 の設問は回答によって最大 6 問続きます。詳細は P9 を参照ください。

A5　あなたは自身で考えた資産の投資がうまくいって、(1 万円, 10 万円)の利益を得ました。利益は 3 年後に受け取れます。3 年後に(1 万円,10 万円)を受け取るか、さらに 1 年後(今から 4 年後)右に提示される額を受け取るかを選ぶことができます。どちらかを選択してください。※さらに 1 年待っても確実に提示された額を受け取れ、100%信頼できるものとします。
A5 の設問は回答によって最大 6 問続きます。詳細は P10 を参照ください。

A6　あなたは自身で考えた資産の投資がうまくいって、(1 万円, 10 万円)の利益を得ました。利益は 3 年後に受け取れます。3 年後に(1 万円,10 万円)を受け取るか、さらに 3 年後(今から 6 年後)右に提示される額を受け取るかを選ぶことができます。どちらかを選択してください。※さらに 3 年待っても確実に提示された額を受け取れ、100%信頼できるものとします。
A6 の設問は回答によって最大 6 問続きます。詳細は P11 を参照ください。

（推移指定）グループ 1, 3 向け　設問 A1 詳細（グループ 2, 4 向けには金額をすべて 10 倍してください。参考までにこのページの金額を 10 倍したものを P12 に掲載しました）

（第 A1-1 問）

右を選んだ回答者はここで全てのアンケートを終了し、回収サンプル数に含めないでください。

左を選んだ回答者は(第 A1-2 問)へ

（第 A1-2 問）

左を選んだ回答者は（第 A1-3 問）へ、その後次の A2 の設問に移行してください。

右を選んだ回答者は(第 A1-4 問)へ

（第 A1-3 問）今 10,000 円を受け取らず 1 年後に受け取るときいくらもらえばよいですか？

選択肢

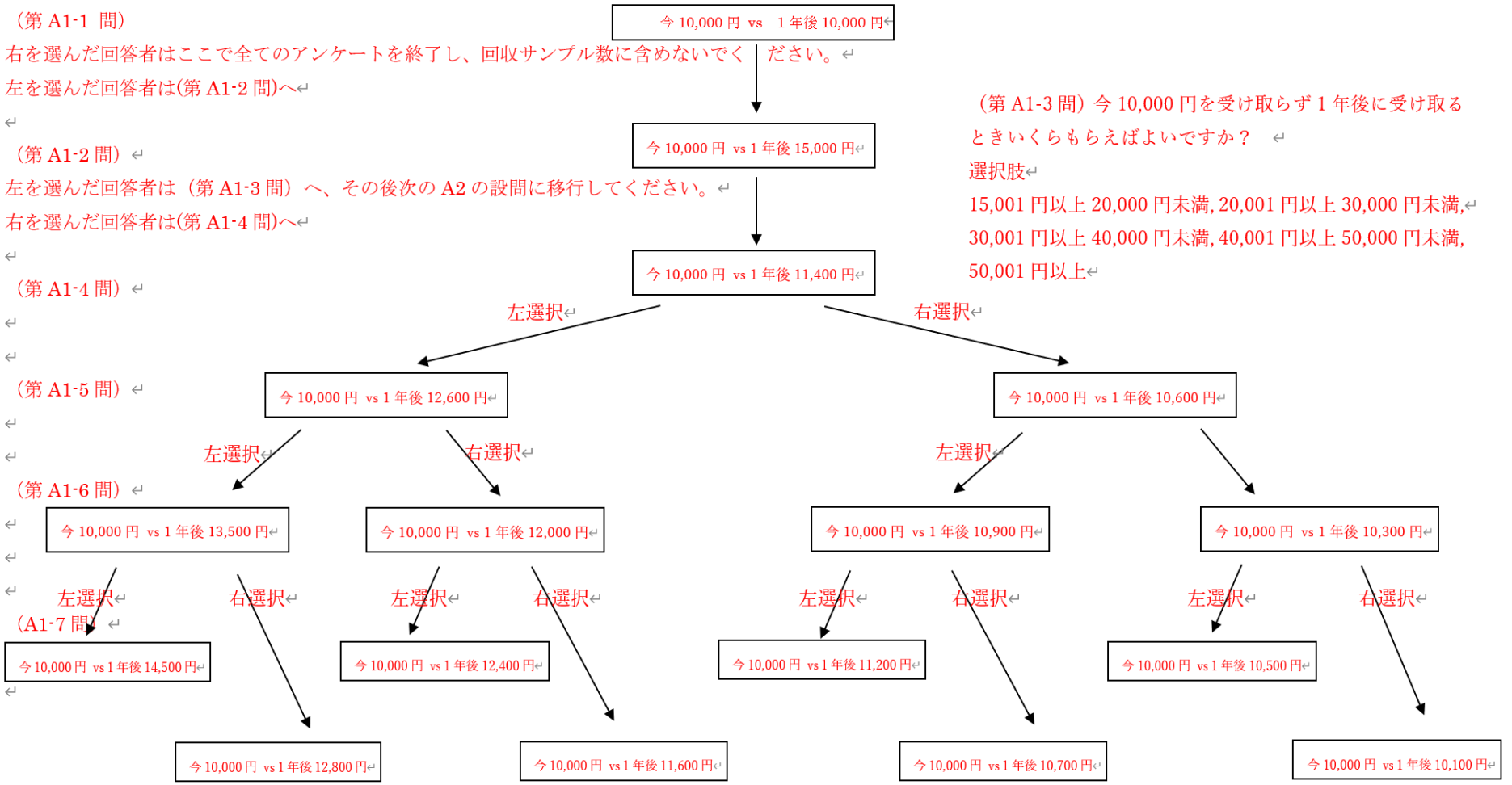
15,001 円以上 20,000 円未満, 20,001 円以上 30,000 円未満,
30,001 円以上 40,000 円未満, 40,001 円以上 50,000 円未満,
50,001 円以上

