Accelerating Residential Energy Transitions: Exploring the Link between Homeowner Barriers to Energy-Efficient Renovations and their Policy Preferences

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2023-2024

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Master of Science Thesis

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Faculty Governance and Global Affairs

Date of Submission: 4-1-2024

Word count: 23824

Chapter 1. Introduction

After the Paris Agreement in 2015, which agreed on international measures to mitigate climate change, the Netherlands agreed on the climate goals, which aims to reduce emissions by 95% by 2050. Therefore, an energy transition in the Netherlands is needed in various sectors to substantially reduce emissions and accomplish the goals of the climate goals. One of the essential factors in order to achieve the goals of the Paris agreement is that around 7 million houses need to be made more energy efficient. In the Netherlands, there are about 4.4 million owner-occupied houses. Of these 4.4 million houses, there have already been substantial improvements in their energy efficiency. For example, approximately 90% of these houses already have double glass. However, in order to achieve more energy efficiency, more renovations are needed in a significant amount of the owner-occupied houses. For example, around 900.000 houses still have a low energy label, which means that they are not sufficiently energy efficient. For that reason, achieving the environmental goals, and therefore, contributing to a less polluting Dutch residential sector, are important reasons for the Dutch government to stimulate energy efficient renovations by homeowners.

An important focus point is making the Dutch residential sector gas-free. Policymakers focus on this aspect because of the geopolitical dependence associated with gas. Therefore, becoming gas-free would aid in reducing the geopolitical dependence on countries like Russia and Saudi Arabia. In addition, becoming gas-free would also prevent homeowners from being disadvantaged by the negative effects of raising gas prices. Especially the recent energy crisis has showed what can happen to gas prices when there is a conflict with the providers of gas. Because of these high gas prices, many Dutch households have gotten into financial troubles. Therefore, making sure the Dutch homeowners are not dependent on, for example Russia, is an

important additional reason for policymakers to stimulate the residential sector to become gas-free.

For these reasons, Dutch policymakers need to incentivize homeowners to make energy-efficient renovations to their homes. In order to achieve this, it is in the best interest of the Dutch government to convince homeowners of the financial benefits, and therefore, convince homeowners of the attractiveness of the business-case of an energy efficient renovation. Although this renovation requires a big investment at the start, the renovations are generally seen as profitable in the long run.

Doing energy efficient renovations can be an effective method to reduce the ecological footprint of households. Mainly because this is a technical energy-saving measure, and not a behavioral energy-saving measure. According to Zundel and Stieß (2011), there are generally two ways to tap into this energy-saving potential of the residential sector. Firstly, policymakers can focus on changing behavior of homeowners, which for example means that homeowners would be encouraged to decrease their energy consumption by changing their behavior. Secondly, energy-saving in the residential sector can be accomplished by taking technical measures. For example, proper insulation, modern heating systems and the installment of solar panels. Poortinga et al. (2003) also make a clear distinction between technical measures and behavioral energy-saving measures and notice that there are distinct differences between the acceptability of technical- and behavioral energy-saving measures.

Although technical measures require a larger investment, they often are more acceptable to individuals than behavioral measures because they can become cost-saving in the future. In contrast, in this case homeowners, often see behavioral measures as more effort and a decrease in comfort. In this context, behavioral energy-saving measures would for example be using the central heating less, which leads to a lower temperature inside, and therefore, to more discomfort (Poortinga et al., 2003, p. 51).

Therefore, according to this theory by Poortinga et al. (2003), the average homeowner would prefer to take technical measures for their house over behavioral measures, and therefore, policymakers should focus on stimulating these technical measures in order to effectively decrease the ecological footprint of Dutch households. Energy efficient renovations fall under these technological measures described by Poortinga et al. (2003), and therefore, should be the focus of the government when it comes to targeting homeowners. The focus should be on these technical measures because homeowners will likely be more open to take these measures rather than changing their behavior. In this research, the primary focus will be on technical measures that will improve the energy efficiency of the Dutch residential sector. Therefore, behavioral changes by homeowners will not be covered.

In order to achieve a more energy efficient home, homeowners must make substantial investments in their houses to make them more energy efficient. This substantial investment can be a barrier for homeowners to make the transition. In addition to the investment, homeowners have several other economic and non-economic barriers when it comes to doing these renovations.

These barriers cause major doubts among homeowners when it comes to making energy-efficient renovations, which in turn, hinder the ambitions of the Dutch government to achieve the goals drawn up in the climate agreement.

On the other hand, there are also economic and non-economic incentives for homeowners to make their houses more energy efficient. Therefore, these aspects of energy-efficient renovations should stimulate homeowners to make renovations. For example, an energy-efficient renovation can increase the value of a home. In addition, it can reduce the energy bill of the home, which can offer protection against volatile energy prices (Friege & Chappin, 2014, p. 202). In order for homeowners to do the energy efficient renovations, the incentives need to outweigh the barriers.

1.1 Problem Statement

When it comes to the rental sector, the main instigator of energy efficient renovations are housing associations and tenant unions, and therefore, not the residents of these apartments. When it comes to responsibility of energy-efficient renovations, in the owner-occupied sector, 'homeowners are entirely responsible for carrying out the energy efficient renovations' (Ebrahimigharehbaghi et al., 2019, p. 546).

Therefore, the responsibility of carrying out the renovations is significantly different when you compare the rental and owner-occupied sector. In this research, the focus will be on the owner-occupied sector of the market in the Netherlands. In the Netherlands, 69.4% of the buildings are part of the owner-occupied residential sector. In addition, this part of the residential sector also has a relatively low energy label. On average, the owner-occupied residential sector has an energy label of D, these energy labels are measured on a scale from A to G.

For these reasons, Ebrahimigharehbaghi et al. (2019) argue that there is substantial energy-saving potential in this specific sector of the Dutch housing market, and therefore, homeowners should be stimulated by Dutch policymakers to do energy efficient renovations. For that reason, the reduction of energy usage in residential buildings can play a significant role in the reduction of CO2 emissions, and therefore, is an important focus point for many governments who aim to reduce its CO2 emissions (Zundel & Stieß, 2011, p. 92).

Despite the energy-saving potential of technical measures, research from Van Gaalen et al. (2019) shows that around 43% of Dutch homeowners are not planning on making an Energy Efficient Renovation (EER) in the coming five years. Because of this, Ebrahimigharehbaghi et al. (2019) argue that the current rate of renovations is not sufficient to achieve the targets set out by the Dutch government.

Especially the size of the investment and the uncertainty that it will pay for itself are the main reasons for this reluctance. In addition, Van Gaalen et al. (2019) concludes that reluctance among homeowners occurs because they are not informed about which financial support they can expect from the government, which means that lack of information is an essential factor concerning this problem. Lastly, Van Gaalen et al. (2019) also concludes that many homeowners are convinced that energy-efficient renovations will be cheaper in the future. Therefore, they delay the investment hoping it will be cheaper in a few years.

Because homeowners delay the investment in energy-efficient renovations, they are confronted with higher energy bills and the risk that their house is less valuable (Van Gaalen et al., 2019, p. 3). In addition, because of this slow pace of energy-efficient renovations, the government is also not on track to achieve its desired climate goals, which can subsequently negatively affect the environment. Therefore, the climate and Dutch homeowners are both negatively affected by the current slow pace of energy efficient renovations.

The current slow rate of homeowners that make energy-efficient renovations is an important problem in the Netherlands. Therefore, the objectives of the policymakers that want to achieve the goals set out in the *Klimaatwet* are negatively affected by this problem. In addition, homeowners are also negatively affected in the long run because they have to deal with a less energy-efficient home and a home with a lower value.

Because of the problems with the slow pace of energy-efficient renovations, it is necessary to develop a policy that further incentivizes homeowners to make energy-efficient renovations, which will help both homeowners and policymakers. In order to achieve this, it is necessary for policymakers to have a good understanding of which policies are effective in incentivizing homeowners to do energy efficient renovations. In order to determine what policies are effective, policymakers need to understand the preferences for policy of homeowners.

The academic literature on energy efficient renovations fails to address two important areas of research on this subject. This research will make a contribution to academics by addressing these two important gaps in the literature on energy efficient renovations.

First of all, previous literature primarily focuses on what incentives and barriers homeowners face when it comes to energy-efficient renovations. However, previous research has not explored the relationship and interaction between the barriers homeowners face and their preferences for policies. In this research, the relationship between these two important aspects of energy efficient renovations will be researched

In addition, previous research primarily analyzed the behavior of homeowners responding to policies in order to determine their preferences for different policies. In contrast, this research will ask homeowners for their preferences for policies in a direct manner, and therefore, will determine their preferences this way, which has not been done in previous research on this subject.

1.3 Research Question

In order to guide this research in achieving its objectives, and address the gaps in academic literature on energy efficient renovations and the preferences for policy of homeowners it will answer the following research question:

In what way do the barriers for homeowners influence their preferences for incentivizing policies when it comes to energy-efficient renovations?

Guided by the research question, this research will explore the relationship between the barriers for homeowners and their preferences for policies. This means that this research wants to find out whether the barriers homeowners experience for making energy efficient renovations will influence their thoughts about in what way they will be incentivized to do this energy efficient renovation.

Understanding this dynamic could help policymakers in designing more appropriate policies, because they have a better understanding which policy can be effective to tackle specific barriers homeowners experience. By answering this research question, policymakers could get more comprehensive information about which barriers can be linked to which types of incentivizing policies.

Therefore, the main objective in this research is to aid the Dutch government in developing more effective incentivizing policies that will motivate homeowners to make energy efficient renovations. As mentioned before, if more homeowners make energy efficient renovations, there is a higher probability that the climate goals of 2030 can be achieved, which is a very relevant talking point in the public debate in the Netherlands.

This research will be conducted by data collected from questionnaires distributed among homeowners in the Netherlands. This questionnaire first wants to assess to what degree different barriers have an influence on the decision-making process of homeowners.

Secondly, the questionnaire will ask respondents for their preferences for policies by making them divide 100 points among different incentivizing policies. By asking them to divide these points, this research wants to gain insight into what policies homeowners think will incentivize them to do energy-efficient renovations. By collecting this data, this research wants to develop more comprehensive insight in the relationship between the barriers homeowners face and their preferences for incentivizing policies.

This research will be divided into several different chapters. The first chapter will provide a literature review that will summarize the existing literature on energy efficient renovations. This chapter will provide more information about the different types of barriers homeowners face when doing energy efficient renovations. In addition, this chapter will also provide insight what different types of incentivizing policies governments generally use to

motivate homeowners to do these renovations, and which policies the Dutch government currently use.

The second chapter will discuss the methodology of this research. It will therefore give a quick overview of the research design, explain the questionnaire distributed to respondents and will explain how the data was collected and analyzed. The third chapter will analyze the data collected by the distributed surveys and will discuss this research's findings based on the collected data. The fourth chapter of this research will discuss the implications of the findings, compare the findings with existing literature and will offer insights or explanations relating to the results. The last chapter of this research will consist of the conclusion, implications and potential areas for future research.

Chapter 2. Literature review

This chapter will give an overview of previous literature on the subject of energy efficient renovations. Firstly, previous literature on the barriers to energy-efficient renovations will be analyzed. Secondly, the previous literature on what policies homeowners prefer and what policies are effective will be discussed. Thirdly, this chapter will give a quick overview of the current policies employed by the Dutch government to stimulate energy-efficient renovations. Fourthly, this chapter will discuss in what way this research will contribute to the previous literature on the subject of energy-efficient renovations. And lastly, this chapter will provide the hypotheses this research has for the analysis.

2.1 Barriers to Energy-Efficient Renovations

The slow rate of energy-efficient renovations in the Netherlands faces can partly be attributed to the energy efficiency gap (Jaffe & Stavins, 1994). This energy-efficiency gap entails that homeowners first look at the initial investment and calculate its net present value. When this net present value is high enough, it is rational in an economic sense to go through with the investment. However, the energy efficiency gap entails that there are also other considerations and factors that are important in this decision-making process, which are often overlooked by experts (Zundel & Stieß, 2011, p. 93). These considerations are often not economic considerations, but other non-economic considerations.

Earlier literature on energy efficient renovations primarily focused on the economic considerations homeowners make in their decision-making process, and therefore, saw energy efficient renovations purely as an investment. However, more recent studies, for example, Gram-Hanssen et al. (2007) view the energy efficient renovation as not just an investment, but rather a consumer good. Gram-Hanssen et al. (2007) see it as a consumer good because of the convenience and comfort the renovation provides, and therefore, provide more than economic profit.

Because an energy-efficient renovation can be seen as a consumer good, Gram-Hanssen et al. (2007) think that it is unlikely that homeowners solely base their decision on economic factors alone, which means that also other factors can play a significant role in the decision-making process. Therefore, recent literature on energy-efficient renovations acknowledges the importance of economic considerations, but also researches other non-economic considerations that are significant in the decision-making process of homeowners. Because of the energy efficiency gap, properly understanding the other barriers than rational-economic considerations, is essential for policymakers in order to design effective policy that will incentivize homeowners to do energy efficient renovations.

When it comes to policy, policymakers also generally make the assumption that homeowners see the energy efficient renovation as an investment. Because of this assumption, current policies primarily focus on enhancing the profitability of these renovations, which means that primarily the economic aspect is targeted by policy (Zundel & Stieß, 2011, p. 92). Although Zundel and Stieß (2011) agree that economic factors are important in the decision-making process, they emphasize that there are also several other factors that play a defining role in this process. Therefore, Zundel and Stieß (2011) also argue that governments should treat energy efficient renovations as a consumer good, and not as solely an investment. Because of this, it is essential for policymakers to also have a deeper understanding of the non-economic barriers homeowners face in their decision-making process.

The three most commonly identified barriers in the literature on energy-efficient renovations relate to finances, information, and decision-making barriers (Wilson et al., 2015).

Firstly, Financial barriers occur when homeowners need more capital to do the energy-efficient renovation and, therefore, cannot or will not do the renovation. In addition to available capital, Wilson et al. (2015) find that homeowners also have an aversion to so-called delayed

gains. As mentioned before, an energy-efficient renovation mainly pays off in the long run and does not give the homeowner an immediate financial benefit.

Therefore, the homeowner has to wait until the substantial investment pays off, and therefore, the benefits of the investment are delayed. Because homeowners would rather see investments pay off immediately, this delayed payoff could be a barrier to doing an energy-efficient renovation.

