The Process of Sustainable Measures Installation for Dutch Homeowners: A Comparison Between Net Worth Groups

MAX EMILIAN SPOELSTRA

Master Thesis
Real Estate Studies

University of Groningen
Faculty of Spatial Science

August 22nd, 2021

COLOFON

Title	Affordability of Sustainable Measures Installation for Dutch Homeowners: A Comparison Between Net Worth Groups
Version	2
Author	Max Emilian Spoelstra
Supervisor	Dr. Xiaolong Liu
Assessor	Dr. Michiel Daams
E-mail	m.e.spoelstra.1@student.rug.nl
Date	August 22nd, 2021

Abstract

At the current rate of greenifying, the Netherlands will not achieve its goals regarding carbon emission reduction. Greenifying is, however, seen by the public to be a thing of the rich. This paper utilizes binomial logistic regression to statistically infer the odds of falling in a specific net worth group (above/below median) with regards to greenifying capability. Additionally, the willingness to install green measures is investigated by net worth group. Data from the WoON 2018 survey is used, which includes factual info as well as convictions of the respondent. The above median net worth group has a decrease in relative odds of finances being a reason for not greenifying by 49.3% compared to the below median net worth group. Willingness to install green measures is unrelated to net worth group and is dependent on personal characteristics. Financial reasons are thought to be the largest determinant in the willingness to greenify, yet the decision is made opportunistically mostly due to maintenance needs or general inaction. Policymakers are recommended to increase financial supports towards lower net worth households, and as there is limited attention towards existing buildings, shift away from the focus of sustainability in new buildings towards existing ones.

Keywords: climate, greenifying, homeowners, the Netherlands, net worth, ability, willingness

Table of Contents

1. INTRODUCTION

1.1. Motivation

The climate is changing; increased human influences on Earth have already caused a rise of one degree Celsius since the Industrial Revolution, which will increase to 1.5 degrees Celsius by 2052 (IPCC, 2014). To reduce the effect of humanity on the climate, there have been initiatives from policymakers from the latter part of the 20th century to curb CO2 emissions. The first policy articles were introduced in the latter part of the 1970s as a result of the oil crisis, which applied to the energy efficiency of buildings. The first landmark event with quantifiable goals was the Kyoto Protocol agreement, where the Netherlands, among 14 others, agreed to reduce their CO2 emissions by 6% by the period of 2008-2012 with 1990 as the index date. In September of 2013, the Dutch government announced their success in keeping to the agreement with a reduction of 6.4% in carbon emissions (PBL, 2013). The Paris Climate Agreement signed in 2016 has been the next landmark event in the growing awareness of society and policymakers alike, following in the footsteps of the Kyoto Protocol agreement, confirming that climate change is one of the biggest challenges of modern history. With substantially more ambitious goals, it aims to keep the increase in temperature 'well below 2 degrees Celsius compared to pre-Industrial levels'. The European Union (EU) quantified these ambitions by aiming for a 55% reduction in greenhouse gas emissions by 2030, and by 2050, the EU aims to have completely shifted its energy usage towards renewable sources.

Naturally, the Netherlands has introduced policies to strive towards the same goal. By 2030 a large share of the proposed goal is estimated to be completed (Ministerie van Economische Zaken en Klimaat, 2021). However, in the housing sector, the proposed goals will not be met were the current rate of change to continue. This is a major issue for the attainment of climate neutrality by 2050, as 36% of total CO2 emissions in the EU are from existing buildings (Filippidou et al., 2017). In 2018, energy use from residential households in the EU was 26% of total energy expenditure (Eurostat, 2018), indicating a pressing need to catch up to ambitions in this sector.