（第 A1-4 問）

（第 A1-5 問）

（第 A1-6 問）

（A1-7 問）



設問画面推移の具体例を一つあげます。○をつけたものを選択したと考えてください。

(第 A1-1 問)　今 10,000 円　vs　1 年後 10,000 円

(第 A1-2 問)　今 10,000 円　vs　1 年後 15,000 円

(第 A1-4 問)　今 10,000 円　vs　1 年後 11,400 円

(第 A1-5 問)　今 10,000 円　vs　1 年後 12,600 円

(第 A1-6 問)　今 10,000 円　vs　1 年後 12,000 円

(第 A1-7 問) →最後の設問

今 10,000 円　vs　1 年後 11,600 円

のどちらかを選択して終了。次の設問 A2 へ

（推移指定）グループ 1, 3 向け　設問 A2 詳細（グループ 2, 4 向けには金額をすべて 10 倍してください）↵

↵

（第 A2-1 問）↵

右を選んだ回答者はここで全てのアンケートを終了し、回収サンプル数に含めないでください。↵

左を選んだ回答者は(第 A2-2 問)へ↵

↵

（第 A2-2 問）↵

左を選んだ回答者は（第 A2-3 問）へ、その後次の A3 の設問に移行してください。↵

右を選んだ回答者は(第 A2-4 問)へ↵

↵

（第 A2-3 問）↵

今 10,000 円を受け取らず 3 年後に受け取るときいくらもらえばよいですか？　↵

選択肢↵

33,801 円以上 50,000 円未満, 50,001 円以上 60,000 円未満,↵

60,001 円以上 70,000 円未満, ・・, 90,001 円以上 100,000 円未満,　100,001 円以上↵

（第 A2-4 問）↵

↵

↵

（第 A2-5 問）↵

↵

↵

（第 A2-6 問）↵

↵

↵

↵

（第 A2-7 問）↵