Secondly, an important barrier for homeowners can be accredited to the amount of information they have on doing an energy-efficient renovation. In the scenario of energy-efficient renovations, the information problem occurs because homeowners think there needs to be more available information on doing an energy-efficient renovation and, therefore, are reluctant to go through with it. In addition, Howarth and Sanstad (1994) also put forward another information barrier. The authors find that often there are misconceptions or uncertainties among homeowners when it comes to their energy costs. Therefore, they do not have a good picture of their energy costs, which means that the energy-saving capabilities of energy-efficient renovations are less salient to homeowners. Which means that there is uncertainty about an energy-efficient renovation's 'cost-saving outcomes' (Wilson et al., 2015, p. 13).

Wilson et al. (2015) see decision-making barriers as the third major category. For example, when people need to decide on energy-efficient renovations, there is a so-called 'cognitive burden.' This cognitive burden mainly occurs when people need to make 'complex and irreversible decisions,' which makes the decision-making process more complex and, therefore, causes transaction costs (Ebrahimigharehbaghi et al., 2019, p. 549). In addition, the anticipated hassle of doing an energy-efficient renovation also falls under the decision-making barriers.

According to Ebrahimigharehbaghi et al. (2019), generally speaking, homeowners face 'lack of awareness and knowledge, lack of cost-effectiveness and funding as the main barriers for energy-efficient renovations' (Ebrahimigharehbaghi et al., 2019, p. 547).

However, according to Schleich (2019), barriers can be vastly different for every individual and, therefore, depend on personal characteristics like their personal beliefs and convictions, which means that both economic and non-economic factors influence homeowners' decisions when it comes to deciding on energy-efficient renovations.

Furthermore, even though financial aspects play a role, many research studies find that often the characteristic, and therefore, the homeowner's behavior is more relevant than their monetary situation (Ebrahimigharehbaghi et al., 2019, p. 548). Therefore, incentivizing policies primarily focusing on the financial aspect lacks efficiency and has not yielded the desired success (Friege & Chappin, 2014, p. 205). For that reason, the Dutch government must develop a more comprehensive picture of homeowners' barriers while considering the psychological factors (Ebrahimigharehbaghi et al., 2019, p. 548).

Transaction costs also negatively influence the decision-making process of doing a renovation and, therefore, can be considered a barrier for homeowners. According to Mundaca et al. (2013), transaction costs in the scenario of energy-efficient renovations are hidden costs that have yet to be accounted for when homeowners do a cost analysis. In this context, transaction costs mainly occur because of the fact that homeowners have to do the energy-efficient renovation themselves.

Generally, homeowners do not have the basic knowledge about the costs and specifics of an energy-efficient renovation, which means it is necessary for these homeowners to acquire 'specialized skills and knowledge before implementation' (Ebrahimigharehbaghi et al., 2019, p. 548). Because of this, the time it takes to acquire this knowledge about energy-efficient renovations represents the transaction costs when it comes to this issue.

In addition, there is a 'cognitive burden' when people must make 'complex and irreversible decisions,' which makes the decision-making process more complex and, therefore, causes transaction costs (Ebrahimigharehbaghi et al., 2019, p. 549).

According to Jakob (2007), you can divide the barriers homeowners face into two different categories. Namely, intrinsic and extrinsic factors. Intrinsic and extrinsic factors can be used to categorize the barriers homeowners experience.

Intrinsic factors are the 'consequences of the interaction between an individual's internal wishes, ambitions, preferences, with their situations' (Ebrahimigharehbaghi et al., 2019, p. 548). Therefore, these factors relate to the circumstances of an individual homeowner, which in turn influences their decision-making process.

In addition, there are also extrinsic factors when it comes to this decision-making process. These factors relate to circumstances like the financial costs of renovations, incentives, and the rules associated with these renovations. Therefore, an energy-efficient renovation's technical, legal, and economic framework (Jakob, 2007, p. 3).

Previous research by Friege and Chappin (2014), Ebrahimigharehbaghi et al. (2021) and Wilson et al. (2015) has researched what withholds and motivates homeowners to make their houses more energy efficient, which means that the authors looked at the behavioral factors relating to the decision of doing an energy-efficient renovation.

The literature identified several barriers when it comes to energy-efficient renovations, mainly corresponding with barriers identified by Van Gaalen et al. (2019) among Dutch homeowners.

Van Gaalen et al. (2019) divides the vast array of barriers into four categories. Namely, (1) payment problems often in combination with energy-inefficient homes, (2) rational-economic considerations, (3) waiting barriers, and (4) other reasons.

Payment problems occur when homeowners do not make energy-efficient renovations because of issues relating to the affordability of the renovations. People that face these payment problems are often the group with energy-inefficient homes, and therefore, would greatly benefit from making their house more energy efficient. Especially during the current energy crisis, becoming gas-free and more energy efficient would benefit these homeowners significantly. However, liquidity constraints and a reluctance to loan money results in troubles with the financing of these renovations. In short, this group of homeowners would benefit significantly in the long run if they invested.

However, their reluctance to make a significant investment prevents them from benefiting from an energy-efficient home. To tackle this issue, the Dutch government wants to make the interest rate 0% for loans relating to energy-efficient renovations.

Homeowners also experience rational-economic barriers, according to Van Gaalen et al. (2019). As explained by Vriend (1996), the main driver of a rational-economic approach is the 'pursuance of self-interest,' which in this case means that homeowners will make the decision based on their own interests and, therefore, will only consider an energy-efficient renovation if it benefits them.

Therefore, with rational economic decision-making, homeowners aim to maximize their utility or profit and, therefore, weigh the costs and benefits of doing an energy-efficient renovation. Barriers in this category are, for example, concerns about the length of the payback period of energy-efficient renovations. In addition, rational-economic barriers could be that homeowners want to spend their money on something other than energy-efficient renovations, which means they do not see the value in investing.

Waiting barriers are also significant when it comes to energy-efficient renovations. Among this category, there are several barriers homeowners experience. Firstly, homeowners wait for energy-efficient renovations because they think doing these renovations will be cheaper

in the future. Secondly, homeowners want to wait for more beneficial incentivizing policies deployed by the government in the future, delaying their investment. Thirdly, homeowners think the government should financially support their energy-efficient renovations. In short, the waiting barriers prevent homeowners from doing energy-efficient renovations because they are convinced they will be cheaper in the near future. As a result of these waiting barriers experienced by homeowners, the current pace of energy-efficient renovations is not as high as it should be.

Van Gaalen et al. (2019) also identifies additional barriers that cannot be placed in the other three categories and are categorized as other reasons. These reasons for not doing renovations, for example, include: renovations will cause a mess in my house, people in the neighborhood do not do renovations, it is too time-consuming, etcetera.

This research will use the array of essential barriers defined by Van Gaalen et al. (2019) among Dutch homeowners. However, the categorization by Van Gaalen et al. (2019) will not be used. Instead, an alternative categorization provided by the article of Hesselink and Chappin (2019) will be utilized for this research. The authors divide the barriers homeowners face into four different groups.

Firstly, structural barriers entail that these barriers are 'outside the sphere of influence of the homeowners.' Barriers under this category include, for example, the lack of incentives and barriers originating from codes, standards, and infrastructure (Hesselink & Chappin, 2019, p. 31). For example, homeowners can experience structural barriers if the current supply infrastructure of energy efficient technologies is limited, which results in homeowners not being able to do the renovation. In addition, structural barriers can occur because of a lack of codes and standards when it comes to energy efficient technologies (Hesselink & Chappin, 2019, p. 33).

In addition, structural barriers can also occur because of uncertainty among homeowners about energy prices of fuels and electricity. This uncertainty causes further uncertainty among homeowners about the production costs of energy efficient technologies in the future (Hesselink & Chappin, 2019, p. 33).

Secondly, economic barriers occur when homeowners lack the funds to do an energy-efficient renovation. Also, homeowners experience an economic barrier when they think the upfront investment is too high.

Thirdly, there are also behavioral barriers when it comes to energy-efficient renovations. These behavioral barriers occur mainly because homeowners have different priorities than energy efficiency. When homeowners have different priorities because of too low gains, this is not a behavioral barrier but an economic barrier. A behavioral barrier is strictly when homeowners don't prioritize energy efficiency in their decision-making process. In addition, homeowners can simply 'be ignorant about energy efficiency' or be 'unwilling to change' (Hesselink & Chappin, 2019, p. 31). An important example of these behavioral barriers is inertia, which means that homeowners tend to 'want to stick to the status quo rather than change for practical reasons and for convenience' (Hesselink & Chappin, 2019, p. 31).

In addition, among behavioral barriers is also the availability bias, which means that homeowners primarily base their knowledge on information that readily available, so if there is a lack of available information, homeowners are uninformed about the benefits of an energy efficient renovation.

Lastly, barriers occur because of social behavior. According to Hesselink and Chappin (2019), these barriers occur when they base their decision on the actions of their social peers. In addition, homeowners could have general reservations, and therefore trust issues, with adopting new technologies in their homes.

For this research, the barrier categorization by Hesselink and Chappin (2019) provides the most precise and most appropriate classification of the different barriers Dutch homeowners face. Therefore, the classification by Hesselink and Chappin (2019) will be used in this research to classify the different barriers put forward by Van Gaalen et al. (2019).

2.2 Incentivizing Policies for Energy-Efficient Renovations

Weiß et al. (2012) describe that policymakers have two different instruments that can influence citizen behavior. Namely, direct and indirect policy instruments.

On the one hand, the direct, also known as regulatory, instruments are processes and activities 'in which government requires or proscribes certain activities or behavior on the part of individuals and institutions" (Reagan, 1987, p. 17). Therefore, meaning that these direct policy instruments have an obligatory characteristic.

On the other hand, indirect policy instruments aim to incentivize the desired citizen behavior in a non-obligatory manner. These indirect policy instruments can be divided into financial, procedural, and communicative instruments (Braun & Giraud, 2008, pp. 162-169). However, the procedural instruments are not relevant to this research, so they will not be used for the categorization of the policy instruments.

According to Braun and Giraud (2008), communicative instruments aim to influence citizens by adequately informing them of several important considerations for energy-efficient renovations. Regarding energy-efficient renovations, this information would be about the benefits of doing an energy-efficient renovation and information about which subsidies homeowners are eligible. Communicative instruments can therefore help the government by spiking homeowners' interest and involvement when it comes to energy-efficient renovations (Weiß et al., 2012, p. 411).

In addition, excellent and personal communication with homeowners by, for example, an energy consultant can alleviate their fears and barriers when it comes to energy-efficient

renovations. For example, currently, there is much uncertainty among homeowners about the business case of energy-efficient renovations. Providing homeowners with the proper information can result in less uncertainty among homeowners because they are appropriately informed about the pros and cons of an energy-efficient renovation.

A policy in the Netherlands that aims to use these communicative instruments is the launch of the website verbeterjehuis.nl. On this website, homeowners can get more information about the advantages and possibilities of doing an energy-efficient renovation and further information about which subsidies homeowners are eligible for.

According to Braun and Giraud (2008), the government uses financial instruments when it aims to steer behavior by making changes in taxes or by providing subsidies, which means that the government gives financial incentives to its citizens to motivate them toward a particular behavior.

When it comes to subsidies, receivers often have to comply with some conditions to receive the subsidies (Braun & Giraud, 2008, p. 186). According to Braun and Giraud (2008), the incentive component of these financial instruments is aimed at the material needs of the receiver, which means that it gives the receiver either a material advantage or disadvantage. For example, when someone receives a subsidy for an energy-efficient renovation, this gives this person a material advantage to do the energy-efficient renovations, mainly because they now have more financial means to do this renovation. Therefore, the current subsidies issued in the Netherlands, like the ISDE, can be categorized as financial instruments of the government. These financial instruments aim to incentivize particular behavior by giving the recipient a financial benefit; in this case, doing an energy-efficient renovation by homeowners is encouraged by giving them financial incentives in the form of subsidies.

In addition to subsidies, financial incentives can also come in other forms, for example, when it comes to loaning money to finance a specific investment. For example, in the

Netherlands, some policies aim to incentivize loaning money for energy-efficient renovations by offering a low-interest rate for loans that will be used for these renovations.

A vital element of indirect policy instruments is that they are generally less controversial than mandatory regulations imposed by the government. In addition, these indirect instruments can also cause better results than regulatory instruments because the incentive can cause citizens to go further than the given standard in the regulatory approach.

However, achieving the goals of the Dutch government by mainly using, for example, financial incentives can lead to very high costs, and therefore, the government must carefully consider the height of subsidies in order to achieve a well-balanced incentive/performance ratio (Lee & Yik, 2004, p. 494).

The height of the subsidies is mainly significant because if they are too high or a subsidy is not necessary when for example, the renovation is already financially beneficial, there is an increased risk of the free-rider effect (Weiß et al., 2012, p. 409).

Lee and Yik (2004) make an alternative classification of the different policy instruments that can be employed to make houses more energy efficient. The first category is 'building energy codes, which are regulatory requirements, so they are legally binding. Secondly, 'incentive-based schemes, including various schemes that provide subsidies or allowances that can offset the costs of improvement measures.' Thirdly, 'eco-labeling schemes, including those that adopt a single threshold performance rating or labels or different grade corresponding to progressively higher standards, and legally non-binding building energy codes and voluntarily building environmental performance assessment schemes' (Lee & Yik, 2004, pp. 481–482).

Therefore, according to the theory by Braun and Giraud (2008), citizens will prefer policies that incentivize them to make energy-efficient renovations over policies that obligate them to make these renovations. Concerning this research, this means that citizens will prefer incentivizing instruments like subsidies over norms and regulations.

However, it can also be the case that citizens prefer direct policy instruments. This is mainly because direct policy instruments provide certainty. For example, it is straightforward for homeowners which rules and regulations need to be followed, while with indirect policy instruments, adhering to certain environmental standards for your house remains optional. In addition, obligatory instruments can also be perceived as fairer because everyone is treated the same, with incentives often only certain people are eligible for the policy. This research will have three categories of instruments: direct policy, indirect financial, and indirect communicative instruments.

Generally, regulatory policies are considered an effective and efficient means of promoting desired societal behavior while minimizing costs (Braun & Giraud, 2008, p. 165) and, therefore, a helpful incentive instrument to use by policymakers.

Considering the mentioned disadvantages of direct policy instruments, the financial instruments, as defined by Braun and Giraud (2008), are often considered a better alternative than the direct policy approach. These financial instruments can be described as a transfer of money to individuals in order to incentivize them towards a particular behavior.