Policy measures in the Dutch setting for energy efficiency have been known since the latter part of the 20th century in the form of building decrees (Boot, 2009). More recent developments include the creation of the 'energy label' in 2008, with the purpose of identifying the energy efficiency of existing housing stock. The labels range from A++++ (most efficient) to G (least efficient) (Milieucentraal, 2021a). The adoption of this label has increased over the years following its inception, with most of the labels given to rental properties. The average energy label for a Dutch house was C in 2018 (Rijksoverheid, 2019). At the current rate of change, a Dutch house is expected to have an A label as the national average by 2055 (Marlisa, 2021). This is due to the slow adoption of energy efficient measures in the existing housing stock. However, the newly built housing stock receives more focus from policymakers which results in near-zero emissions in this field (Filippidou et al., 2017). Nevertheless, renovation of the

existing housing stock as opposed to demolishing is considered a much more sustainable option when compared on a life cycle basis (Itard & Klunder, 2007), and is also considered the 'trump card' to reach the EU's goals of lower emissions (Saheb et al., 2015). However, only half of the homes in the period of 2013-2018 have had sustainable measures installed (de Groot & Ryszka, 2019). One-third of this group that did not greenify thinks that their house is already energy efficient. Only 44% of this group does in fact live in an energy efficient home (energy label B or higher), and 14% lives in an energy inefficient home (energy label F or lower).

The 'lag' of results versus the set goals are thought to lie in a two-way split: the rich and poor socio-economic classes (Marijnissen, 2018; de Groot & de Waal, 2020; RTL Nieuws, 2017). Also, because of a 'laissez-faire' attitude of the Dutch government towards supports in household greenifying, the rich are thought to utilize the opportunity more than the poor. Energy efficient measures save money in the long run, and thus propose a net gain for the homeowner which has the funds to pay for greenifying measures such as solar panels, heat pumps and insulation. As these are capital intensive investments, the poor do not have the funds available to pay for them and are left behind, simultaneously making the sustainability goals of the Dutch government harder. For example, a lower net worth household with a higher energy bill caused by a less energy efficient house is barred from installing energy efficient measures as they have no free capital to invest. A higher net worth household, however, generally has more free capital available and therefore has the possibility to install such measures. By doing this, the higher net worth household increases their energy savings which cause them to free up more capital. This 'snowball effect' is not immediately present for lower net worth households, as their installation procedure often involves taking out loans on which they pay interest.

From these indications it becomes clear that, while the Dutch government is invested in reducing their carbon emissions over the long run, its policy is leaving much needed emission savings on the table to achieve the goals set by themselves and the EU. This research focuses specifically on the Dutch homeowner context in the installation of energy efficient measures by exploring different net worth groups from a financial perspective.

1.2 Literature review

Net worth is seen as the amount of value which remains after subtracting liabilities from assets. This, along with a household's income, provides a snapshot of a person or entity's financial position (Ganti, 2021). As it is a proxy of financial position, the general availability of funds for greenifying purposes can be derived from it. As such, it is used as a focal point of the paper.

Sustainability has many facets. Jongbloed (2004) describes sustainability as:

"*The developments which connect to the needs of the present day without endangering the ability of future generations to fulfill their own needs."*

The interpretation of this definition can be ambiguous. A more practical definition of sustainability is the "triple bottom line" of balanced developments regarding social, economic and ecological needs. The catchphrase in this definition is "People, Planet & Prosperity" (Nijhoff, 2010). Sustainability, in the context of this paper, is meant as the amount of energy/gas a house uses. By greenifying, the homeowner increases the efficiency of their house in using these resources. This is beneficial for people, as it increases their standard of living by higher comfort. It benefits the planet, as the pressure on finite resources such as gas and oil decreases and benefits prosperity in increasing the standard of living for people who have installed sustainable measures as well as creating jobs for the parties which install these measures. Thus, the greenifying of homes is a perfect fit for the issue of sustainability. The financial costs which are incurred now will cause a net positive effect in the future.

As a concrete example, these energy efficient measures allow for savings and provide short payback periods on their installation (EST, 2011). Increased comfort in the home provided by effects such as thermal insulation and condensation reduction is also experienced (Jakob, 2006). For example, a house with floor and wall insulation experiences less draft than a house without it, making the need for constant heating less necessary which saves on bills while increasing experienced comfort. In the Netherlands, the attitude towards energy efficient measures is generally positive (Ebrahimigharehbaghi et al., 2019).