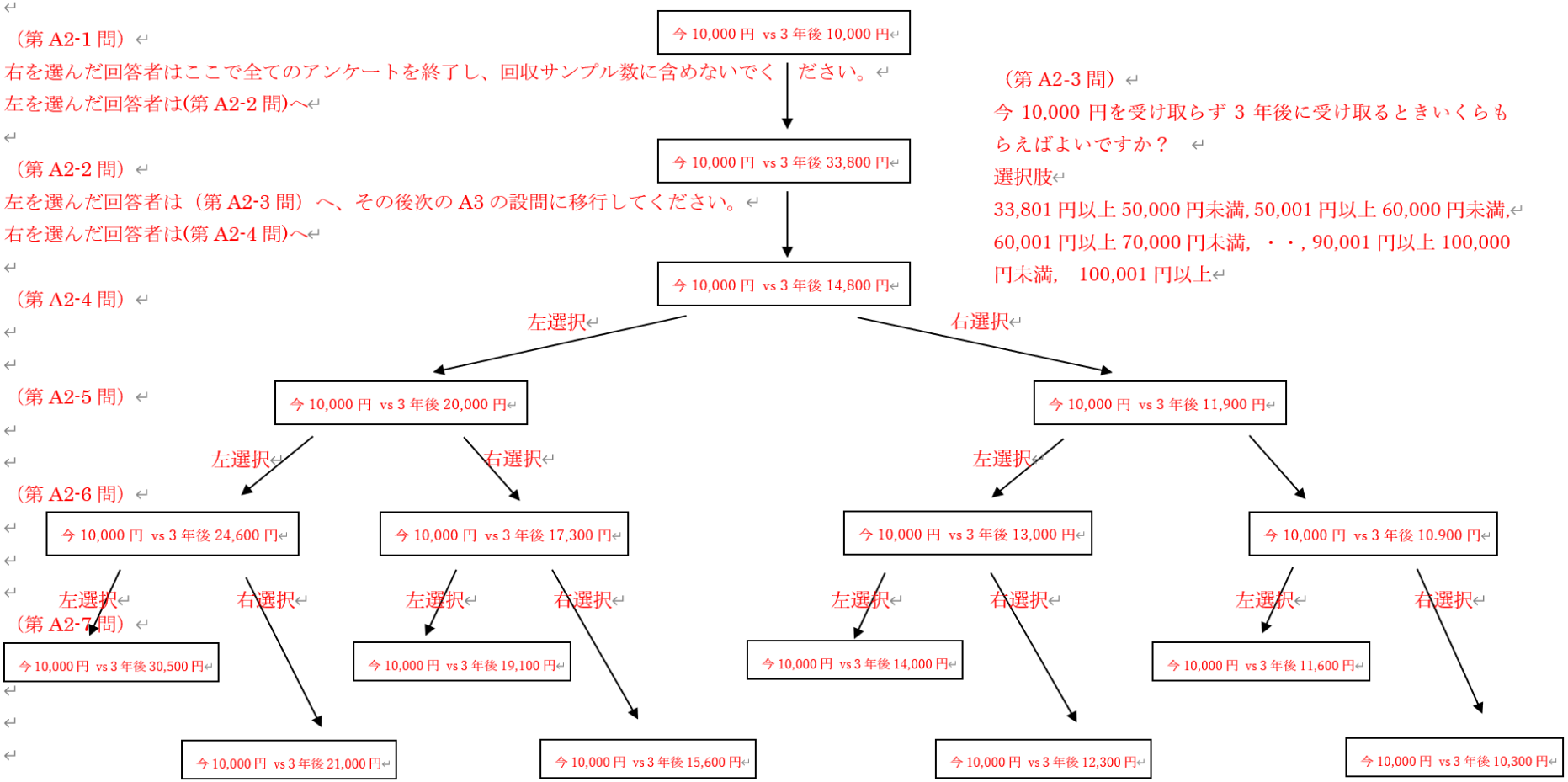
↵

↵

↵

↵

次の設問 A3 へ↵



（推移指定）グループ 1, 3 向け　設問 A3 詳細（グループ 2, 4 向けには金額をすべて 10 倍してください）↵

↵

（第 A3-1 問）↵

右を選んだ回答者はここで全てのアンケートを終了し、回収サンプル数に含めないでください。↵

左を選んだ回答者は(第 A3-2 問)へ↵

↵

（第 A3-2 問）↵

左を選んだ回答者は（第 A3-3 問）へ、その後次の A4 の設問に移行してください。↵

右を選んだ回答者は(第 A3-4 問)へ↵

↵

（第 A3-4 問）↵

↵

↵

（第 A3-5 問）↵

↵

↵

（第 A3-6 問）↵

↵

↵

↵

（第 A3-7 問）↵

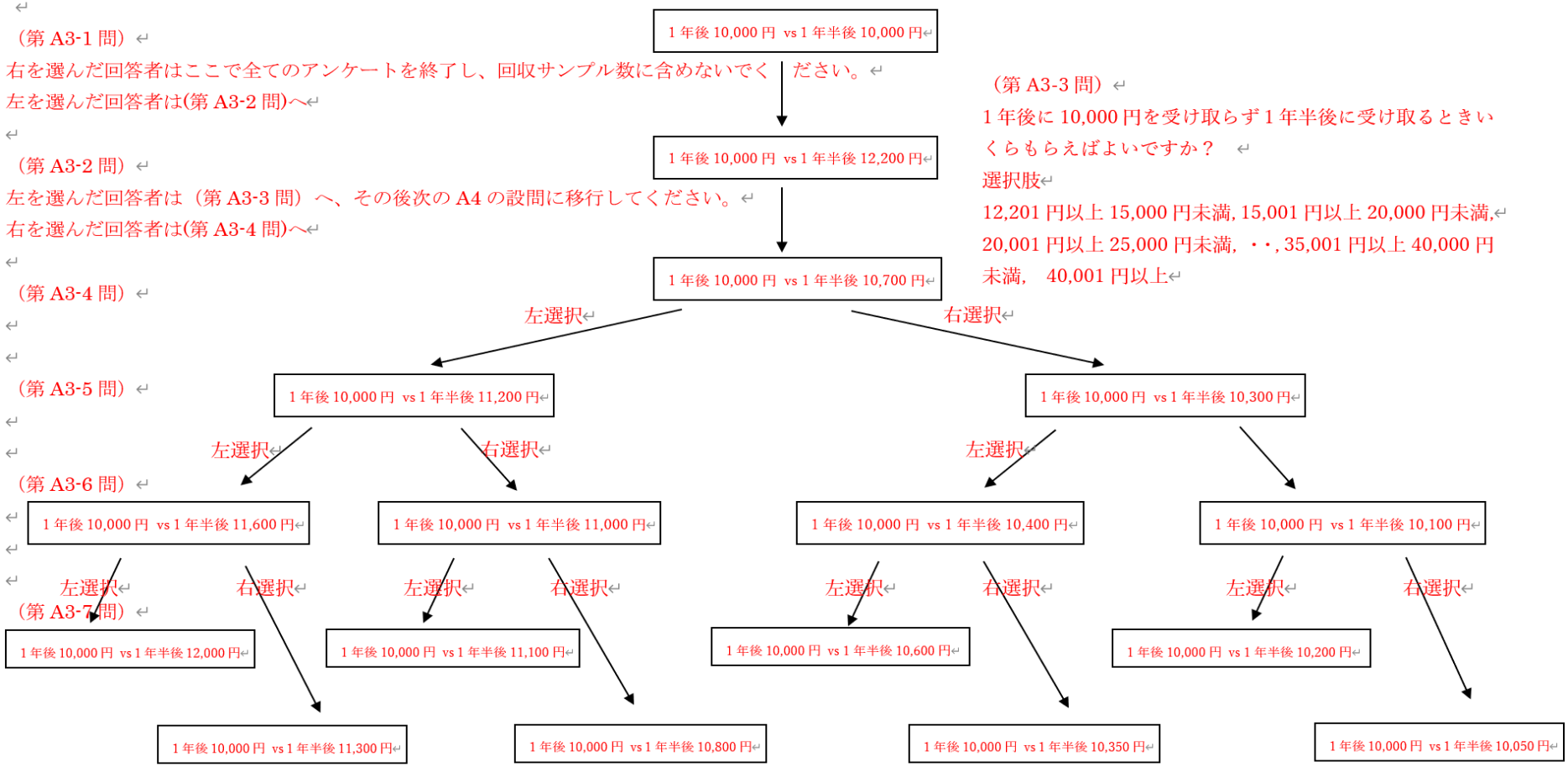
（第 A3-3 問）↵

1 年後に 10,000 円を受け取らず 1 年半後に受け取るときいくらもらえばよいですか？　↵

選択肢↵

12,201 円以上 15,000 円未満, 15,001 円以上 20,000 円未満,↵

20,001 円以上 25,000 円未満, ・・, 35,001 円以上 40,000 円未満,　40,001 円以上↵



次の質問 A4 へ↵

（推移指定）グループ 1, 3 向け　設問 A4 詳細（グループ 2, 4 向けには金額をすべて 10 倍してください）↵

↵

（第 A4-1 問）↵

右を選んだ回答者はここで全てのアンケートを終了し、回収サンプル数に含めないでください。↵

左を選んだ回答者は(第 A4-2 問)へ↵

↵

（第 A4-2 問）↵

左を選んだ回答者は（第 A4-3 問）へ、その後次の A5 の設問に移行してください。↵

右を選んだ回答者は(第 A4-4 問)へ↵

↵

（第 A4-4 問）↵