A vital element of these financial incentives is that they are generally less controversial than mandatory regulations imposed by the government. In addition, these financial incentives can also cause better results than regulatory instruments because the incentive can cause citizens to go further than the given standard in the regulatory approach.

This research will test this theory on Dutch homeowners by applying an alternative way to measure preferences in its research. This will give a better understanding of the preference of homeowners for which incentivizing policies they prefer. This better understanding of preferences will aid policymakers in designing more effective incentivizing policies that will stimulate the growth of energy-efficient renovations in the Netherlands.

2.3 Current policies in the Netherlands

The program *Versnelling Verduurzaming Omgeving* by the Dutch Ministry of the Interior and Kingdom Relations shows the plan of the Dutch government to speed up the process of making the Dutch residential sector more energy efficient. In order to achieve this, the Ministry proposes several incentivizing policies that will stimulate Dutch homeowners to do energy-efficient renovations.

First of all, the Ministry argues that a vital stimulant could be supporting Dutch homeowners with subsidies. For example, the ISDE subsidy for homeowners has been increased to 30% of the total investment from the 1st of January 2022. In terms of subsidies and loans, these are the current policies the Dutch government employs in order to incentivize Dutch homeowners. These policies fit in the indirect financial policy instruments, as described by Weiß et al. (2012), which means that these policies aim to incentivize specific behavior of Dutch homeowners in a non-obligatory manner. Secondly, the application procedure for doing this will be simplified when it comes to owner corporations that want to do an energy-efficient renovation together.

Secondly, the Ministry wants to offer Dutch homeowners more extensive and better possibilities for financing energy-efficient renovations. Therefore, homeowners will be offered more compelling interest rates for loans meant for energy-efficient renovations. This is especially useful for people who cannot afford the renovation from their savings. In addition, liquidity constraints and a reluctance to loan are essential barriers for homeowners. To tackle this issue, the Dutch government wants to make the interest rate 0% for loans relating to energy-efficient renovations, making getting a loan more attractive for homeowners.

Thirdly, the Ministry wants to provide more extensive information for Dutch homeowners regarding these energy-efficient renovations. In order to achieve this, they launched the website verbeterjehuis.nl. On this website, homeowners can get more information

about the advantages and possibilities of doing an energy-efficient renovation and further information about which subsidies homeowners are eligible for.

Fourthly, the Dutch government also applies direct policy instruments in their policy mix, which means that these instruments have an obligatory characteristic.

For example, newly built homes in the Netherlands are prohibited from being reliant on gas. In addition, the Dutch government is planning on obligating homeowners to install a heat pump when their boiler needs replacing.

Furthermore, the Dutch government wants to oblige homeowners that live in a house with energy label G to go to energy label F by 2030, which can be accomplished by doing energy efficient renovations.

Lastly, the Dutch government also wants to aid homeowners in energy-efficient renovations, mainly by developing local helpdesks organized by the local municipalities to assist homeowners with energy advice. In addition, they can offer help when homeowners are actually doing a renovation.

In the questionnaire, respondents will have to choose between four different policies. Firstly, a policy that is focused on giving homeowners more subsidies, secondly, a policy focused on providing homeowners with more information about the renovation, thirdly a policy that has a obligatory characteristic, and lastly a policy that gives homeowners more possibilities do get a loan for doing an energy efficient renovation.

These four different policies relate to the categorization of incentivizing policies by Weiß et al. (2012). The subsidy policy can be categorized as an indirect financial policy instrument. Secondly, the policy that focuses on providing more information to homeowners can be categorized as an indirect communicative instrument. Thirdly, the policy with an obligatory characteristic can be categorized as a direct policy instrument. Lastly, the policy that

gives homeowners more possibilities for loaning money can be categorized as an indirect financial instrument.

In addition to these four policies, the government also uses other instruments to incentivize homeowners to, for example become gas-free. In terms of pricing, the current situation in the Netherlands is that the tax on CO_2 emissions from the use of gas is higher than the CO_2 emissions associated with the use of electricity. Without changes in these taxes, the difference between these two will only increase more.

Therefore, this difference in price will be a barrier for homeowners because making an Energy Efficient Renovation will make their house rely on electricity. To alleviate this barrier, it is essential that gas is taxed the same as electricity. In order to achieve this, Zhang et al. (2022) propose the *gasschuif (*gas lever), which means that the tax on gas will be increased and the tax on electricity will be reduced. By doing this, the government hopes to indirectly influence homeowners to become gas-free by raising the price of gas, while lowering the price of electricity, which would result in homeowners wanting less gas and more electricity. This measure doesn't necessarily directly incentives energy-efficient renovation, it could also lead to behavioral changes among homeowners, for example, using less gas.

2.4 Academic contribution

Previous research on energy-efficient renovation has focused primarily on homeowners' observed behavior concerning energy-efficient renovations to determine their preferences. Looking at observed behavior entails that researchers look at situations before and after the implementation of a particular policy and, from that conclude what effect the policy had on the behavior of citizens. Then, from these observations on homeowners' behavior, researchers make conclusions about what policies homeowners prefer.

However, there are some limitations when research focuses on behavior. Firstly, behavior does not observe all the constraints people face. Secondly, some preferences cannot

be expressed by actual choices. Lastly, it is hard to observe what people believe about the consequences of their behavior.

Therefore, it can be beneficial to ask respondents for their preferences directly. When it comes to economic decisions, 'actions reveal monetary commensurability in everyday choices' (Aldred, 2006, p. 148). In this context, the revealed part means that researchers look to actual behavior and actual choices instead of other methods like the stated preferences method or hypothetical scenarios. According to Aldred (2006), a choice reveals a preference. Therefore, this revealed monetary commensurability determines the values of individuals by looking at their observed choices. In the context of this research, this means that the preferences for policy of the homeowners are determined by directly asking them for their preferences, instead of inferring these preferences from other indicators.

The revealed monetary commensurability approach looks at behavior in real-world scenarios. In this research, the questionnaire attempts to mimic this real-world scenario by forcing respondents to make trade-offs between different policies, just like policymakers have to do in the real world.

In addition, another benefit of asking respondents about their preferences directly is that it possible to ask them about policies which might not have been implemented yet. Because of this, one could measure the potential effects of these policies before implementation. In contrast, when researchers strictly look at behavior in reaction to different policies, the effects of these policies can only be measured after implementation. Therefore, measuring potential effects of policies before implementation could offer valuable insights to policymakers, which in turn can help them with designing more effective and appropriate incentivizing policies to motivate homeowners to do an energy-efficient renovation.

In the case of energy-efficient renovations, researchers would, therefore, only look at whether or not homeowners did energy-efficient renovations because of a specific policy

without asking these homeowners which policies they prefer. In addition, Measuring the potential effects before implementation is much cheaper than after because policymakers don't actually have to implement a policy in order to determine what homeowners think about this policy.

When researchers only look at behavior, so if homeowners did the renovations, this might not give a complete picture of the preferences of the homeowners. As mentioned before, behavior does not observe all the constraints people face, so if a particular subsidy does not result in homeowners doing more energy-efficient renovations, this does not necessarily mean that the subsidy is not an excellent incentivizing instrument; it could also mean that there are more profound barriers beyond financial barriers that homeowners face. Because other barriers could also play a role, some homeowners prefer a policy mix of several incentivizing policies. Therefore, asking them about their policy preferences directly would be relevant instead of strictly looking at their behavior. For that reason, looking further than behavior can provide valuable insights for policymakers that want to develop adequate incentivizing policies that cater to the preferences of Dutch homeowners.

For that reason, research that has an alternative approach to measure preferences instead of looking at behavior would contribute to the existing literature on this subject. This contribution would mainly consist of a more comprehensive understanding of the preferences of Dutch homeowners when it comes to energy-efficient renovations.

In order to achieve this comprehensive understanding, an alternative approach rather than just analyzing behavior when researching which policies Dutch homeowners prefer could be beneficial. Subsequently, this will give insight into Dutch homeowners' values when it comes to energy-efficient renovations.

Having a more comprehensive understanding of these preferences of Dutch homeowners will aid policymakers in designing a more effective policy that will aid in

incentivizing homeowners to make energy-efficient renovations. Both economic and non-economic factors influence the decisions of homeowners when it comes to deciding on energy-efficient renovations. Therefore, current incentivizing policies that primarily focus on the financial aspect lack efficiency and have yet to yield the desired success (Friege & Chappin, 2014, p. 205).

Previous literature on energy-efficient renovations can be divided into two main categories. One part of the literature primarily focuses on the barriers homeowners face in their decision-making regarding energy-efficient renovations.

The other part of the literature primarily focuses on incentivizing policies employed by governments to motivate homeowners to do an energy-efficient renovation and, therefore, looks at how effective different incentivizing these policies are.

In terms of categorizing these different incentivizing instruments, Braun and Giraud (2008) make the main distinction between these instruments. This distinction is between direct policy instruments and indirect policy instruments. These indirect policy instruments can be divided into financial, procedural, and communicative instruments (Braun & Giraud, 2008, pp. 162-169).

Therefore, previous literature has identified homeowners' barriers and the effects of different incentivizing policies. However, there are still some gaps in the body of literature concerning energy-efficient renovations.

Firstly, when it comes to incentivizing policies, previous literature has primarily focused on the behavioral approach when evaluating these policies. In the context of energy-efficient renovations, using the behavioral approach would mean looking at different incentivizing policies and seeing how these policies have affected the number of people that did energy-efficient renovations. However, strictly looking at behavior does have its limitations and may give a partial picture of the preferences for policy of Dutch homeowners. For these

reasons, this research applies an alternative way of measuring preferences by directly asking the respondents for their preferences for policy in the questionnaire instead of deriving the preferences of Dutch homeowners from looking at their behavior.

Secondly, previous literature either researches barriers to energy renovations or researches the effects of incentivizing policies. However, the literature still needs to provide research that provides data on how these two together. In this research, the barriers homeowners face will be linked to their preferences for incentivizing policies, which means that it will research how the barriers they face influence their policy preferences.

So, in short, the main contribution of this research will be that it will measure the preferences of homeowners more directly compared to other research, and subsequently, will link these preferences to the barriers homeowners face, and therefore, collect data on how the barriers influence the preferences of homeowners.

2.5 Hypotheses

Firstly, based on the literature, this research hypothesizes that people that experience economic barriers, as defined by Hesselink and Chappin (2019), prefer indirect financial policy instruments. Homeowners that experience economic barriers are reluctant to make big investments in the energy efficiency of their homes. This reluctance mainly originates from limited financial possibilities, which form a barrier to doing an energy-efficient renovation.

Therefore, this group of homeowners needs a financial stimulus like a subsidy or the possibility to loan money at a low interest rate. Because these homeowners need a fiscal stimulus, this research hypothesizes that they will express their preferences for indirect financial policy measures through a subsidy or more favorable loaning conditions. When these homeowners receive these benefits, the financial hurdle for doing an energy-efficient renovation becomes less insurmountable, resulting in more energy-efficient renovations among this group.

Secondly, when it comes to structural barriers homeowners experience, this research expects that homeowners who experience these barriers will prefer indirect communicative and direct policy instruments. For example, structural barriers occur when homeowners feel that there is a lack of codes and standards for energy efficient technologies. This barrier can partly be alleviated by direct policy instruments because one of the main benefits of these instruments is that they provide clarity to homeowners with regards to what is expected of them. In addition, homeowners can experience uncertainty about the future prices of energy efficient technology because they don't know how energy prices will develop in the future. Therefore, there is a lot of uncertainty among homeowners, which causes a barrier. For that reason, it is realistic that because of this uncertainty homeowners need more information about how energy prices might develop in the future, which means they would prefer a communicative instrument.

Thirdly, when it comes to behavioral barriers, this research hypothesizes that homeowners who primarily face behavioral barriers would prefer communicative instruments as a way to be incentivized. According to Hesselink and Chappin (2019), behavioral barriers often have to do with ignorance about energy efficiency, which means that providing more information alleviates this barrier. In addition, the availability bias described by Hesselink and Chappin (2019) can be alleviated by communicative instruments because information would be more readily available to homeowners. Therefore, homeowners who feel that information is not readily available about energy efficient renovations, and therefore experience an availability bias, will prefer communicative instruments because it makes information more accessible.

Lastly, regarding social behavioral barriers, this research expects that homeowners will prefer direct policy measures. When it comes to social, behavioral barriers, the surroundings of the homeowners are particularly relevant. Therefore, these barriers often occur when homeowners do not want to do energy-efficient renovations because people in their vicinity also do not do them. Therefore, they might prefer obligatory instruments because then people

in their neighborhood will do the energy-efficient renovations, which will, in turn, motivate them also to do the renovations.

Chapter 3. Method

This research has the main objective to explore the relationship between the barriers homeowners experience in their decision-making process for doing energy efficient renovations in their homes, and their preferences for incentivizing policies regarding energy efficient renovations. By exploring this relationship, this research wants to address the current gap in the literature regarding this relationship between the barriers and preferences for policy among homeowners regarding energy-efficient renovations. This chapter will give an overview of the method used to explore this relationship, and therefore, answer the research question. Therefore, providing more detail about the research design, data collection method, research participants, variables and control variables, limitations, and finally how the collected data will be analyzed.

3.1 Research Design

This research employs a cross-sectional study by researching a sample of Dutch homeowners, in order to explore the relationship between the barriers for homeowners and their preferences for policy. This research uses cross-sectional study design because the data is collected in a small period of time from a sample of Dutch homeowners.

In addition, the data is collected to describe a relationship, namely between barriers and preferences, at a specific time. Therefore, it won't research changes over a period of time, which would not be an appropriate method to achieve the research objectives.

Questionnaires will be distributed among a sample of Dutch homeowners, and the results of these questionnaires will be analyzed in a quantitative way. From these results, the

objective of this research is to explore the relationship between the barriers for homeowners and their preferences for policy.

This research wants to mimic policymakers' constraints by designing a questionnaire that lets respondents divide a certain amount of points among the different incentivizing policies the Dutch government currently uses. Therefore, the questionnaire results will show which policies Dutch homeowners prefer when it comes to energy-efficient renovations while also incorporating the fact that there is a limited budget for such policies, making trade-offs necessary. Employing this alternative method compared to previous studies will give a complete picture of the preferences of Dutch homeowners.

As mentioned, this research will use a research design where respondents will be asked about their preferences for policy in a direct manner instead of looking at behavior. One of the main reasons for using this method is that the results will portray a clearer picture of the respondents' preferences, in this case, Dutch homeowners. In previous literature, researchers primarily focused on looking at the behavior of homeowners, which means that they looked at how homeowners adjusted their behavior in reaction to different policies. However, this research will take a different approach and ask respondents about their preferences more directly.