A study regarding greenifying of the affordable housing sector suggests that low-cost sustainable housing is more cost effective with regards to net present value than conventional building methods (Bradshaw et al., 2005). Yet, lower income categories are not adopting energy efficient technologies as well as their higher income counterparts in some EU countries (Schleich, 2019). The Netherlands was not included in this research. This supports the argument that, while homeowners are willing to install sustainable measures in their house, the ability of doing so is mostly dependent on finances and therefore less attainable for households with low funding. In the Dutch context, homeowners are expected to carry much of the costs up front for more beneficial returns later. One such example is the "salderingsregeling" (netting arrangement) for energy created from solar panels or other green sources. Under this policy, energy which is supplied back onto the grid can be netted one-to-one with the energy used from the grid.

This leads to lower electricity costs, decreasing the payback period. Other financial subsidies are available, but most are only given when the greenifying project is already finished, and little subsidies are given up front. This however depends on the municipality and their budget towards homeowner greenifying (Milieucentraal, 2021b). For example, the municipality of Leeuwarden has an additional subsidy for installing insulation on top of the one already given by the government. This subsidy is made available for all homeowners in the province of Friesland. Therefore, it also depends on the region a person lives in whether the financial barriers are present. In the WoON 2018 dataset however, which will be used for the empirical analysis, the sample is representative of the population and therefore gives an average of all availabilities of subsidy in the Netherlands. Why this is the case will be covered in section 2.

Homeowners, in contrast to renters, experience different user costs for housing (Poterba, 1984). Renters' user costs are simply the monthly rent, while the homeowners' user cost function consists of more factors. Due to this divide, the motivations between the two groups for greenifying their homes will be different. As an example, capital gains decrease the user cost for the homeowner but not the renter. Making the house more energy efficient increases the value of the home, which will not be beneficial to the renter, as they do not own the property itself, while the homeowner does experience the positive effect. Because of this inherent divide, the two groups cannot be seen as homogenous for research purposes. Renters' greenifying options are therefore very limited from a financial gain perspective alone. As the goals set by the EU and the Dutch government alike cannot be attained with the current speed of adoption in existing buildings, the question becomes where the points of improvement are. Earlier research suggests that the main driver of willingness to install sustainable measures is dependent mostly on quality-of-life improvements, such as increased heating efficiency (Ebrahimigharehbaghi et al., 2019). The practical financial attainability of installing these measures is not extensively researched. Earlier literature regarding the financial impact of sustainable measures on homeowners is however more prevalent in the European setting. Vringer et al. (2016) conclude that the Dutch policy measures are sufficient for new builds, while the existing housing stock needs "a more compelling policy", such as tax breaks for houses which have better energy labels.

The 'low-cost hypothesis' by Diekmann & Preisendorfer (2003) suggests that the environmental actions a person undertakes increase when costs and inconveniences decrease. In a U.K. study, motives for the decision in household greenifying were dominated by the resulting financial impact (Caird & Roy, 2010). This indicates that financial incentives should be leading for households, especially those which are in a lower financial position. For Dutch homeowners, the costs of installing sustainable measures are higher than renters (EIB, 2018). However, the potential savings are also higher for homeowners. This creates a larger initial hurdle for homeowners to overcome.

Contrary to these indications, the initiative of installing sustainable measures does not seem to rely solely on financial factors. I&O Research (2019) find that, when the installation of a heat pump is fully subsidized, only 36% of households is willing to install it within two years. Even when households have enough savings to finance energy efficient measures themselves, only 42% of this group is willing to install them. Financial stimuli are therefore important to make the installation of energy efficient measures a possibility, however it is not the sole proprietor of the decision to go forward with the construction.

Information asymmetry is also a commonly identified barrier to the decision-making process of a person (Wilson et al., 2015). Lack of credible information, information availability, misperceptions on costs and contractor reliability are stated factors in this. Additionally, decision making barriers such as the problematic view on construction activities, causing disruption to the household, are also considered.