↵

↵

（第 A4-5 問）↵

↵

↵

（第 A4-6 問）↵

↵

↵

↵

（第 A4-7 問）↵

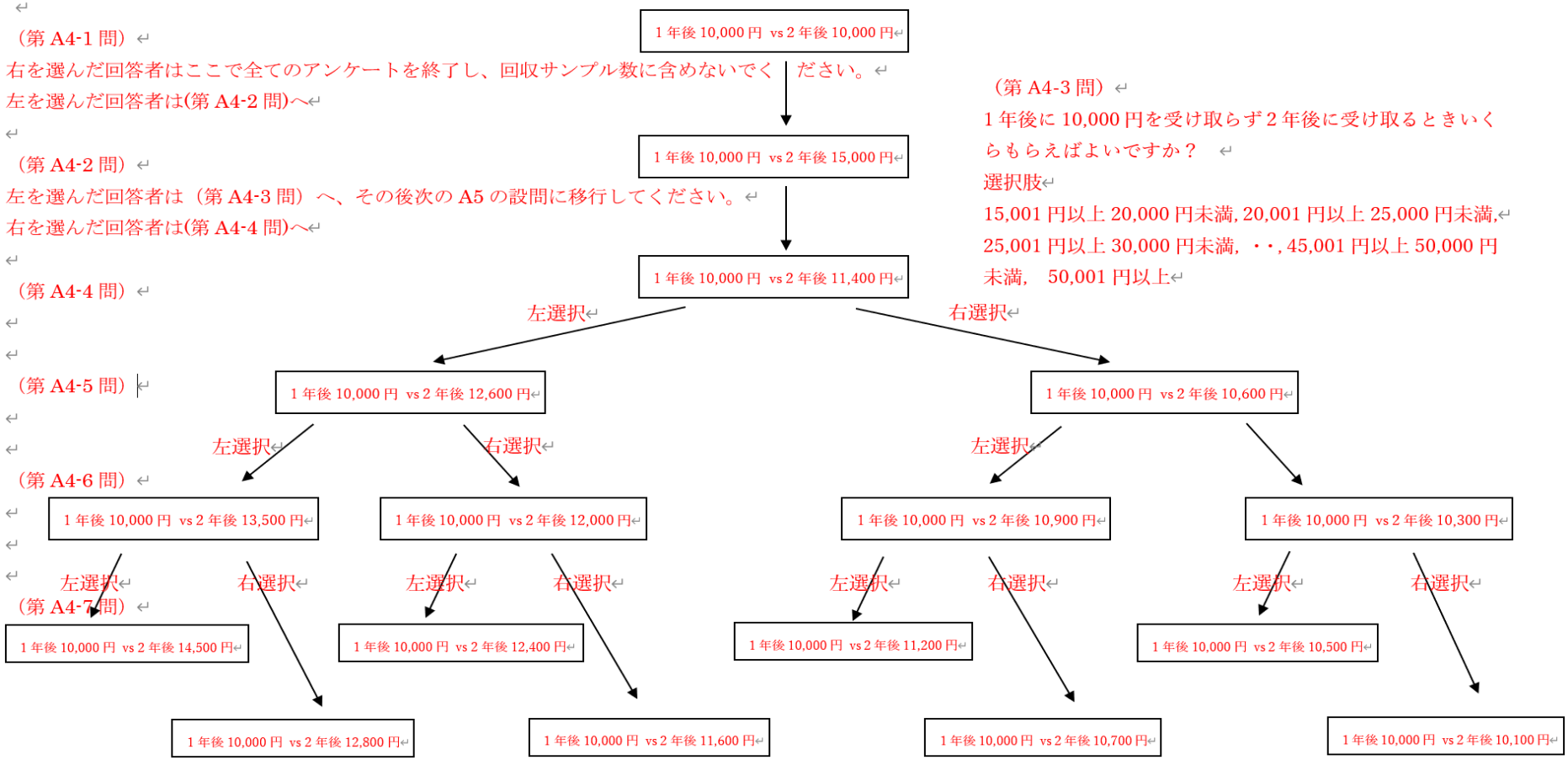
（第 A4-3 問）↵

1 年後に 10,000 円を受け取らず 2 年後に受け取るときいくらもらえばよいですか？　↵

選択肢↵

15,001 円以上 20,000 円未満, 20,001 円以上 25,000 円未満,↵

25,001 円以上 30,000 円未満, ・・, 45,001 円以上 50,000 円未満,　50,001 円以上↵



次の質問 A5 へ↵

（推移指定）グループ 1, 3 向け　設問 A5 詳細（グループ 2, 4 向けには金額をすべて 10 倍してください）↵

↵

（第 A5-1 問）↵

右を選んだ回答者はここで全てのアンケートを終了し、回収サンプル数に含めないでください。↵

左を選んだ回答者は(第 A5-2 問)へ↵

↵

（第 A5-2 問）↵

左を選んだ回答者は（第 A5-3 問）へ、その後次の A6 の設問に移行してください。↵

右を選んだ回答者は(第 A5-4 問)へ↵

↵

（第 A5-3 問）↵

3 年後に 10,000 円を受け取らず 4 年後に受け取るときいくらもらえばよいですか？　↵

選択肢↵

15,001 円以上 20,000 円未満, 20,001 円以上 25,000 円未満,↵

25,001 円以上 30,000 円未満, ・・, 45,001 円以上 50,000 円未満,　50,001 円以上↵

（第 A5-4 問）↵

↵

↵

（第 A5-5）↵

↵

↵

（第 A5-6 問）↵

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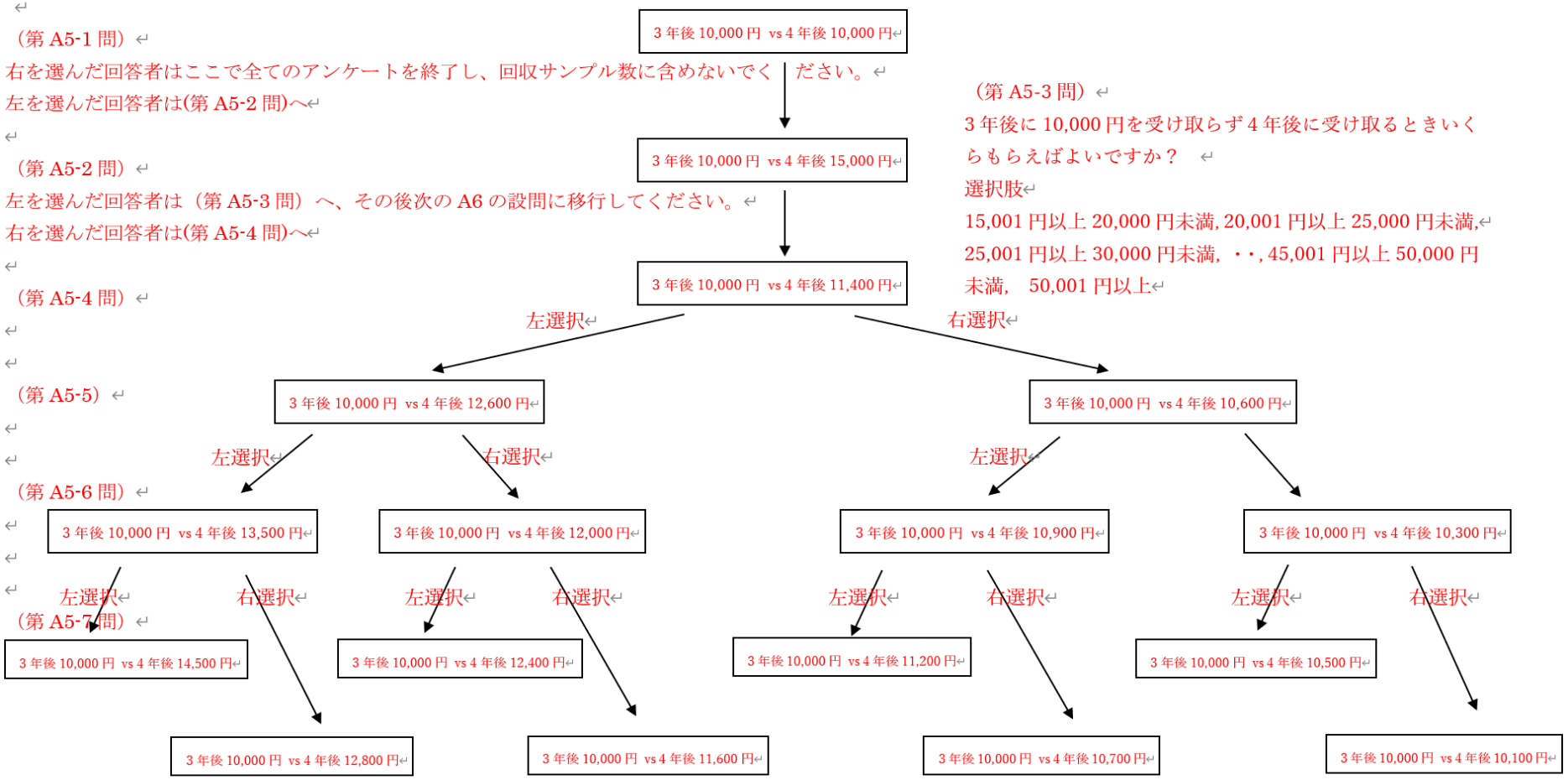
↵