An essential aspect of this method is that respondents have to make trade-offs between different policies, which results in an accurate simulation of the decision-making process of a policymaker. Therefore, it is essential that the trade-offs policymakers face also are prevalent in the questionnaire to mimic somewhat the trade-offs that policymakers have to consider.

So, one of the advantages of this method is that it accurately places the respondent in the shoes of the policymaker by incorporating trade-offs in the decision-making process.

Compared to previous research, this is an alternative way to measure preferences because, in this method, respondents are asked about their preferences directly. In other

research on this subject, researchers often strictly look at the behavior of the respondents when it comes to determining their preferences for different policies. Therefore, researchers look at how people respond to different types of policies and conclude from this response what the effects of these policies are. In the alternative method this research uses, behavior is not the deciding factor when researchers determine someone's preferences for policy. Instead, people are asked about their policy preferences directly.

Therefore, this research determines preferences by looking at which policies the respondents prefer, which is an alternative way to measure preferences instead of strictly looking at behavior.

This way of measuring preferences entails that when respondents are put in the shoes of policymakers and, for example, pick a specific subsidy as their preferred policy, respondents think this is the best way to be incentivized.

For example, when respondents pick a specific subsidy as their preferred incentivizing instrument, one could conclude that the respondents think this is the best way to be incentivized while also considering the trade-offs associated with picking this policy.

These trade-offs come from the fact that the government has a specific budget to incentivize homeowners to make energy-efficient renovations. Therefore, when a respondent prefers a specific policy and allocates more points to this policy, this will result in another policy getting less budget.

The current policies used by the Dutch government will be incorporated into the questionnaire, and respondents will have to divide 100 points over the different policies, which will simulate a situation where they are the policymaker. Therefore, they have to divide points based on what they think policies will incentivize them the most to do energy-efficient renovations.

In this research, the preferences for a policy of the respondent are the Y variable. This variable will be measured by how the respondent allocates their 'budget' of 100 points among the previously mentioned incentivizing policies. Therefore, this allocation will show the preferences of the homeowner. In the questionnaire, respondents can divide 100 points in total among the different policies, which means allocating much budget to a particular policy will result in another policy getting less attention. This type of question will aid this research in developing a better understanding of the preferences for a policy of the homeowners. At the same time, the homeowners must also consider policymakers' constraints.

The homeowner's preference will show from this allocation of points because the respondent is asked to divide these points in a way that he or she thinks would be an effective policy to be stimulated to make energy-efficient renovations.

In this research, the X variable will be the barriers homeowners experience when considering energy-efficient renovations. First, the research will look at each barrier separately and see if a striking result emerges. This means that a specific barrier will be compared to the preferences for policy, so compare the data from a specific barrier to the data for the policy preferences.

Secondly, The vast array of barriers will be divided into different categories that classify these barriers. These barriers are categorized in the same manner as research by Hesselink and Chappin (2019), who divide the different barriers into structural, economic, behavioral, and social behavior barriers. These categories will not be communicated to the respondents but will aid the research in categorizing the barriers homeowners experience. This variable is researched by asking respondents which barriers they face when doing energy-efficient renovations.

The barriers that fall under the first category, namely structural barriers, are the following: I will wait for what policies the government will arrange; my house is unsuitable for this type of renovation.

The barriers under the second category, namely, the economic barriers, are the following: I think the payback period is too long, I cannot afford it, I will wait because I think it will be cheaper in future, I do not think the investment will be reflected in the value of my house.

The third category, namely the behavioral barriers, includes: I do not want to spend money on this, I already live in an energy-efficient home, I do not know which measures are effective for my house, the renovation will cost too much of my time, I will move soon, I do not think it is necessary to renovate my house, this will cause a mess in my house.

The last category, the social behavioral barriers, includes: my neighbors do not do energy-efficient renovations, My partner does not want renovations does not want this, and what I do does not matter for the climate.

3.2 Data Collection Method

This research will collect its data through surveys. Respondents will answer a survey with two main parts. One part will be focused on the barriers the respondents experience when it comes to energy-efficient renovations. The other part will ask respondents about their preferences for incentivizing policies and, therefore, ask them what they think the best policy would be to incentivize them to do energy-efficient renovations.

Firstly, respondents will be asked about the barriers they experience when doing energy-efficient renovations, which provides essential information about their decision-making process when they consider energy-efficient renovations.

Using the most common barriers identified by Van Gaalen et al. (2019) and categorizing them like Hesselink and Chappin (2019), this research will present respondents with different barriers and ask them to what extent this barrier will play a role in the decision-making process of energy-efficient renovations. The respondents can give their answers on a scale from 0 to 8. In this case, zero means that the barriers do not play a role at all in their decision-making

process. Four means that they are neutral towards the barrier. Lastly, eight means that the barriers play a crucial role. The results will give a clear picture of what barriers play a significant role and what barriers do not play a role in the decision-making process of homeowners and, therefore, which barriers are relevant for policymakers to consider when designing an incentivizing policy.

After asking the respondents about the barriers they experience in their decision-making process concerning energy-efficient renovations, the second part of the questionnaire is about how respondents value different incentivizing policies.

Before valuing these policies, it is essential for the research to first briefly explain all the different incentivizing policies to the respondents. Explaining the policies is essential because respondents can only value these policies properly if they understand what they entail and, therefore, what the consequences of these incentivizing policies would be. When respondents value different policies but need a clearer picture of the details of the different incentivizing policies, it could hurt the validity of the results because respondents would not make an informed decision about their preferred policy mix. Therefore, it is essential to quickly brief the respondents about the nature of the different incentivizing policies before getting into the part of the questionnaire where they value these policies.

The valuing part of the questionnaire will ask respondents to value different policies by dividing 100 points among policies that are based on the most common incentivizing policies in the Netherlands. It is assumed that the respondents have a relatively good understanding of what the current policies look like. For additional information about these policies, the research provides a short explanation of what each policy entails before the question.

Respondents value different policies based on their thoughts on which policy would motivate them the most to do energy-efficient renovations while also considering the benefits

and drawbacks of each policy. Therefore, which policies would incentivize them the most due to energy-efficient renovations?

To make an informed decision on this question, the respondents must be informed about each policy before answering the question. Giving the respondents more information about the policies will give them more knowledge about the advantages and drawbacks of each policy and, therefore, will result in adequately informed respondents.

In the questionnaire, four different incentivizing policies are presented to the respondents. Firstly, a policy that will increase the possibilities for subsidies regarding energy-efficient renovations. Therefore, this policy will employ a financial incentive to achieve the desired behavior of homeowners. In this scenario, this desired behavior is that homeowners will do an energy-efficient renovation.

Secondly, a policy that focuses on the information supplied by the government is directed to the homeowners. As mentioned before, many homeowners need more information about, for example, the overall picture of the business case of an energy-efficient renovation. Therefore, this policy focuses on providing homeowners with more knowledge and information about the potential benefits of an energy-efficient renovation and information about the process of doing an energy-efficient renovation.

Thirdly, a policy that has an obligatory character. In the context of energy-efficient renovations, homeowners would be obligated to adhere to specific environmental standards for their homes. This policy would, for example, be enforced by instruments like fines. Therefore, because of the obligatory character of this policy, the policy can be defined as a direct policy instrument.

Fourthly, a policy focused on creating more room for homeowners to finance their energy-efficient renovation by making it more attractive to loan money for the renovation and for example, getting a loan with 0% interest for investments used for energy-efficient

renovations. This policy can also be interpreted as a financial instrument because the loan ensures homeowners have more budget for an energy-efficient renovation.

3.3 Research Participants

The participants in this research have to live in the Netherlands. Because these homeowners are asked about Dutch policies to stimulate energy-efficient renovations, homeowners from other countries would not be relevant. Therefore, the scope of this research limits itself to the Netherlands and does not include respondents from other countries. In addition, the participants in this research also need to be owners and occupants of a home.

Although Energy efficient renovations in the rental sector are also relevant, the Dutch government uses a significantly different policy mix to stimulate the rental sector to do energy-efficient renovations. In addition, in the rental sector, occupants of a home are not responsible for doing the energy-efficient renovations; the owners of the building are. Because of these differences, the rental and owner-occupied sectors cannot be treated similarly and, therefore, have to be researched separately. For this reason, this research will only focus on the owner-occupied sector of the market. Therefore, survey respondents who do not own their houses will be excluded from the analysis.

In order to filter non-homeowners from the data, respondents will be asked if they are a homeowner at the beginning of the survey. This question will also mention that if the answer is no, this questionnaire is irrelevant to the respondent.

When it comes to these Dutch homeowners, a significant number have done some energy-efficient renovations. For example, almost 90% of the owner-occupied have taken the measure of installing double glass in their house. However, only 20% of the owner-occupied houses have the A energy label, meaning their house is energy efficient. Therefore, in many cases, even though homeowners have done energy-efficient renovations, there can still be more to make their house, even more energy efficient.

Because of this, this research will not exclude homeowners who have already done energy-efficient renovations in their homes. Instead, these homeowners can interpret the question about what barriers they experience in their decision-making as barriers to further energy-efficient renovations.

Research participants will be collected by distributing the questionnaire among friends and family in my network. In addition, the research will also be distributed in the network of the foundation mijngroenehuis.nl, specifically, the foundation branch located in the town of Zeist. The survey link will be distributed so respondents can complete it on their computer or mobile device.

3.4 Control Variables

In order to conduct proper research and data analysis, it is also necessary to have some control variables in the research design. The control variables in this research mainly aim to isolate the variables of interest in this research, the barriers for homeowners, and their preferences for incentivizing policy. Therefore, these control variables aim to minimize the effect of exogenous factors and therefore confounding effects that could influence the study.

First of all, age is a control variable in this research. According to research by Poortinga et al. (2003), older homeowners are less likely to invest in energy-efficient renovations. Therefore, the respondent's age can be an essential factor in their decision-making for an energy-efficient renovation. In addition, Poortinga et al. (2003) found that respondents aged 20 through 39 and 40 until 64 were more open to technical improvements to their houses than those older than 65. Because of these findings, it is necessary to control for the variable age in the research. Therefore, in the questionnaire, respondents will be asked about their age by a multiple-choice question giving three options: age 20 to 39, 40 to 64, and 65+.

Secondly, Poortinga et al. (2003) also noticed that family composition could be an essential determinant of the attitude of homeowners towards energy-efficient renovation. In

their research, the authors concluded that families and couples were more open to energy-efficient renovations than single households (Poortinga et al., 2003, p. 60). In order to control for this variable, homeowners in the sample will be asked about with whom they live in their house. The alternatives in the questionnaire would be single, couple/married, and family.

Thirdly, the research also controls how environmentally conscious respondents are in the questionnaire. For example, Pelenur (2018) finds that environmentally aware individuals are generally more open to energy-efficient renovations. Therefore, people who are unaware of the environmental problems are generally less open to energy-efficient renovations. For these reasons, it is necessary to control for this variable in the research to adequately isolate the effect of the independent variable on the dependent variable.

Fourthly, another relevant variable to control for is whether or not homeowners have already done energy-efficient renovations in their homes. For example, Ma et al. (2021) find that among Chinese homeowners, the likelihood of doing an energy-efficient renovation decreases when homeowners have previously already done a renovation. Therefore, it is necessary to control for this variable to mitigate any confounding effect.

Lastly, the truthfulness of the respondents can also negatively influence the results of this research. Even though homeowners might not need subsidies to incentivize them to do energy-efficient renovations, they can still express their preference for it in the research. In order to account for this, the questionnaire asks respondents if they can afford energy-efficient renovations without help from the government. Asking respondents this will mitigate the effect that respondents can afford energy-efficient renovations, but still express their preferences for subsidies. Therefore, this research controls for this possible confounding effect.

3.5 Limitations

One of the main limitations of this research is the sample of the data. Because the research respondents will predominantly be from my network and the Zeist branch of mijngroenehuis.nl, most will be located in Zeist. Furthermore, because these respondents are predominantly from the same area, it might not be possible to conclude that this research applies to Dutch homeowners in general.

There are two reasons why sampling residents of Zeist might not be an accurate representative sample for the rest of the Netherlands. Firstly, the average value of homes in Zeist is relatively high compared to the rest of the Netherlands. In Zeist, the average value of a home is 440.000, while in the rest of the Netherlands, the average value of a home is 317.000. Secondly, compared to the rest of the Netherlands, the average income of Zeist's residents is slightly higher. On average, the income in the Netherlands is 29.200, while in Zeist, the average income is 34.500.

These differences in income and home value could influence the general applicability of the results to the rest of the Netherlands. Because of this higher income and home value, doing an energy-efficient renovation will be less financially challenging for this group of homeowners than other homeowners in the Netherlands. According to Banfi et al. (2008), high-income households are more willing to pay for an energy-efficient renovation.

Therefore, the relatively higher income of the sample group could impact the validity of the research results. Because they have more financial means, the barriers they experience for energy-efficient renovations can differ from what the average Dutch homeowner experiences. In addition, it can also result in these homeowners from Zeist preferring different policies than the average Dutch homeowner. This limitation of the research is significant because less convincing conclusions can be drawn about Dutch homeowners based on this research. Therefore, the external validity of this research is negatively affected.

However, because of the relatively higher income and home value of the sample could also give this research valuable insights. These insights would be on a specific group of homeowners in the Netherlands who can afford energy-efficient renovations with, for example, their savings. According to Zhang et al. (2022), this group of homeowners that could afford the energy-efficient renovation from their savings is about 50% of Dutch homeowners. However still, a large percentage of this group has yet to make the necessary investment.

Therefore, it would be valuable to learn why people with enough financial means to invest still do not invest. For that reason, having respondents from Zeist, where the income and home value are relatively high, makes it a valuable sample to research.

Another limitation of the research could be that even though some people can afford an energy-efficient renovation from their savings, they are still interested in receiving a subsidy because they do not want to use it for this purpose. Therefore, they would answer the questionnaire that they want a subsidy, which means they are not entirely truthful in their response. On the surface, this answer looks like they need financial support for an energy-efficient renovation. However, this might not be the case; they do not want to use their savings for energy-efficient renovations.

In the questionnaire, there will be controlled for this problem by asking respondents if they have enough savings to finance an energy-efficient renovation of around 20.000, which is the average cost of doing such a renovation.