1.3. Research problem statement

Based on the previous literature it is seen that the research regarding progress of sustainable measures, both in their capabilities of energy saving and the factual share of green installations, is well-researched. A practical view on what drives homeowners to make the decision is however underrepresented. On one hand, the financial incentives are taken as the main factor in Vringer et al. (2016) and general theories such as the 'low cost hypothesis' by Diekmann & Preisendorfer (2003). On the other hand, the comfort in the home is seen as the largest factor in Ebrahimigharehbaghi et al. (2019) and Jakob (2006). This, as well as the disparity between poorer and richer countries in the broader context (Schleich, 2019), gives motivation to explore the divide between net worth groups in a more contextual setting. All in all, the observations and discoveries in the broader (mostly EU) setting regarding greenifying and green energy lends credibility to more specific research for individual countries, specifically between measures of wealth and its implications.

Therefore, the research aim of this study is to explore the divide between the higher and lower net worth categories in greenifying of owner-occupied property in the Netherlands. Doing so would expand the current literature into the Dutch context compared to a more general EU view, which leads to more concrete suggestions for Dutch policymakers. Because of this focus, the central research question is as follows: *What is the impact of net worth group on the greenifying process of Dutch owner-occupied property?*

The central research question will be answered using three sub-questions.

In some EU countries it is observed that lower incomes are not adopting greenifying measures as much as their higher income counterparts. However, taking income as the sole variable only captures a part of a household's financial situation (Kim et al., 2004). It is recommended to take both into consideration when analyzing a households' financial situation. Therefore, this research will take net worth as the focal point in the analysis to amend the focus on income thus far. However, the general conclusion that the financial situation of a household influences the feasibility of installing sustainable measures still holds. Yet, the gravity of this effect is important. If it is indeed a large factor, as the public space suggests, then steps must be taken to reduce the burden on households with a sub-par financial situation. To examine this effect, the first sub-question is formulated as follows:

Sub-question 1: *How important is the inability to pay for greenifying measures for lower net worth Dutch homeowners compared to higher net worth Dutch homeowners?*

This question will be answered with a logistic regression which specifically targets the net worth group variable as the key independent variable. The dependent variable is a binary variable which surveys if the reason for not greenifying is due to the respondent not being able to afford the costs. Note that, due

to the question itself, it already substrates the sample to respondents who do not have sustainable measures installed. This allows for a specific analysis into the sub-question. This sub-question relates to the ability of a homeowner to install sustainable measures.

As the analysis focuses on the divide between net worth, the willingness to install measures which greenify a house should be investigated between these groups. If lower net worth categories show an aversion towards installing greenifying measures, the suggestion becomes to investigate possible ways in which they could increase the enthusiasm in lower net worth households. Therefore, the second sub-question is:

Sub-question 2: *Is there a difference between the net worth categories of Dutch homeowners regarding willingness to install sustainable measures?*

This question will make use of the same logistic regression method as in sub-question 1, however with the use of a different key dependent variable which is the willingness to install sustainable measures. Willingness, in contrast to ability examined in sub-question 1, is another factor in the eventual decision process a homeowner undergoes. Willingness to greenify is generally present among the Dutch populace, yet it remains to be seen whether this applies to both net worth categories equally.

As the higher net worth households have a larger share of sustainable housing than the lower net worth households, it begs the question whether this relationship is purely due to financial reasons. Other reasons than financial ones to install sustainable measures are also a factor in their adoption (Ebrahimigharehbaghi et al., 2019; Asses, 2015). If it shows that the importance of financial barriers is the primary reason to greenify instead of different factors influencing greenifying decision, the suggestion to policymakers by financial argumentation becomes leading. This effectively gives sub-question 3:

Sub-question 3: *What is the importance of financial incentives for Dutch homeowners in installing greenifying measures?*

This sub-question will be answered by recombining different descriptive statistics in the data. This is to verify that willingness and ability to greenify are indeed the factors in determining whether a homeowner took the decision to greenify.