（第 A5-7 問）↵



次の質問 A6 へ↵

（推移指定）グループ 1, 3 向け　設問 A6 詳細（グループ 2, 4 向けには金額をすべて 10 倍してください）↵

↵

（第 A6-1 問）↵

右を選んだ回答者はここで全てのアンケートを終了し、回収サンプル数に含めないでください。↵

左を選んだ回答者は(第 A6-2 問)へ↵

↵

（第 A6-2 問）↵

左を選んだ回答者は（第 A6-3 問）へ、その後次のパート B に移行してください。↵

右を選んだ回答者は(第 A6-4 問)へ↵

↵

（第 A6-4 問）↵

↵

↵

（第 A6-5 問）↵

↵

↵

（第 A6-6 問）↵

↵

↵

↵

（第 A6-7 問）↵

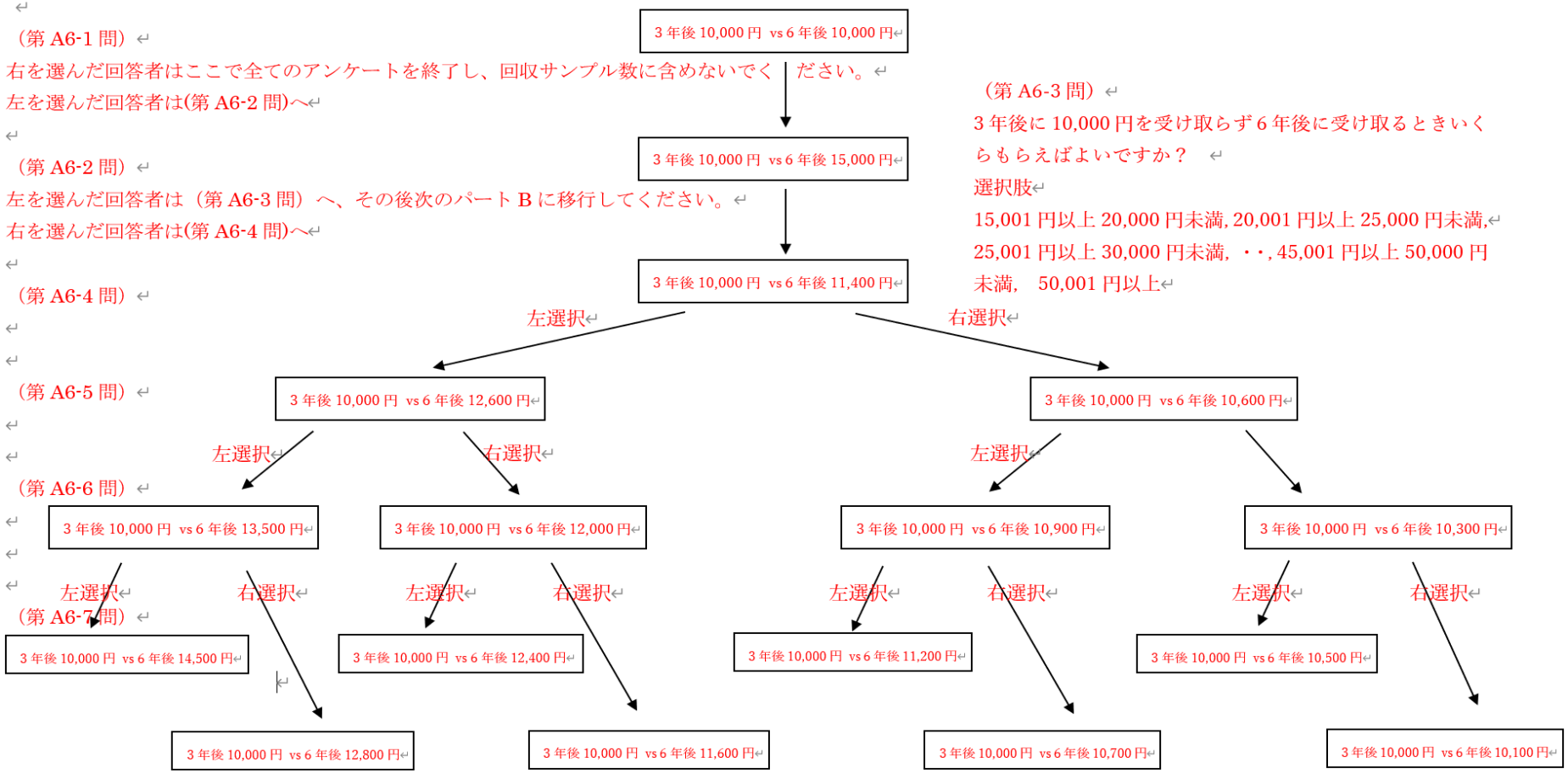
（第 A6-3 問）↵

3 年後に 10,000 円を受け取らず 6 年後に受け取るときいくらもらえばよいですか？　↵

選択肢↵

15,001 円以上 20,000 円未満, 20,001 円以上 25,000 円未満,↵

25,001 円以上 30,000 円未満, ・・, 45,001 円以上 50,000 円未満,　50,001 円以上↵



パート A の推移指定はここまでです↵

（推移指定）↵

（参考）グループ 2, 4 向け　設問 A1 詳細（P5 の金額を 10 倍したものです）↵

（第 A1-1 問）↵

右を選んだ回答者はここで全てのアンケートを終了し、回収サンプル数に含めないでください。↵

左を選んだ回答者は(第 A1-2 問)へ↵

↵

（第 A1-2 問）↵

左を選んだ回答者は（第 A1-3 問）へ、その後次の A2 の設問に移行してください。↵

右を選んだ回答者は(第 A1-4 問)へ↵

↵

（第 A1-3 問）↵

今 100,000 円を受け取らず 1 年後に受け取るときいくらもらえばよいですか？　↵

選択肢↵

150,001 円以上 200,000 円未満, 200,001 円以上 300,000 円未満, 300,001 円以上 400,000 円未満, 400,001 円以上 500,000 円未満, 500,001 円以上↵

（第 A1-4 問）↵

↵

↵

（第 A1-5 問）↵

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（第 A1-6 問）↵

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（第 A1-7 問）↵

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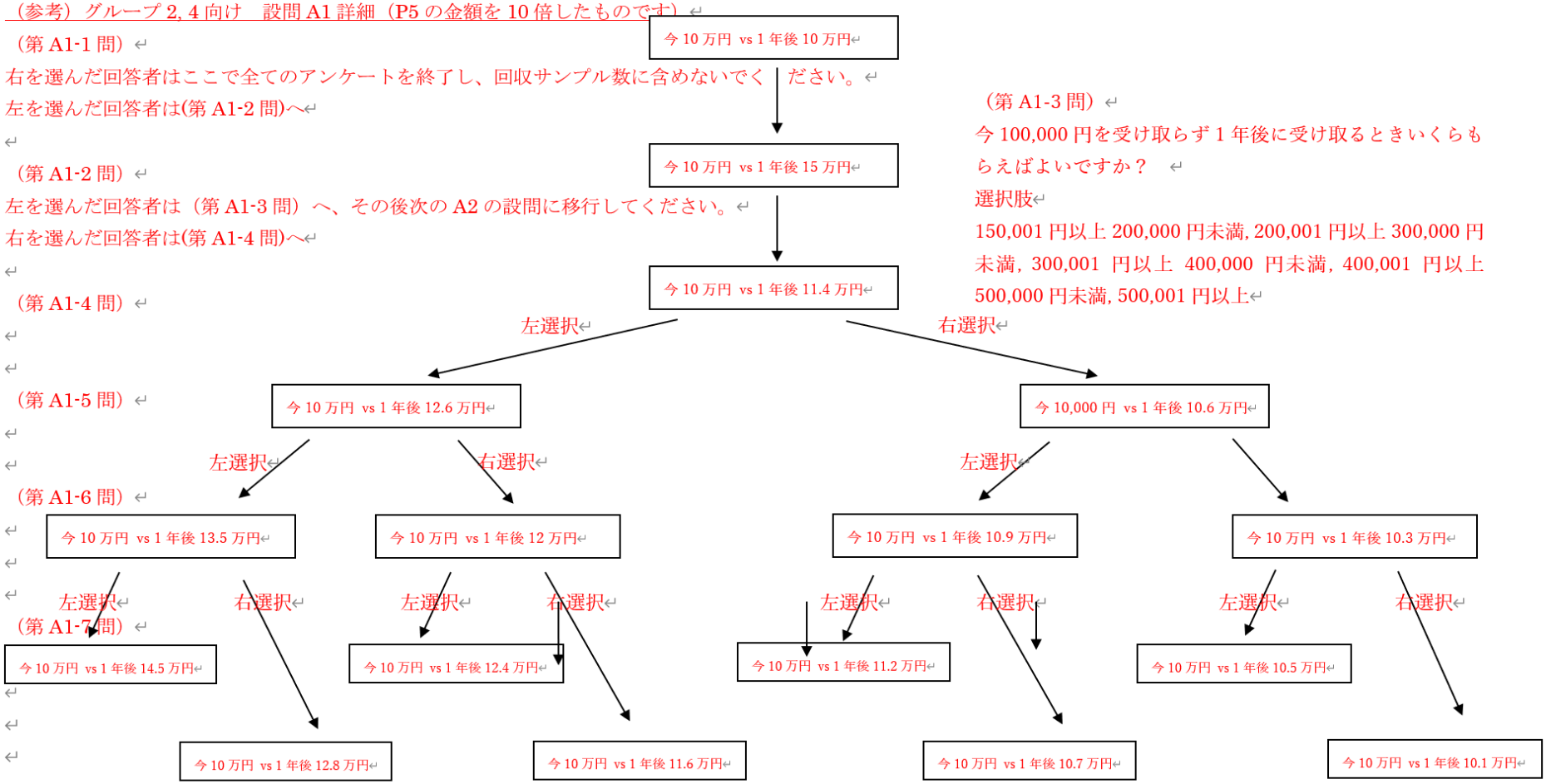