However, because of the relatively higher income and home value of the sample could also give this research valuable insights. These insights would be on a specific group of homeowners in the Netherlands who can afford energy-efficient renovations with, for example, their savings. According to Zhang et al. (2022), this group of homeowners that could afford the energy-efficient renovation from their savings is about 50% of Dutch homeowners. However still, a large percentage of this group has yet to make the necessary investment. Therefore, it

would be valuable to learn why people with enough financial means to invest still do not invest. For that reason, having respondents from Zeist, where the income and home value are relatively high, makes it a valuable sample to research.

Another limitation for this research could be that it might not be generalizable over time. This is mainly because the current situation with energy prices is significantly different than before and can be significantly different in a few years' time. For example, in a few years' time, it is possible that the gas prices are significantly lower if the Ukraine war ends. Because of these lower gas prices, in the future there might not be the same urgency as now for making your house energy efficient. Therefore, in the future homeowners might not be as open to these renovations like they are currently, which would yield different results in the research.

3.6 Data analysis

The barriers for doing energy efficient renovations will be the X variables in this research. The X variables are measured on a Likert scale and can be characterized as an ordinal variable. This is mainly because the variable is measured on a scale from zero to eight. With this variable, zero means that a barrier does not play a role in the decision-making process, and eight means that it plays a big role in the decision-making process, which means that are different levels of influence on the decision-making process when it comes to barriers for energy efficient renovations. Therefore, the ordered levels of the variable are relevant because it implies a clear progression of not playing a role in the decision-making process to playing a big role in the decision-making process. Because of this, there is a meaningful rank order with this variable, which is an important characteristic of an ordinal variable. A Likert scale is often used in social sciences to measure perceptions or attitudes towards something, this research also does this when it comes to barriers homeowners face when doing energy efficient renovations.

Secondly, the variable that measures the preferences for policy of the homeowners can be categorized as an ordinal variable. This research will treat each policy alternative in the questionnaire as a separate independent variable in order to properly determine the relationship of each policy alternative with the independent variables. This variable is treated like a continuous variable.

In order to analyze the collected data, this research will do its analysis in several steps. Each policy alternative will serve as a different dependent variable that will be compared to all the independent variables and the control variables. By doing this, this research will establish how the barriers homeowners face influence their preferences for different policies.

Firstly, this research will conduct an analysis where the dependent variable is 'Subsidies', which entails the policy alternative where homeowners receive more subsidies for doing energy-efficient renovations.

Secondly, the variable *Information Provision* will be the dependent variable, which entails a policy where homeowners are provided with more extensive information about doing an energy-efficient renovation.

Thirdly, the variable *Obligatory Policy* will be the dependent variable, which entails a policy where homeowners are obligated to do energy-efficient renovations by the Dutch government. Fourthly, the variable *Lending Space* will be the dependent variable, which entails a policy where homeowners are able to loan money more easily if its intended for energy-efficient renovations.

In order to analyze this data, the analysis will employ a multiple linear regression analysis to investigate the relationships between the policy preferences of homeowners and the barriers faced by homeowners when doing energy-efficient renovations. A multiple linear regression analysis is appropriate in this research because it is a robust statistical technique that can determine the effects of multiple predictor variables, in this case the barriers for energy-

efficient renovations, on a continuous dependent variable, in this case the preferences for policy among homeowners. A multiple linear regression analysis allows for multiple independent variables, and therefore, will give data on the predicting effect of each independent variable on the dependent variable. Therefore, these results will provide information about how each barrier influences a policy preference, while also take into account potential confounding effects by including the control variables in the analysis. This possibility to analyze each independent variable individually is valuable for this research because it can determine which barriers have the most significant impact on the preferences for policy of a homeowner. In addition, applying this method will give information about the overall effect of all the independent variables on the dependent variable, and therefore, can provide more information about the overall relationship between preferences and barriers.

Moreover, employing the multiple linear regression analysis will also provide insights into the magnitude of the effect of each independent variable on the dependent variable. In addition to the magnitude of the effect, the multi linear regression analysis provides information about the direction of the relationship between the independent variables and the dependent variables. Therefore, employing this method provides information about if an independent variable has a positive or negative relationship with the dependent variable, which is valuable information in the context of this research. By analyzing the direction and magnitude of the effects of the independent variables on the dependent variable the hypotheses of the research can be tested. Moreover, by examining the p-values of the regression coefficients, this research can determine which barriers have significant effect on the policy preferences of homeowners.

In order to control for potential confounding effects, for each dependent variable there will be two models. One without the control variables, and one without the control variables.

Chapter 4. Analysis

This chapter will analyze the data obtained by distributing the surveys among Dutch homeowners. Firstly, it will provide some general observations. Secondly, this chapter will analyze the data with the variable *Subsidies* as the dependent variable. Thirdly, this chapter will analyze the data with the variable *Information Provision* as the dependent variable. Fourthly, the data with the variable *Obligatory Policy* as a dependent variable will be analyzed. Lastly, the data with the variable *Lending Space* as the dependent variable will be analyzed.

4.1 Descriptive Statistics and Sample Characteristics

Firstly, before analyzing the results from the research it is important to consider the descriptive statistics and the sample characteristics. The sample in this research consisted of 102 Dutch homeowners, aged between 20 and above. The age variable was divided into three categories. The first category was 20 to 39, the second 40 to 64, and the third was 65 and older. Among these respondents, only 17% of the people lived alone, while around 50% lived together without kids, and 31% lived with their family. About 58% of the respondents fell into the second category, so the majority of the respondents were aged between 40 and 64. The majority, about 60% of these respondents either agreed or strongly agreed with the statement that they were environmentally conscious. In addition, about 64% of the respondents state that they previously have not done any energy-efficient renovations. The characteristics described above are the control variables in this research, which have been added to the analysis in order to control for any confounding effects, which can help in isolating the effect of the different barriers on the preferences for policy.

4.2 General observations

Firstly, it is essential to understand which barriers are the most relevant for the questionnaire respondents. Therefore, what barriers described by Van Gaalen et al. (2019) are the most deciding in their decision-making process to do an energy-efficient renovation? As

mentioned, the respondents must value each barrier from 1 to 8. In this context, one means that the variable does not play a role in their decision-making process, and eight means that it plays a vital role in their decision-making process. By analyzing the results from the questionnaire, it becomes clear that the barrier, *I think the payback period is too long*, is the most important barrier in the decision-making process of the respondents. One could conclude this because the mean of this barrier is the highest among all the barriers, which means that, on average, the respondent's value is the highest in terms of how it affects their decision-making process. The mean of the variable relating to the payback period in the sample of participants was 5,79(SD=2,14), which indicates a relatively high level of the variable *Payback Period* on the 1 to 8 scale. Therefore, respondents in this research consider the payback period of an energy-efficient renovation as the most crucial barrier in their decision-making process.

The general observations on the barriers homeowners experience, so the means and the standard deviations are all summarized in table 1.

Table 1. Barriers to Energy-Efficient Renovations.

Variable	Mean	Std. dev.
Payback Period	5.794118	2.140317
Cheaper in Future	4.696078	2.237348
Wait for Government Regulations	4.578431	2.301254
Renovation not Reflected in Home Value	4.519608	2.201396
I cannot afford it	3.882353	2.376844
House Already Energy-efficient	3.313725	2.138661
Don't know which measures to take	4.45098	2.423595
Don't want to spend money on renovation	3.303922	2.169953
Takes too much time	4.284314	2.261943
Measures don't matter for the environment	2.470588	1.933068
I will move soon	1.588235	1.188667
I don't think Renovation is necessary	2.833333	2.193976
My house is unsuited for Renovations	2.519608	1.922923
My neighbours don't do renovations	3.176471	2.296841
Renovations will cause a mess	2.058824	1.681722
My partner does not want renovations	1.588235	1.196968

Secondly, it is essential to determine what policies homeowners prefer regarding energy-efficient renovations. As mentioned before, homeowners had to value these policies from 0 to 100 and divide 100 points in total among the four different incentivizing policies. The policy option that entails more subsidies had a mean of 45.1(SD=21.95), the policy option that entails more information provision by the government had a mean of 20.51 (SD=16,44), the policy option that entails an obligatory measure had a mean of 15.9 (SD=16,37), and lastly, the policy option that entailed more possibilities to loan money for a renovation has a mean of

18.48 (SD=14,54). Therefore, on average, respondents value the policy that entails more subsidies the highest and the policy that has an obligatory character the lowest.

In addition, respondents also value the policy that makes it easier to get a loan for a renovation higher than an obligatory policy, namely the mean of this policy is 18,48 (SD=14,55).

The general observations on the preferences of homeowners for incentivizing policies, so the means and the standard deviations will be summarized in table 2.

Table 2. Preferences for Incentivizing Policies

Variable	Mean	Std. dev.
Subsidies	45.09804	21.95563
Information Provision	20.51961	16.44055
Obligatory Policy	15.90196	16.37101
Lending Capacity	18.48039	14.54983

4.3 Subsidies as Dependent Variable

The assumption of linearity is met with *Subsidies* as the dependent variable and the different barriers and control variables as independent variables. This assumption is met because the scatterplots of the different independent variables with the dependent variable 'Subsidies' show a roughly straight line. When examining the plot of the residuals against the predicted values, there is no fan or megaphone shape in the plot, which means that the assumption of homoscedasticity is also met. In addition, in the normality probability plot, the points roughly follow a straight line, which means that the assumption of normality is met. Lastly, the variables' VIF scores are lower than 5, the commonly used threshold for multicollinearity. Therefore, because the Vif scores are lower than 5, there is no reason for concerns about multicollinearity in this model.

Firstly, this research will examine the relationship between the dependent variable *Subsidies* and the independent variables, and a multiple linear regression analysis will be conducted. This analysis aims to investigate the impact of various factors on the level of preference for subsidies among homeowners. In order to properly assess the effects of the independent variables, two separate models will be used. Model 1 will only incorporate the independent variables and not the control variables. Model 2 will include the independent variables and the control variables. By dividing it into two models, the effect of the control variables on the dependent variable will become more apparent.

Model 1, the model without the control variables but with independent variables *Payback Period, Cheaper in Future, Wait for Government Regulations, Renovation not reflected in Home value, Can't afford the renovation, House already energy efficient, Don't know which measures to take, Don't want to spend money on renovation, Takes too much time, Measures don't matter for the environment, I will move soon, I don't think renovation is necessary, My house is unsuited for renovations, My neighbors don't do renovations, Renovations will cause a mess, My partner does not want renovations*, has an adjusted R-squared value of 0,178, which means that Model 1 explains 17.8% of the variance in the dependent variable *Subsidies*. The 17.8% probability associated with the F-statistic (Prob>F = 0,059) entails that the model's overall fit is not statistically significant at the conventional level of $\alpha = 0.05$.

The F-statistic, which estimates the overall significance of the model, is 2.36 in Model 1, with 16 degrees of freedom for the numerator and 85 degrees of freedom for the denominator. The F-value of 2.36 indicates a moderate degree of association between the independent variables and the dependent variable *Subsidies*. However, this degree of association does not have statistical significance at the conventional level, namely $\alpha = 0.05$.

Model 1 has the following regression equation: Subsidies = 44.214 + 2.268 * *Payback Period* + 1.577 * *Cheaper in Future* + 0.322 x *Wait for Government Regulations* - 1.644 * *Renovation not reflected in Home value* + 1.949 * *Can't afford the renovation* + 0.293 * *House already energy efficient* - 0.283* *Don't know which measures to take* - 1.064* *Don't want to spend money on renovation*- 2.065 * *Takes too much time* + 3.876 * *Measures don't matter for the environment* - 4.534 * *I will move soon* - 1.150 * *I don't think renovation is necessary* + 0.030 * *My house is unsuited for renovations* - 0.449 * *My neighbors don't do renovations* + 0.120 * *Renovations will cause a mess* - 4.173 * *My partner does not want renovations*

Model 2, with *Subsidies* being the dependent variable and the independent variables being the same as model 1. However, In addition to the independent variables, the regression model also includes control variables *Environmentally consciousness, Need help from the government, Age, Household composition*, and *Already done renovations* to account for potential confounding effects that might influence the relationship between the independent variables and the dependent variable. This model has an adjusted R-squared of 0,1674, meaning that approximately 16,74% of the variation in the dependent variable *Subsidies* was explained by the independent and control variables. This model significantly predicted the degree of preferences for *Subsidies* among homeowners, $F_{(21,78)} = 1,95$, $p < 0,005$, Adjusted R^2 = 0,1674, suggesting that this model with the independent variables and the control variables had a significant relationship with the preferences of homeowners for a policy that entails more subsidies. In addition to the regression equations, both models one and two will be summarized in Table 1 in the appendix of this research.

For Model 2, this research will use the following regression equation: *Subsidies = 18.85 + 2.61* Payback Period + 1.60* Cheaper in Future) + 0.04 *Wait for Government Regulations - 1.32* Renovation not reflected in Home value + 2.48* Can't afford the renovation + 0.84* House already energy efficient - 0.44* Don't know which measures to take - 0.76* Don't want*

to spend money on renovation - 1.93* Takes too much time + 3.73* Measures don't matter for the environment - 4.43* I will move soon - 0.38* I don't think renovation is necessary - 0.35* My house is unsuited for renovations - 0.34* My neighbors don't do renovations + 0.22* Renovations will cause a mess - 3.32* My partner does not want renovations + 0.15* Environmentally consciousness + 6.72*Need help from the government + 4.64 * Age + 5.57* Household composition - 2.69* Already done renovations

This regression analysis examined the relationship between the dependent variable 'Subsidies' and the independent variables. The independent variable *I will move soon*, which measures the barrier for energy efficient renovations that people will move soon, is measured on a 1 to 8 scale. In model 1, the regression coefficient for the variable *I will move soon* is statistically significant (p <0,05) with a value of -4,534. This coefficient indicates that each one-unit increase of I will move soon results in a 4.534 decrease in the dependent variable *Subsidies*. Therefore, there is a negative relationship between the barrier that a homeowner will move soon and their preference for a policy that gives more subsidies to homeowners. This means that if homeowners value the barrier that they will move soon with one point higher on the 1 to 8 scale, their preference for a subsidy policy will decrease by 4.534 points on the 0 to 100 scale.

Because of the statistical significance of the regression coefficient (p <0,05), there is reason to believe there is a significant association between the dependent and independent variable *I will move soon*. However, in Model 2 with the control variables, this regression coefficient becomes non-significant. This suggests that including control variables has influenced the relationship between the independent variable *I will move soon* and the dependent variable *Subsidies*.