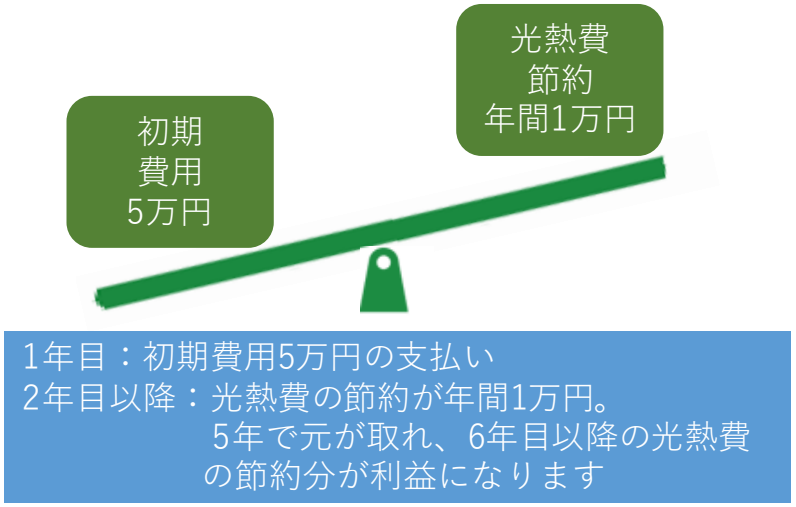
パート B【間接便益】

● グループ 1 とグループ 3 向け（設問 B1～B4）

B1　住宅の光熱費を減らす新しい省エネ製品が販売されたとします。この製品をあなたの家庭に導入すると、毎年 1 万円の光熱費が節約できることがわかりました。この省エネ製品の価格は 5 万円でそれ以外の費用はかかりません。製品の耐用年数は 10 年程度です。この情報が正しいと確信できる場合、あなたは購入をしますか？なお、初期費用 5 万円は一括払いで支払うとします。

はい

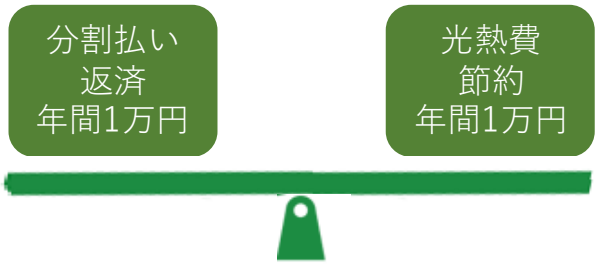
いいえ



B2　前問と同じ状況で、住宅の光熱費を減らす 5 万円の新しい省エネ製品をあなたの家庭に導入すると、毎年 1 万円の光熱費が節約できます。製品の耐用年数は 10 年程度です。ここで 5 万円の初期費用を一括で支払わず、毎年 1 万円ずつ返済する分割払いがあると考えてください。この場合、最初の 5 年間は省エネ製品の購入によって節約した 1 万円の光熱費をそのまま分割払いの支払いにあてることになり、購入する前と家計の出費額は変わりません。返済を終えた 6 年目以降は毎年 1 万円の利益を得ます。分割払いの金利と手数料はゼロとします。この情報が正しいと確信できる場合、あなたはこのような分割払いでこの製品を購入しますか？

はい

いいえ

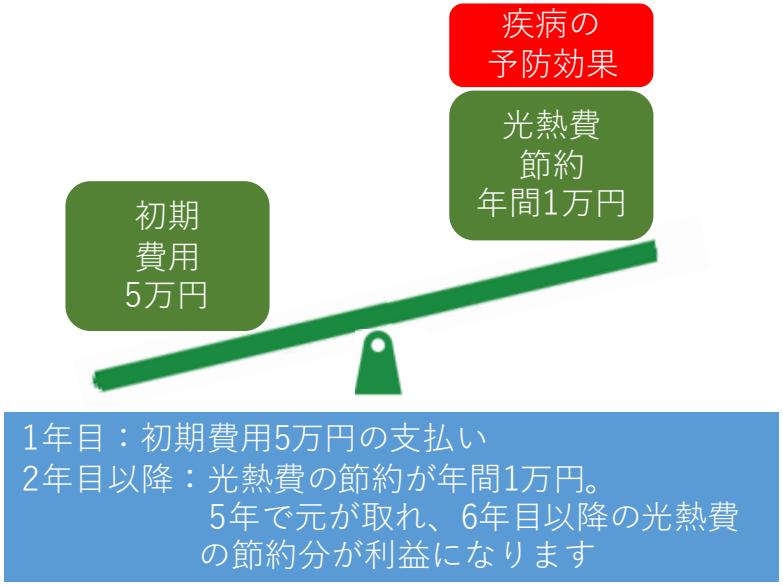


1年目～5年目：光熱費の節約分で、ローンを返済
6年目以降：光熱費の節約分が利益に

B3　住宅の光熱費を減らす新しい省エネ製品が販売されたとします。この製品をあなたの家庭に導入すると、毎年 1 万円の光熱費が節約できることがわかりました。価格は 5 万円でそれ以外の費用はかかりません。製品の耐用年数は 10 年程度です。ただこの製品の導入によって家全体の断熱や保温の効果により、心疾患、脳血管疾患など病気の予防効果があるとします。年間 1000 人に 1 人の死亡率を、1 万人に 1 人の死亡率に減らす効果があることがわかっているとします。この情報が正しいと確信できる場合、あなたはこの製品の購入をしますか？なお、初期費用 5 万円は一括払いで支払うとします。