In addition, the regression analysis also examined the relationship between the dependent variable *Subsidies* and the independent variable *Can't afford the renovation* in Model 2. The regression coefficient of the independent variable was 2.481, with p <0,10.

The coefficient of 2.481 suggests that if the independent variable *Can't afford the renovation* increases with one unit on the 1-8 scale, the preferences for a subsidy policy are expected to increase by approximately 2.481 points on the 0 to 100 scale. The independent variable *Can't afford the renovation* measures to what degree the barrier 'I cannot afford an energy efficient renovation' plays a role in the decision-making process of homeowners. Therefore, there is a positive relationship between the independent and the dependent variable. Although the p-value is higher than the conventional significance level of p <0,05, it is lower than 0,10. For this reason, the significance level indicates a marginal level of statistical significance. Therefore, these findings suggest that when homeowners see their inability to pay for the renovations as a more significant barrier, they are more likely to prefer policies that will give more subsidies for energy-efficient renovations.

The independent variable *Payback Period* has a regression coefficient of 2.611, with a p-value of less than 0,05, which means this coefficient is statistically significant. In this context, the regression coefficient of 2.611 means that the dependent variable 'Subsidies' is expected to increase with 2.611 on the 0-100 scale when the independent variable *Payback Period* increases by one point on the 1 to 8 scale. Therefore, the regression indicates a positive relationship between the independent and dependent variables. In this context, this positive relationship means that when people see the payback period of an energy-efficient renovation as a more significant barrier, their preference for a subsidy policy increases.

The independent variable *Measures don't matter for the environment* has a regression coefficient of 3.732, with a p-value of less than 0,05, which means this coefficient is statistically significant. In this context, the regression coefficient of 3.732 means that the dependent variable

Subsidies is expected to increase with 3.372 on the 0-100 scale when the independent variable *Measures don't matter for the environment* increases by one point on the 1 to 8 scale. Therefore, the regression indicates a positive relationship between the independent and the dependent variable. In this context, this positive relationship means that when people see 'what I do does not matter for the climate' as a more significant barrier to energy-efficient renovation, their preference for a subsidy policy increases.

When comparing Models 1 and 2, it becomes clear that Model 1 explains a more considerable proportion of the variation in the dependent variable *Subsidies*. One could conclude this because the adjusted R-squared of Model 1 is higher than that of Model 2. Therefore, a model with only the independent variables, not the control variables, explains more of the variation in the dependent variable than a model that incorporates the control variables. However, by incorporating the control variables in Model 2, the model accounts for potential confounding effects. These control variables account for other relevant factors influencing the dependent variable *Subsidies*.

Because the model accounts for these confounding effects, it offers a more comprehensive and robust analysis, even though it has a lower R-squared than Model 1. Including control variables reduces potential bias and provides a more accurate estimation of the relationship between the independent and dependent variables. However, in this case, none of the control variables have a significant predicting effect on the dependent variable. Table 3 will show all the regression coefficients for the two models with *Subsidies* as dependent variable.

Table 3. Linear Regression on Subsidies

	Model 1	Model 2
Payback Period	2.268** (1.160)	2.611*** (1,268)
Cheaper in Future	1.577* (1.147)	1.607* (1,240)
Wait for Government Regulations	0,322 (1.023)	0,045* (1,089)
Renovation not Reflected in Home Value	-1,644* (1.119)	-1.318* (1,170)
Can't Afford the Renovation	1.949** (1.064)	2.481** (1,253)
House Already Energy-efficient	0,293 (1.064)	0.836* (1,133)
Don't know which measures to take	-0,283 (1.081)	-0,445 (1.140)
Don't want to spend money on renovation	-1.065* (1.316)	-0.765 (1,363)
Takes too much time	-2.065** (1.146)	-1.932* (1.190)
Measures don't matter for the environment	3.876*** (1.462)	3.732*** (1.562)
I will move soon	-4.534*** (1.909)	-4.425* (2.134)
I don't think Renovation is necessary	-1.150* (1.259)	-1.376* (1.298)
My House is unsuited for Renovations	0.030 (1.446)	-0.136 (1.539)
My Neighbors don't do renovations	-0.449 (1.168)	-0.339 (1,204)
Renovations will cause a mess	0,120 (1.752)	0.224 (1.861)
My partner does not want renovations	-4.173** (2.185)	-3.321* (2.375)
Environmentally Consciousness		0.153 (2.094)
Need Help from Government		6.724* (5.896)
Age		4.641* (3.729)
Household Composition		5.567* (3.592)
Already done Renovations		-2.689 (5.204)
Constant		18.848* (17.386)

Note: unstandardized regression coefficients with standard deviations in brackets.*** $p < 0,05$, **$p<0,10$, *$p<0,5$

4.4 'Information Provision as Dependent Variable

Secondly, this research will examine the relationship between the different barriers homeowners experience, the independent variables, and their degree of preference for a policy that ensures that homeowners are more informed about doing energy-efficient renovations. Two separate models will be used with *Information Provision* as the dependent variable.

Model 1 will only incorporate the independent variables and not the control variables. Model 2 will include the independent variables and the control variables. By dividing it into two models, the effect of the control variables on the dependent variable *Information Provision* will become more apparent.

With Model 1, the multiple linear regression model exhibits a significant relationship between the dependent variable Information Provision and the independent variables *Payback Period, Cheaper in Future, Wait for Government Regulations, Renovation not reflected in Home value, Can't afford the renovation, House already energy efficient, Don't know which measures to take, Don't want to spend money on renovation, Takes too much time, Measures don't matter for the environment, I will move soon, I don't think renovation is necessary, My house is unsuited for renovations, My neighbors don't do renovations, Renovations will cause a mess, My partner does not want renovations*. The adjusted R-squared in this model has a value of 0,331, which means that the independent variables in Model 1 can explain 33.1% of the variability in the dependent variable. Therefore, the independent variables explain the variation in the dependent variable *Information Provision*. In addition, the model's overall significance is determined using the F-test; this yielded a highly significant result ($p<0,01$).

The F-statistic of this model is $F_{(16,85)} = 4,14$, with 16 and 85 as degrees of freedom, which means that the model is statistically significant in explaining the variance in *Information Provision*. Therefore, the independent variables collectively have a significant association with

Information Provision. The regression equation of Model 1, with *Information Provision* as the dependent variable, will look like this:

Information Provision = 12.725 + 0.359 * Payback Period -1.083 * Cheaper in Future -0.215 * Wait for Government Regulations + 0.096 * Renovation not reflected in Home value -1.650 * Can't afford the renovation -1.069 * House already energy efficient + 3.246 * Don't know which measures to take -0.063 * Don't want to spend money on renovation+ 0.305 * Takes too much time -1.095 * Measures don't matter for the environment + 0.304 * I will move soon + 0.275 * I don't think renovation is necessary -0.829 * My house is unsuited for renovations + 1.238 * My neighbors don't do renovations + 0.432 * Renovations will cause a mess + 2.808 * My partner does not want renovations

In Model 2, the control variables *Environmentally consciousness, Need help from the government, Age, and Already done renovations* are added to the independent variables. The regression of model 2 suggests that the model is statistically significant because the p-value associated with the F-test is 0,00, which is lower than a conventional significance level of $p < 0,05$. Therefore, this suggests that the independent variables collectively significantly impact the dependent variable.

In Model 2, the adjusted R squared has a value of 0,3917, which means that 39,17% of the variation in the variable *Information Provision* can be explained by the independent variables and the control variables, which means that Model 2 has a moderate level of explanatory power. The F statistic of 4.04 with degrees of freedom (21,78) also suggests a relationship between the independent variables and the variable *Information Provision*.

Model 2 has the following regression equation, with *Information Provision* as the dependent variable: *Information Provision = 24.335 + 0.098 * Payback Period - 0.592 * Cheaper in Future - 0.339 * Wait for Government Regulations - 0.454 * Renovation not reflected in Home value - 1.973 * Can't afford the renovation - 1.565 * House already energy*

efficient + 3.396 * Don't know which measures to take - 0.465 * Don't want to spend money on renovation + 0.018 * Takes too much time - 0.468 * Measures don't matter for the environment - 0.067 * I will move soon + 0.547 * I don't think renovation is necessary - 0.607 * My house is unsuited for renovations + 1.468 * My neighbors don't do renovations - 0.114 * Renovations will cause a mess + 2.232 * My partner does not want renovations - 1.505 * Environmentally consciousness - 0.238 * Need help from the government - 4.588 * Age - 3.989 * Household composition + 8.321 * Already done renovations. The regression analysis of models 1 and 2 will be summarized in Table 4.

In Model 2, the independent variable *Don't know which measures to take* has a regression coefficient of 3.396, with a p-value of less than 0,05, which means this coefficient is statistically significant. This variable measures to what extent the barrier 'I do not know which measures are effective for my home' plays a role in the decision-making process of homeowners.

The regression coefficient of 3.396 means that the dependent variable *Information Provision* is expected to increase with 3.396 on the 0-100 scale when the independent variable *Don't know which measures to take* increases with one unit on the 1 to 8 scale. Therefore, this regression coefficient indicates a positive relationship between the dependent and independent variables. In this context, this positive relationship means that if homeowners value the barrier that they do not know which measures to take for their house, they are more likely to value a policy that provides them with more information higher.

In Model 2, The independent variable *Can't afford the renovation* has a regression coefficient of -1.973, with a p-value of less than 0,05, which means this coefficient is statistically significant. The variable *Can't afford the renovation* measures to what extent homeowners see 'I cannot afford an energy efficient renovation' as a significant barrier in their decision-making process.

The regression coefficient of -1.973 means that the dependent variable *Information Provision* is expected to decrease with 1.973 on the 0-100 scale when the independent variable *Can't afford the renovation* increases with one point on the 1 to 8 scale.

Therefore, the regression indicates a negative relationship between the dependent and independent variables. In this context, this negative relationship means that when people see payment problems as a more significant barrier in their decision-making process, they are expected to have a lower preference for a policy that provides more information.

When comparing models 1 and 2, the adjusted R-squared value for model 2 is higher than that of model 1. Therefore, this difference suggests that including control variables improves the model's overall fit because Model 2 accounts for more of the variability in the dependent variable Information Provision. Also, the p-value, and therefore, the significance of the F-statistic, is lower in model 2 than in model 1. This lower p-value in model 2 means that model 2 has more robust evidence against the 0 hypothesis than model 1. From this, adding control variables improves the overall fit of the regression model. However, in model 1, the value for F (4,14) is slightly higher than that for F (4,04) in model 2. Therefore, based on the F statistic, Model 1 has a slightly stronger relationship between the independent and dependent variables. All in all, Model 2 does demonstrate a higher adjusted R-squared and, therefore, provides a better understanding of the factors influencing Information Provision by incorporating the control variables in the model.

Table 4 will show all the regression coefficients, p-values and standard errors of the variables of model 1 and 2 with *Information Provision* as dependent variable.

Table 4. Linear Regression on Information Provision

	Model 1	Model 2
Payback Period	0.359* (0,783)	0,098 (0,819)
Cheaper in Future	-1.083* (0,774)	-0,592* (0,800)
Wait for Government Regulations	-0.215 (0,690)	-0,339 (0,703)
Renovation not reflected in Home value	0.096 (0,756)	-0,454 (0,756)
Can't afford the renovation	-1.650*** (0,718)	-1,973*** (0,809)
House already energy efficient	-1.069* (0,718)	-1,565*** (0,731)
Don't know which measures to take	3.246*** (0,730)	3.396*** (0,736)
Don't want to spend money on renovation	-0.0625 (0,888)	-0,468 (0,880)
Takes too much time	0.305 (0,773)	0,018 (0,768)
Measures don't matter for the environment	-1.095* (0,987)	-0,468 (1,009)
I will move soon	0.304 (1.289)	-0,067 (1.378)
I don't think renovation is necessary	0.276 (0,849)	0,547 (0,838)
My house is unsuited for renovations	-0.829* (0.976)	-0,607 (0,994)
My neigbours don't do renovations	1.238* (0,788)	1.468** (0,778)
Renovations will cause a mess	0.432 (1.183)	-0.114 (1.201)
My partner does not want renovations	2.808** (1.475)	2.322* (1.534)
Environmentally consciousness		-1.505 (1.352)
Need help from the government		-0,238 (3.807)
Age		-4.588** (2.408)
Household composition		-3.989** (2.320)
Already done renovations		8.321*** (3.360)
Constant	12.725*** (6.010)	24.335*** (11.227)

Note: unstandardized regression coefficients with standard deviations in brackets

*** p <0,05, **p<0,10, *p <0,5

4.5 Obligatory Policy as Dependent Variable

Thirdly, this research will determine the relationship between the independent and control variables and the dependent variable, in this case, *Obligatory Policy*. Therefore, it will analyze the different barriers that influence on homeowners' preferences for obligatory measures.

Like with *Subsidies* and *Information Provision,* this research will run two different models. Model 1 will not incorporate the control variables, while Model 2 will incorporate the control variables of this research.

Model 1 has an adjusted R-Squared of 0,0955, which means that approximately 9.55% of the variance in the dependent variable *Obligatory Policy* can be explained by the independent variables. From this adjusted R-squared value, one could conclude that this model has limited explanatory power. Because of this, other factors not incorporated in this model might contribute to the variation in the dependent variable.

Furthermore, the probability value of model 1 is 0,0693, which is higher than a significance level of 0,05. Therefore, the relationship between the independent variables and the dependent variable may not be statistically significant. Also, the F-statistic $F(18,85) = 1.67$ of model 1 also suggests a weak overall fit of the model. Therefore, refinement of this model may be necessary in order to have a better understanding of the factors influencing *Obligatory Policy*.

The regression equation of Model 1, with *Obligatory Policy* as the dependent variable, is: *Obligatory Policy = 15.541 - 1.047 * Payback Period - 0.369 * Cheaper in Future - 0.872 * Wait for Government Regulations + 0.851 * Renovation not reflected in Home value - 1.981 * Can't afford the renovation - 0.291 * House already energy efficient - 0.071 * Don't know which measures to take + 1.040 * Don't want to spend money on renovation + 1.067 * Takes too much time - 1.739 * Measures don't matter for the environment + 3.860 * I will move soon*

+ 1.125 * I don't think renovation is necessary + 0.731 * My house is unsuited for renovations - 0.184 * My neighbors don't do renovations + 0.017 * Renovations will cause a mess + 1.862 * My partner does not want renovations

Model 2 has an adjusted R-square of 0,086, which means that the independent variables in the model explain approximately 8.6% of the variation in the dependent variable *Obligatory Policy*. Therefore, Model 2 has a low ability to explain changes in the dependent variable.