はい

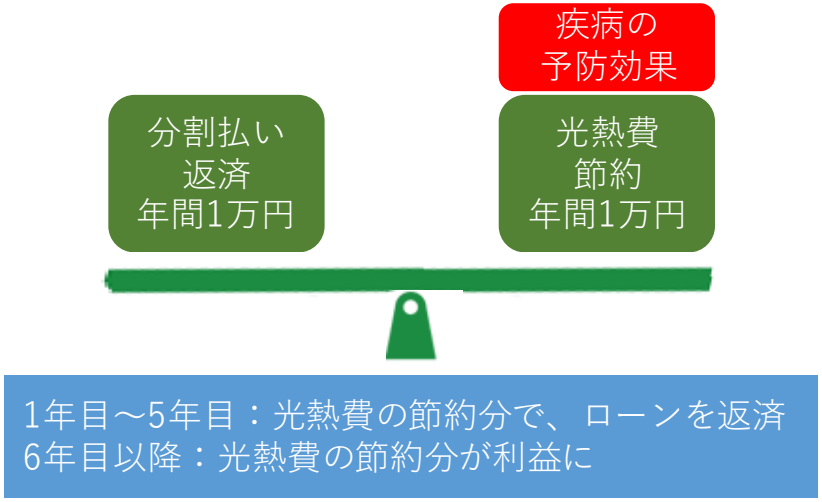
いいえ



B4 前問と同じ状況で、住宅の光熱費を減らす 5 万円の新しい省エネ製品をあなたの家庭に導入すると、毎年 1 万円の光熱費が節約できます。製品の耐用年数は 10 年程度です。ここで 5 万円の初期費用を一括で支払わず、毎年 1 万円ずつ返済する分割払いがあると考えてください。この場合、最初の 5 年間は省エネ製品の購入によって節約した 1 万円の光熱費をそのまま分割払いの支払いにあてることになり、購入する前と家計の出費額は変わりません。返済を終えた 6 年目以降は毎年 1 万円の利益を得ます。分割払いの金利と手数料はゼロとします。ただこの製品の導入によって家全体の断熱や保温の効果により、心疾患、脳血管疾患など病気の予防効果があるとします。年間 1000 人に 1 人の死亡率を、1 万人に 1 人の死亡率に減らす効果があることがわかっているとします。この情報が正しいと確信できる場合、あなたはこのような分割払いでこの製品を購入しますか？

はい

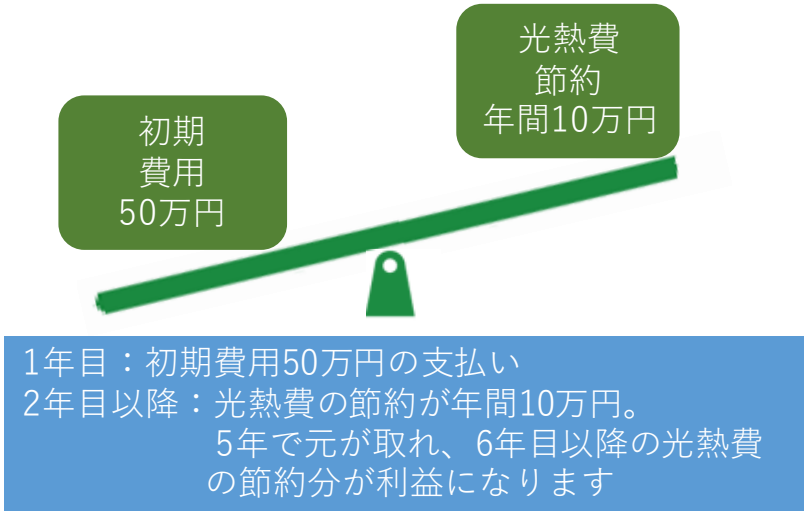
いいえ



- グループ 2 とグループ 4 向け（設問 B5～B8）※グループ 1 、3 との違いは、金額の「1 万円」が「10 万円」、「5 万円」が「50 万円」に変わる点だけで、あとはすべて同じです。

B5　住宅の光熱費を減らす新しい省エネ製品が販売されたとします。この製品をあなたの家庭に導入すると、毎年 10 万円の光熱費が節約できることがわかりました。価格は 50 万円でそれ以外の費用はかかりません。製品の耐用年数は 10 年程度です。この情報が正しいと確信できる場合、あなたは購入をしますか？なお、初期費用 50 万円は一括払いで支払うとします。

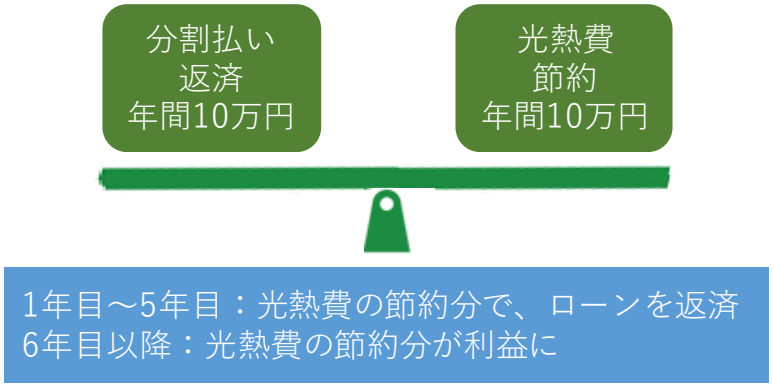
はい
いいえ



B6　前問と同じ状況で、住宅の光熱費を減らす 50 万円の新しい省エネ製品をあなたの家庭に導入すると、毎年 10 万円の光熱費が節約できます。製品の耐用年数は 10 年程度です。ここで 50 万円の初期費用を一括で支払わず、毎年 10 万円ずつ返済する分割払いがあると考えてください。この場合、最初の 5 年間は省エネ製品の購入によって節約した 10 万円の光熱費をそのまま分割払いの支払いにあてることになり、購入する前と家計の出費額は変わりません。返済を終えた 6 年目以降は毎年 10 万円の利益を得ます。分割払いの金利と手数料はゼロとします。この情報が正しいと確信できる場合、あなたはこのような分割払いでこの製品を購入しますか？

はい

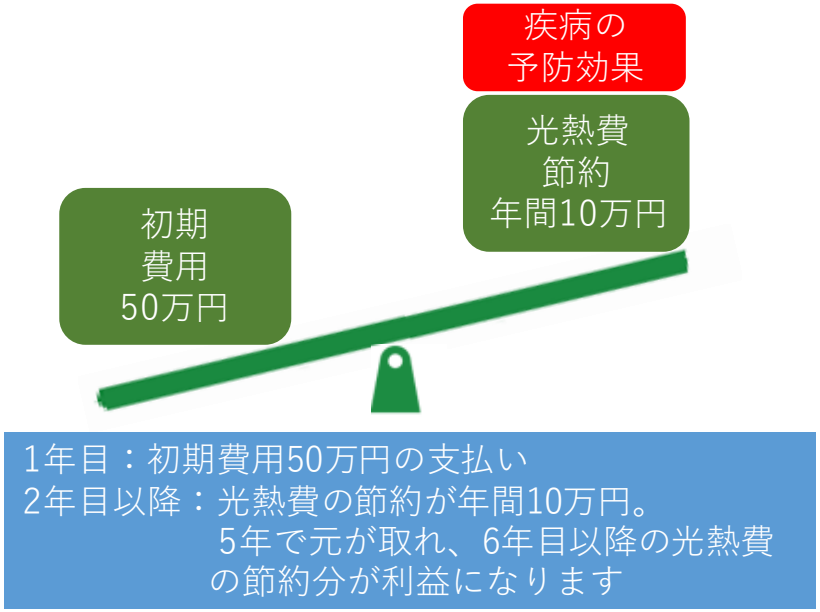
いいえ



B7　住宅の光熱費を減らす新しい省エネ製品が販売されたとします。この製品をあなたの家庭に導入すると、毎年 10 万円の光熱費が節約できることがわかりました。価格は 50 万円でそれ以外の費用はかかりません。製品の耐用年数は 10 年程度です。ただこの製品の導入によって家全体の断熱や保温の効果により、心疾患、脳血管疾患など病気の予防効果があるとします。年間 1000 人に 1 人の死亡率を、1 万人に 1 人の死亡率に減らす効果があることがわかっているとします。この情報が正しいと確信できる場合、あなたはこの製品の購入をしますか？なお、初期費用 50 万円は一括払いで支払うとします。