In terms of significance, model 2 has a p-value of 0,126 and, therefore, does not satisfy the condition $p < 0,05$, which means that the overall regression model might not be statistically significant. This means that the relationship between the dependent and independent variables might not be significant.

In addition to the significance, the F statistic, $F_{(21,78)} = 1,44$ is also relatively low; the low significance and low value for the F-statistic together means that the independent variables might not significantly impact the dependent variable. Therefore, Model 2 might not be a significant predictor of the independent variable *Obligatory Policy*. The regression equation of Model 2, with *Obligatory Policy* as the dependent variable, is:

Obligatory Policy = 22.120 - 1.217 * Payback Period - 0.472 * Cheaper in Future - 0.699 * Wait for Government Regulations + 1.232 * Renovation not reflected in Home value - 2.412 * Can't afford the renovation - 0.202 * House already energy efficient + 0.039 * Don't know which measures to take + 1.487 * Don't want to spend money on renovation + 1.121 * Takes too much time - 2.197 * Measures don't matter for the environment + 3.637 * I will move soon + 1.214 * I don't think renovation is necessary + 0.910 * My house is unsuited for renovations - 0.297 * My neighbors don't do renovations + 0.399 * Renovations will cause a mess + 1.911 * My partner does not want renovations + 0.349 * Environmentally consciousness - 2.039 * Need help from the government - 2.071 * Age + 2.492 * Household composition - 5.360 * Already done renovations

In model 2, the independent variable *Can't afford the renovation* has a regression coefficient of -2.412, with a p-value of less than 0,05, which means this coefficient is statistically significant. The variable *Can't afford the renovation* measures to what extent 'I cannot afford an energy efficient renovation' plays a role in the decision-making process of homeowners.

The regression coefficient of -2.412 means that the dependent variable *Obligatory Policy* is expected to decrease with 2.412 on the 0-100 scale when the independent variable *Can't afford the renovation* increases with one unit on the 1-8 scale. Therefore, this regression coefficient indicates a negative relationship between the dependent and independent variables.

In the context of this research, this negative relationship means that if homeowners value the barrier 'I cannot afford an energy efficient renovation' higher, they are less likely to prefer a policy with an obligatory characteristic.

When comparing models 1 and 2, model 1 has a higher adjusted R-squared than Model 1, which means it better fits the data than Model 2. On the other hand, in both models, the R-squared values are low, which means that in both models, the independent variables might not explain the variability in the dependent variable.

In addition, the F-statistic for model 1 (1,67) is higher than the F-statistic of model 2(1.44). From this, model 1 provides a relatively better overall fit to the data, which means that adding the control variables does not cause a better fit to the data. However, both models do not have a strong overall significance. In conclusion, neither models demonstrate a strong relationship between the dependent and the independent variables.

Table 5 will provide all the regression coefficients of the variables, the p-values and the standard deviations.

Table 5 Linear Regression on Obligatory Policy

	Model 1	Model 2
Payback Period	-1.047* (0,907)	-1.217* (0,998)
Cheaper in Future	-0.369 (0,897)	-0.472 (0,976)
Wait for Government Regulations	-0.872* (0,780)	-0.699* (0,857)
Renovation not reflected in Home value	0.851* (0,875)	1.232* (0,921)
Can't afford the renovation	-1.981*** (0,832)	-2.412*** (0,987)
House already energy efficient	-0.291 (0,832)	-0.202 (0,892)
Don't know which measures to take	-0.071 (0,846)	0.039 (0,897)
Don't want to spend money on renovation	1.040* (1,028)	1.487* (1,073)
Takes too much time	1.067* (0,896)	1.121* (0,937)
Measures don't matter for the environment	-1.739* (1,144)	-2.197** (1.123)
I will move soon	3.860*** (1,493)	3.637*** (1.680)
I don't think renovation is necessary	1.125* (0,984)	1.214* (1.022)
My house is unsuited for renovations	0.731 (1,131)	0.910* (1.211)
My neigbours don't do renovations	-0.184 (0,913)	-0.297 (0.948)
Renovations will cause a mess	0.017 (1,370)	0.399 (1.465)
My partner does not want renovations	1.862* (1,709)	1.911* (1.870)
Environmentally consciousness		0.349 (1.648)
Need help from the government		-2.039
Age		-2.071* (2.936)
Household composition		2.492* (2.828)
Already done renovations		5.360* (4.097)
Constant	15.541*** (6,963)	22.120* (13.686)

Note: unstandardized regression coefficients with standard deviations in brackets
*** p <0,05, **p<0,10, *p <0,

4.6 'Lending Space' as Dependent Variable

Lastly, this research will determine the relationship between the independent and control variables and the dependent variable, in this case, *Lending Space*. Therefore, it will analyze the different barriers' influence on homeowners' preferences for a policy that makes it easier to loan money for energy-efficient renovations. Like *Subsidies*, *Information Provision*, and *Obligatory Policy*, this research will run two different models on the dependent variable. Model 1 will not incorporate the control variables, while Model 2 will incorporate the control variables of this research.

Model 1 has an adjusted R-squared of 0,1770, which means that the independent variables explain around 17.70% of the variability in the dependent variable *Obligatory Policy*. Therefore, this model has a moderate level of explanatory power.

Furthermore, the p-value of model 1 is 0,0060, which indicates the overall statistical significance of the regression model. The p-value of model 1 is lower than the commonly used significance level of $p < 0,05$, suggesting that regression model 1 is statistically significant.

Also, the F-statistic for the model is 2.36, which measures the overall fit of the regression model. This value is higher than the critical value associated with a significance level of $p < 0,05$, which means that the null hypothesis can be rejected and that the independent variables have a significant effect on the dependent variables.

The regression equation of Model 1, with *Lending Space* as the dependent variable, is the following:

*Lending Space = 27.520 - 1.580 * Payback Period - 0.124 * Cheaper in Future + 0.765 * Wait for Government Regulations + 0.697 * Renovation not reflected in Home value + 1.682 * Can't afford the renovation + 1.067 * House already energy efficient - 2.892 * Don't know which measures to take + 0.087 * Don't want to spend money on renovation + 0.694 * Takes too much time - 1.042 * Measures don't matter for the environment + 0.370 * I will move soon*

- 0.250 * I don't think renovation is necessary + 0.068 * My house is unsuited for renovations - 0.605 * My neighbors don't do renovations - 0.569 * Renovations will cause a mess - 0.498 * My partner does not want renovations

Model 2 has an adjusted R-squared of 0,1844, meaning that the independent variables can explain approximately 18.4% of the variation in *Lending Space*. The adjusted R-squared value suggests that the independent variables have a moderate effect on predicting the value of the dependent variable. Furthermore, the F-statistic of this model, $F(21,78) = 2,07$, associated with a p-value of 0,0114, which is lower than a conventional significance level of 0,05, shows that the overall model is statistically significant. Because of this information, this research can reject the null hypothesis and conclude that there is a relationship between the independent and the dependent variables.

Model 2, with *Lending Space* as the dependent variable, and the addition of the control variables, has the following regression equation:

Lending Space = 34.697 - 1.492 * Payback Period - 0.542 * Cheaper in Future + 0.993 * Wait for Government Regulations + 0.540 * Renovation not reflected in Home value + 1.904 * Can't afford the renovation + 0.931 * House already energy efficient - 2.991 * Don't know which measures to take - 0.257 * Don't want to spend money on renovation + 0.794 * Takes too much time - 1.067 * Measures don't matter for the environment + 0.856 * I will move soon - 0.385 * I don't think renovation is necessary - 0.168 * My house is unsuited for renovations - 0.832 * My neighbors don't do renovations - 0.509 * Renovations will cause a mess - 0.822 * My partner does not want renovations + 1.003 * Environmentally consciousness - 4.446 * Need help from the government + 2.018 * Age - 4.070 * Household composition - 0.272 * Already done renovations

In model 2, the independent variable *Can't afford the renovation* has a regression coefficient of 1.904, with a p-value of less than 0,05, which means this coefficient is statistically

significant. The variable *Can't afford the renovation* measures to what extent the barrier 'I cannot afford an energy efficient renovation' plays a role in the decision-making process of homeowners.

The regression coefficient of 1.904 means that the dependent variable *Lending Space* is expected to increase with 1.904 on the 0-100 scale when the independent variable *Can't afford the renovation* increases with one unit on the 1-8 scale. Therefore, this regression coefficient indicates a positive relationship between the independent- and dependent variable.

In the context of this research, this positive relationship means that if homeowners value the barrier 'I cannot afford an energy-efficient renovation' higher, they are more likely to prefer a policy that will make it easier to loan money for an energy-efficient renovation.

In model 2, the independent variable *Don't know which measures to take* has a regression coefficient of -2.991, with a p-value of less than 0,05, which means that this regression coefficient is statistically significant. The variable *Don't know which measures to take* measures to what extent the barrier 'I do not know which measures to take for my house' plays a role in the decision-making process of homeowners.

The regression coefficient of -2.991 means that the dependent variable *Lending Space* is expected to decrease with 2.991 on the 0-100 scale when the independent variable *Don't know which measures to take* increases with one unit on the 1-8 scale. Therefore, this regression coefficient indicates a negative relationship between the independent- and dependent variable.

In the context of this research, this positive relationship means that if homeowners value the barrier 'I do not know which measures to take for my house' higher, they are less likely to prefer a policy that will make it easier to loan money for an energy-efficient renovation.

When comparing the two models, Model 2 has a higher value of the adjusted R-squared (0,1844) compared to Model 1 (0,1770). Because of this higher value of the adjusted R-squared, Model 2, the model with the control variables, explains a slightly more considerable proportion

of the variation in *Lending Space*. Therefore, adding the control variables improves the overall explanatory power of Model 2 when comparing Model 2 to Model 1.

On the other hand, the F statistic for Model 2 (2,07) is slightly lower than the F-statistic for Model 1 (2,36). Both models are statistically significant, but Model 2 shows an overall better fit to the data.

Table 6 will provide all the regression coefficients of the variables and will also include the associated p-values and standard deviations.

Table 6. Linear Regression on Lending Space.

	Model 1	Model 2
Payback Period	-1.580*** (0,769)	-1.492** (0.835)
Cheaper in Future	-0.124 (0,760)	-0.542 (0.816)
Wait for Government Regulations	0.765* (0,678)	0.993* (0.717)
Renovation not reflected in Home value	0.697* (0,742)	0.540* (0.770)
Can't afford the renovation	1.682*** (0,706)	1.904*** (0.825)
House already energy efficient	1.067* (0,706)	0.931* (0.746)
Don't know which measures to take	-2.892*** (0,717)	-2.991*** (0.750)
Don't want to spend money on renovation	0.087 (0,872)	-0.257 (0.897)
Takes too much time	0.694* (0,759)	0.794* (0.783)
Measures don't matter for the environment	-1.042* (0,970)	-1.067* (1.028)
I will move soon	0.370 (1.266)	0.856 (1.404)
I don't think renovation is necessary	-0.250 (0,834)	-0.385 (0.854)
My house is unsuited for renovations	0.068 (0,959)	-0.168 (1.013)
My neighbors don't do renovations	-0.605* (0,774)	-0.832 (0.793)
Renovations will cause a mess	-0.569 (1,162)	-0.509 (1.224)
My partner does not want renovations	-0.498 (1,449)	-0.822 (1.563)
Environmentally consciousness		1,003 (1,378)
Need help from the government		-4,446 (3.880)
Age		2,018 (2.454)
Household composition		-4,070 (2.364)
Already done renovations		-0,272 (3.425)
Constant	27.520*** (5,903)	34,697 (11.442)

Note: unstandardized regression coefficients with standard deviations in brackets
*** p <0,05, **p<0,10, *p <0,5

Chapter 5. Discussion

This chapter will analyze and interpret the findings from the quantitative analysis conducted based on the survey results. By doing this, this chapter will answer the research question and hypotheses. In addition, this chapter will contribute to fulfilling the research objectives.

5.1 Interpretation of the General Findings

From the survey results, this research found that the policy that entails more subsidies for homeowners is the most popular among homeowners, which means that this is the preferred policy option. The policy option that entailed providing more information to homeowners was the second most popular among homeowners, which means that homeowners need more information on energy-efficient renovations. The need for information is preferred over the policy alternative, which entails more possibilities to loan money for energy-efficient renovations. In contrast, the obligatory policy option in the questionnaire was valued the lowest by the homeowners, which means that an obligatory policy is the least popular among homeowners in this research. These results correspond with the findings by Braun and Giraud (2008), who found that homeowners will always prefer indirect incentives in the form of financial or communicative incentives over obligatory measures, which explains why the obligatory measure is the least preferred policy alternative among homeowners in the sample of this research.

Based on the literature, it was expected that the financial incentives, namely subsidies and loans would be the two most popular policy alternatives. However, the communicative measures were more popular than the policy that would make it easier to loan money for energy-efficient renovations. This preference for information above loaning money among homeowners can result from the fact that homeowners have an aversion to loaning money for energy-efficient renovations (Weiß et al., 2012). In addition, the analysis shows that the barrier

that homeowners did not know which measures to take from their house was also one of the most important barriers for homeowners. Because of this barrier, homeowners will be more inclined towards a policy that will provide them with more information about the energy-efficient renovations.

Regarding barriers homeowners experience when doing energy-efficient renovations, the most significant barrier respondents from this research experience has to do with the payback period of an energy-efficient renovation. This barrier entails that homeowners want to avoid doing an energy-efficient renovation because they think the payback period of the investment is too long. This payback period entails that the initial investment of an energy-efficient renovation is relatively high. However, the higher energy efficiency of the house means that the investment should repay itself in the long term because of lower energy bills. This barrier entails that homeowners encounter problems because they think it takes too long to make the initial investment profitable. As mentioned before, homeowners have a strong aversion to delayed gains, which means that homeowners would rather see the investment pay off in the short term than in the long term (Wilson et al., 2015, p. 13). Therefore, the findings in this research about the payback period of an energy-efficient renovation correspond with previous literature on the aversion against delayed gains among homeowners.

5.2 Interpretation of the Findings on *Subsidies*

From the survey results, this research found that there is a positive relationship between the dependent variable *Subsidies*, which measures the preferences of homeowners for a policy that gives more subsidies for energy efficient renovations, and the independent variable *Can't afford the renovation,* which measures to what degree homeowners see the barrier 'I cannot afford an energy efficient renovation' as an essential barrier in their decision-making process. Therefore, a positive relationship between these two variables means that when homeowners consider the affordability of an energy-efficient renovation as a more significant barrier, they

are more likely to prefer a policy that constitutes giving out more subsidies for these renovations. These findings from the survey correspond with previous literature on this subject. As mentioned before, Braun and Giraud (2008) that financial instruments, in this case, a subsidy, can give homeowners a material advantage for doing an energy-efficient renovation. The subsidy will give the homeowner a material advantage to do the energy-efficient renovation because the homeowner will have more financial means for this investment. Therefore, when homeowners see affordability as a barrier, they need a financial incentive to alleviate this barrier that occurs because of the affordability of the investment. Because of this, homeowners will prefer a policy that will give them this financial incentive because this will tackle the issues they encounter with the affordability of energy-efficient renovations.

In addition, there is also a positive relationship between the independent variable *Payback Period*, which measures to what degree the barrier 'I think the payback period is too long' plays a role in the decision-making process of homeowners, and the dependent variable *Subsidies*. The payback period entails how long it will take until the benefits of having a more energy-efficient home pay for the initial investment to do these energy-efficient renovations. Therefore, if homeowners see the length of the payback period as too long, they are more likely to prefer a policy that will give them more subsidies. In the context of the payback period, this positive relationship between the two variables makes sense because subsidies give homeowners additional funding when investing in an energy-efficient renovation, which means they have to use less of their own money for the energy-efficient renovation. Because of this, the initial investment for the energy-efficient renovation will be lower than it would be without subsidies. Because the initial investment is lower, the payback period of the investment will be less extensive because the investment's gains will stay the same. Therefore, homeowners that see the length of the payback period as an issue would like to see this payback period reduced and, therefore, will prefer a subsidy as a policy to help reduce the length of the payback period.

The independent variable *I will move soon* has a negative relationship with the dependent variable, *Subsidies.* This independent variable entails to what degree homeowners see the fact that they will move soon as a barrier to energy-efficient renovations. In the context of this research, this negative relationship means that if homeowners see that they will move soon as a more significant barrier, they have a lower preference for the policy that entails more subsidies. This relationship can be explained because homeowners that will move soon are not likely to do energy-efficient renovations to their current house, even if they receive subsidies for doing these renovations. Therefore, subsidies will not be their preferred policy if they move soon.

5.3 Interpretation of the Findings on Information Provision

The independent variable *Don't know which measures to take* has a positive relationship with the dependent variable *Information Provision*. This positive relationship between the two variables means that if homeowners see ignorance about what energy-efficient measures to take for their house as a bigger barrier, they are more likely to have a higher preference for a policy that entails more information provided by the Dutch government to homeowners. Therefore, homeowners have a higher preference for a communicative incentive instrument when they are ignorant about which measures to take to make their house more energy efficient. This barrier of ignorance about energy-efficient renovations can be defined as a behavioral barrier by Hesselink and Chappin (2019). This lack of awareness about what measures to take can be a significant barrier for homeowners. However, communicative instruments can cause homeowners' interest in energy-efficient renovations to increase (Weiß et al., 2012, p. 411). In the hypotheses of this research, it was hypothesized that communicative instruments would effectively alleviate the barrier of ignorance. This relationship is reflected in the positive relationship between the ignorance barrier and the preference among homeowners for a policy that will provide them with more information.

In addition, the independent variable *Can't afford the renovation* has a negative relationship with the dependent variable *Information Provision.* This negative relationship between the variables means that if homeowners see the affordability of energy-efficient renovations as a more significant barrier, they have a lower amount of preference for a policy that entails more information provision by the government. This relationship can be explained by the fact that homeowners in the questionnaire must divide a limited amount of points among the four different incentivizing policies. As mentioned before, when homeowners see affordability as a significant barrier, they are more likely to prefer a policy that gives them more subsidies. Therefore, if homeowners think affordability is a significant problem, they are not worried about getting more information about the renovations but more worried if they can even afford the renovation. Therefore, based on the questionnaire results, homeowners are less likely to prioritize a communicative instrument as an incentivizing policy when they see affordability as a problem. In contrast, they are more likely to prefer a financial incentive in this scenario.

5.4 Interpretation of the Findings on Obligatory Policy

The independent variable *Can't afford the renovation* has a negative relationship with the dependent variable *Obligatory Policy.* In the context of this research, this negative relationship means that if people see the affordability of the renovations as a more significant barrier, they are likely to have a lower preference for the policy alternative with an obligatory character. These results from the research are quite logical. After all, when homeowners cannot afford an energy-efficient renovation, they will not prefer it if these renovations are obligated because they cannot afford them at this moment. Therefore, if the renovations became obligated, they would have significant troubles financing it, which explains why homeowners with trouble with the financing have a lower level of preference for an obligatory policy.

5.5 Interpretation of the Findings on Lending Space

The independent variable *Can't afford the renovation* has a positive relationship with the dependent variable *Lending Space.* In the context of this research, this positive relationship means that if people see the affordability of energy-efficient renovations as a more significant barrier, they are more likely to express their preference for a policy that will make it easier to loan money for these energy-efficient renovations. Just like with the subsidy policy, giving people more access to loans for energy-efficient renovations gives them a material advantage for doing an energy-efficient renovation. Receiving this material advantage will appeal to homeowners, resulting in them expressing more preference for this specific policy. Therefore, this policy gives a financial incentive to homeowners by contributing to the material needs of the homeowners, therefore, giving the homeowners a material advantage for doing an energy-efficient renovation (Braun & Giraud, 2008).

Secondly, the findings suggest that the independent variable *Don't know which measures to take* has a negative relationship with the dependent variable *Lending Space*. This negative relationship means that if homeowners see the fact that they do not know which measures to take for their house, so they experience a lack of information, they are less likely to prefer a policy that entails more accessibility to loans for energy-efficient renovations. These findings link to the fact that these homeowners have more need for communicative incentives than financial incentives. This preference is mainly because a financial incentive will not eliminate the problems with the information barrier homeowners encounter when doing energy-efficient renovations. Therefore, it is not an effective policy alternative to alleviate this barrier of a lack of information. In contrast, homeowners will prefer a communicative policy alternative that will provide them with more information on the energy-efficient renovation and, therefore, alleviate the informational barrier. This preference becomes apparent when the variable *Information Provision* is the dependent variable because there is a positive and

significant relationship between *Don't know which measures to take* and the dependent variable *Information Provision.*

Chapter 6. Conclusion

6.1 Limitations

Concerning this research, there are also several limitations that may influence the outcomes and the interpretation of this study. It is important to acknowledge these limitations in order to properly take into the account the possible constraints of this study when interpreting the results. Therefore, this section will cover these limitations and their possible effects on the overall findings and the interpretation of the results.

First of all, a limitation of this research is the relatively small sample size, namely, a sample size of 102 respondents. Even though efforts have been made to ensure the robustness of the study, the sample size of 102 is relatively small when you compare it to the population of Dutch homeowners. The sample is relatively small because there are around 156 thousand owner-occupied homes in the Netherlands, which means a larger sample of Dutch homeowners would contribute to the generalizability of the findings of this research. Therefore, the findings of this research should be interpreted with caution, because the small sample size might negatively affect the generalizability of the results over the whole population of Dutch homeowners.

As mentioned before, the representativeness of the sample is also a problem because Zeist and Amsterdam have a relatively high income compared to the rest of the country, which means that they are more willing to do a energy-efficient renovation.

Secondly, in this research the linear regression model is utilized in order to analyze the data obtained from the questionnaires distributed among 102 Dutch homeowners. Using a linear regression model can give conclusions about the association between the variables, in this scenario, the association between the barriers homeowners experience, and their preferences

for incentivizing policies. However, a linear regression model cannot give definitively determine causality between these variables. In order to achieve definitive conclusions about the causal relationship between the barriers to energy-efficient renovations and the preferences for policies, further research would be necessary.

Thirdly, another noteworthy limitation of the results from this research is that all the regression coefficients have relatively low values. The significant regression coefficients did not reach values higher than 10. Because the preference variable is measured from zero to 100, these regression coefficients are relatively low. Therefore, even though some of the regression coefficients were statistically significant, the magnitude of these regression coefficients was relatively low. In the context of this research, this low magnitude means that if a barrier increases one point on the zero to eight scale, the preference for policy only changes a few points on the zero to 100 scale. In short, although there are significant regression coefficients in the results of this research, the low magnitude of this coefficient raises questions about the overall meaningfulness of the observed relationships. Therefore, the models used in this research might have limited ability to explain large variations in the outcome variable, which means that the overall effect of the barriers on the preferences for policy might be low.

Fourthly, the statistical models of this research do not take into account that homeowners can only divide a limited amount of points among the different policy alternatives, and therefore, this could negatively influence the validity of the results of this research. Therefore, future research should design a model where this is considered in order to find more reliable results. In order to achieve this, future research could apply the fractional multinomial logit model, which accounts for the fact that only a limited amount of points can be divided among several options.

6.2 Research Objectives

This research set out the objective to find out what relationship there is between the barriers homeowners face for doing energy-efficient renovations, and their preferences for incentivizing policies. In order to examine this relationship, surveys were distributed among homeowners that asked them about their preferences and barriers. On the basis of the data of these surveys, a statistical analysis was conducted to examine the relationship between the barriers and the preferences of homeowners.

The main findings of the research suggest that there is a positive relationship between financial barriers and preferences for financial incentives. Therefore, homeowners are more likely to prefer financial stimulating measures if they experience financial barriers when it comes to doing energy-efficient renovations. Therefore, when it comes to the financial aspect of the renovations, the findings of this research suggest that there is a significant relationship between the barriers and the preferences for policy.

In addition, obligatory policies are also the least popular type of incentivizing policies when it comes to energy-efficient renovations. These obligatory policies also have a negative relationship with financial barriers, which means that homeowners will decrease their preference for obligatory policies when they experience financial barriers.

Lastly, the research also found that often homeowners need more information about energy-efficient renovations, which means that the information barrier is significant in their decision-making process. The findings of this research suggest that homeowners that experience information barriers, have a higher preference for communicative incentivizing policies, which means policies that provide them with more information about the renovation.

Therefore, the findings of this research suggest that there is a relationship between barriers and preferences for policy in the context of energy-efficient renovations. Therefore, the conducted research has fulfilled the set-out research objectives by exploring the relationship between barriers and preferences for policy.

6.3 Implications

When it comes to the main findings of this research, there are many policy implications associated to these findings. These policy implications are essential for Dutch policymakers in designing more effective incentivizing policies to motivate homeowners to do energy-efficient renovations. When more homeowners are motivated to do these renovations, this could be important in reducing the carbon footprint of the residential sector.

Firstly, the positive relationship between financial incentives and preferences for financial incentives is an important consideration for policymakers. This relationship is important for policymakers because it shows that providing financial backing to homeowners can positively affect the financial barriers they experience. Therefore, these findings suggest financial stimulus can motivate homeowners to do energy-efficient renovations because they alleviate financial barriers. However, policymakers will consider the expensiveness of these financial incentives, because providing every homeowner in the Netherlands with a subsidy will cost a substantial amount of money. Therefore, just because homeowners prefer this measure, does not automatically mean that this measure should be the main focus point in designing policy.

In addition, homeowners that don't need a subsidy for financing a energy-efficient renovation can still say that they do need it, and therefore, are not truthful in their response. Therefore, only utilizing financial instruments to incentivize homeowners could have perverse effects because homeowners that don't need subsidies will apply for these subsidies, which will result in additional costs for the government.

Secondly, policymakers should take note that obligatory policies are not popular among homeowners, and therefore, should not be a focus point when designing incentivizing policies. This is mainly because other measures are more preferred among homeowners in the context of energy-efficient renovations, and therefore, are more likely to be effective in motivating

homeowners to do energy-efficient renovations. However, obligatory policies could be necessary to motivate some homeowners in the Netherlands, and therefore, might be an unavoidable measure in order to stimulate energy-efficient renovations in the Netherlands.

Thirdly, policymakers should provide homeowners with more information when it comes to energy-efficient renovations. This would be beneficial to the energy transition because a lot of homeowners experience an information barrier when it comes to energy-efficient renovations, which makes them more reluctant to do energy-efficient renovations. This research also found that homeowners that experience information barriers, are more likely to prefer a policy that focuses on providing homeowners information about renovations. Therefore, if the government provides homeowners with more information about doing an energy-efficient renovation, this would further motivate them to do these renovations.

Therefore, the main implications of this research are that policymakers should devise an incentivizing policy mix that primarily targets the financial and information barriers that homeowners experience.

In order to tackle the financial barriers, policymakers should devise a policy that provides homeowners with further financial backing for doing these energy-efficient renovations. This financial backing should be primarily done through subsidies, because this research finds that this is the most popular incentivizing policy among homeowners. Increasing the loaning possibilities is also a viable option to motivate homeowners, because this research also shows that homeowners that experience financial barriers are more likely to have a higher preference for this type of policy.

In order to tackle the informational barriers, policymakers should design policy that provides homeowners with more appropriate information on energy-efficient renovations. This information would aid homeowners in understanding which measures are effective to undertake for their home and what further steps are necessary for making their house energy efficient. A

significant portion of homeowners have a high preference for these type of measures, so it will be a measure that will be accepted and supported by homeowners.

However, when considering the policy alternatives, the preferences of homeowners are not the only criteria in the decision-making process. For example, the affordability of a policy alternative should also be considered. Homeowners could want a subsidy, but this would be a way more expensive alternative than for example a policy that stimulates homeowners by providing them with more information. Therefore, the costs of a policy alternative is an important factor in deciding whether it is suitable to implement.

As mentioned in the methodology of the research, another important consideration is that homeowners might not answer truthfully in this research. In the context of this research, this means that homeowners that can actually afford an energy-efficient renovation, still would say that they cannot afford it and need a subsidy to finance it. Therefore, this consideration further nuances the outcome of this research.

6.4 Potential future research

As mentioned in this research, making the owner-occupied sector more energy-efficient and climate proof will be an important factor in achieving the climate goals. Therefore, it is essential to further expand the knowledge what drives homeowners to do energy-efficient renovation. In contrast, it is also essential to understand what withholds them from doing these renovations.

Future research should focus on a more experimental approach, where certain neighborhoods serve as a test-case for different policies. By applying this experimental design, researchers and policymakers will gain a more comprehensive understanding of which policies actually help in stimulating homeowners. For example, when a certain area gets more consulting and information on doing energy-efficient renovations, it would be interesting to see if this area does more energy-efficient renovations.

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