はい

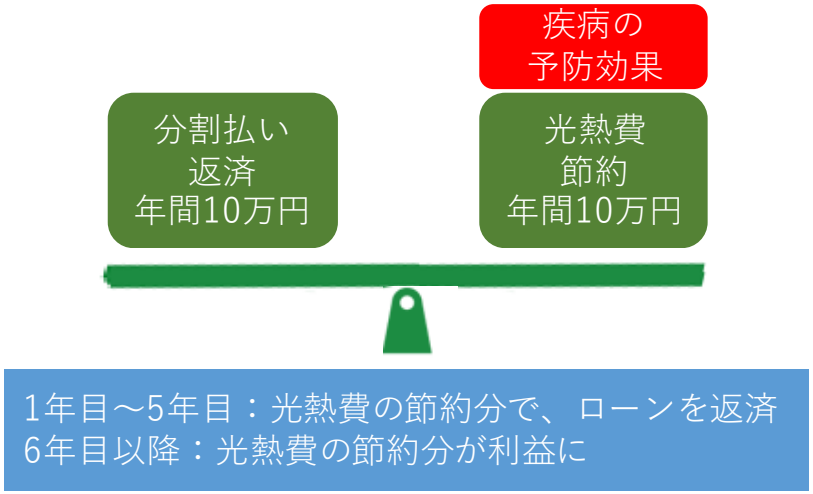
いいえ



B8 前問と同じ状況で、住宅の光熱費を減らす 50 万円の新しい省エネ製品をあなたの家庭に導入すると、毎年 10 万円の光熱費が節約できます。製品の耐用年数は 10 年程度です。ここで 50 万円の初期費用を一括で支払わず、毎年 10 万円ずつ返済する分割払いがあると考えてください。この場合、最初の 5 年間は省エネ製品の購入によって節約した 10 万円の光熱費をそのまま分割払いの支払いにあてることになり、購入する前と家計の出費額は変わりません。返済を終えた 6 年目以降は毎年 10 万円の利益を得ます。分割払いの金利と手数料はゼロとします。ただこの製品の導入によって家全体の断熱や保温の効果により、心疾患、脳血管疾患など病気の予防効果があるとします。年間 1000 人に 1 人の死亡率を、1 万人に 1 人の死亡率に減らす効果があることがわかっているとします。この情報が正しいと確信できる場合、あなたはこのような分割払いでこの製品を購入しますか？

はい

いいえ



パートC【個人属性等】

※各質問について、調査会社様のモニター属性で情報ありの場合は質問を削除でお願いします。

C1 あなたの性別をお答えください。男性　女性

C2 あなたの年齢をお答えください。

※選択式

C3 お住まいの都道府県をお答えください。

※選択式

C4 家族構成をお答えください。

1 単身　2 夫婦 2 人　3 未婚の自分と親との 2 世代世帯

4 既婚の自分(夫婦)と親との 2 世代世帯　5 自分(夫婦)と子供の 2 世代世帯

6 自分(夫婦)と子供と孫との 3 世代世帯　7 自分(夫婦)と親と子供との 3 世代世帯　8 その他(　)

C5 あなたの学歴をお答えください。

高校卒業未満

高校卒業

専門学校卒業

短大卒業

大学・大学院卒業

C6 あなたのお住まいのタイプをお答えください。

一戸建て(持家)

一戸建て(賃貸)

集合住宅(持家)

集合住宅(賃貸)

その他(具体的に:　　)

C7　世帯年収(個人ではなく世帯)をお答えください

1.200 万円未満　2 .200~300 万円未満　3. 300~400 万円未満

4 .400~500 万円未満　5 .500~600 万円未満　6. 600~700 万円未満

7.700~800 万円未満　8.800~900 万円未満　9.900~1000 万円未満

10.1000~1250 万円未満　11.1250 万円~1500 万円未満　12.1500 万円以上

13.わからない・答えたくない

C8　健康に関する疾病の有無をお答えください。

アレルギー性鼻炎

アレルギー性結膜炎

高血圧性疾患

アトピー性皮膚炎

気管支喘息

関節炎

肺炎

糖尿病

心疾患

脳血管疾患

睡眠不足

慢性疲労

精神的ストレス

※複数選択式

C9　現在あなたの世帯で、支払っているローンの有無をお答えください。

1 現在あり　（ローンの種類：　　）

2 過去にあったが現在はなし　（ローンの種類：　　）

3 過去にも現在にもない

C10 あなたは汗をかく程度の運動やスポーツをする頻度をお答えください

1　週 6 回以上

2　週 4～5 回

3　週 2～3 回

4　週 1 回程度

5　しない

C11 あなたの一日の平均の睡眠時間をお答えください

1　　9 時間以上

2　 8 時間～9 時間

3　 7 時間～8 時間

4　 6 時間～7 時間

5　5 時間～6 時間

6　5 時間未満

C12　以下の項目について、あなたに最も当てはまるものを選んでください。

番号	質問	当てはまる	やや当てはまる	どっちでもない・分からない	やや当てはまらない	当てはまらない
1	地球温暖化問題についてよく知っている					
2	二酸化炭素が温室効果ガスのひとつで化石燃料が人為的な排出の原因であることを知っている。					
3	地球温暖化対策としてのパリ協定について知っている。					
4	1ヶ月の自宅の電力消費量を把握している。					

5	個人の省エネ努力は政府や企業の努力と同等、もしくはより重要だと思う。
6	先進国は途上国より大きい環境への責任を負うべきだと思う。
7	シャワーを使うときには、節水ヘッドを使ったり、使用時にまめに栓を閉じるようにしている。
8	省エネのためには個人の習慣を変える必要があると思う。
9	省エネのため、冷房の設定温度は28度を目安にしている
10	使っていない部屋の照明を消している。
11	商品を選ぶ時、環境ラベル（エコラベル）があるものや省エネ性能が高い商品を優先する。
12	可能な限り、外出時に自転車や公共交通機関を使う。

番号	質問	当てはまる	やや当てはまる	どっちでもない・分からない	やや当てはまらない	当てはまらない
1	現在、肉体的には健康である。					
2	現在、精神的には健康である。					
3	1日 3 回規制正しく食事をしている。					
4	塩分、糖質、油分を摂りすぎないようにしている。					
5	食事では栄養バランスを考えている。					
6	定期的に、何らかの運動を行っている。					
7	帰宅後には手洗いをするようにしている。					
8	睡眠時間は充分だと思う。					
9	睡眠の質は高いと思う。					

10	室内の冷暖の変化について敏感だと思う。
11	健康を考えて、室温をいつも適切に設定している。