For control variables, the personal factors and house factors will be used. These are known control variable groups in this avenue of literature (van der Borgh, 2020; Asses, 2015; Ebrahimigharehbaghi et

al., 2019). Personal factors include age, education level and satisfaction. House factors include household weight, whether the house is built after 1985 and if the house is well-maintained.
For the personal factors, age and education level are seen as standard socio-economic variables to include (Ebrahimigharehbaghi et al., 2019, Wilson et al., 2015). Satisfaction is included to test whether this influences the economic situation of a person (in particular for Model 1) and if it influences the willingness of a certain person to greenify their house (in particular for Model 2).

In terms of house factors, household weight could be a determinant for the financial situation of a person. For example, a household which contains a couple without kids could be more financially well-off than a household which contains a couple with kids. As kids have a financial impact to a person's life, the household weight is important in determining this. Further, a house built after 1985 is subject to more strict efficiency and building regulations (Boot, 2009) and is less depreciated than a house built before 1985. Therefore, it makes sense to include as a control variable. This ties into the last control variable which is whether the house is well-maintained. When a house is not well-maintained, it could quantify a reason for a homeowner to not invest in sustainable measures. It could also say something about the financial situation of a person, as they might not have sufficient funds to perform maintenance on their property. Therefore, it is included as a control variable.

By looking at the sub-questions one could reasonably assume that by answering these questions the difference between high and low net worth categories in terms of the greenifying process becomes apparent, as well as the importance of finances in general as a factor for greenifying measures. It also distinguishes between three factors in the greenifying process, namely willingness, ability and decision. This results in the following conceptual model:

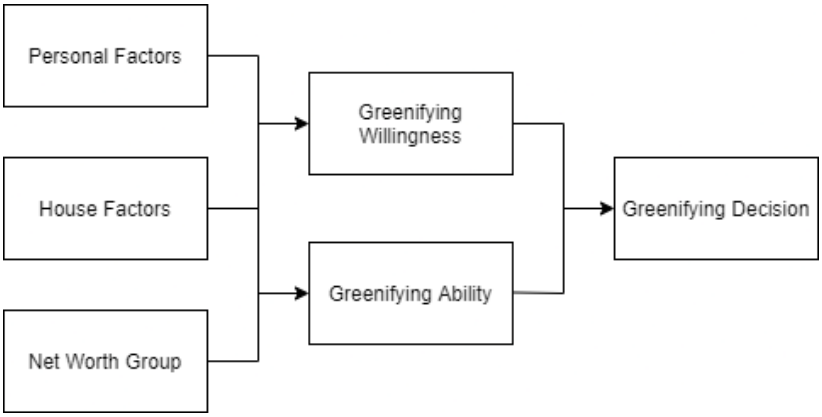

Figure 1. Conceptual model explaining the factors determining the greenifying process for Dutch homeowners.

The remainder of this paper is organized as follows. Section 2 describes our empirical approach. Section 3 describes the data, shows the results of the regressions and discusses the results thereafter. Section 4 concludes, as well as making recommendations to policymakers and covering the limitations of the study.

2. DATA & METHOD

2.1 Context

The dataset used is from the WoON (Woononderzoek Nederland) 2018 survey. This is a triannual survey first taken in 1995, with its latest edition being from 2018. Its goal is to collect information about the living situation of the Dutch population, as well as their wants and needs in terms of housing. The survey also includes questions of personal convictions mainly relating to sustainability and neighborhood (CBS, 2019). In total, 115,000 people were invited to participate in the survey of which 67,523 participated. Data collection took place between August 2017 and May 2018. The data was collected across all of the Netherlands, in which the locations of respondents are known on the municipal level and rate of urbanity. This causes the data to be representative for the whole country.[1]

[1] To increase the transparency of this research, the changes in the variables as well as all the commands which have been used in the statistical analysis are found in the DO file syntax of Appendix 1. This DO file syntax can be used in combination with the statistical program STATA to recreate the empirical analysis, as well as the descriptive statistics of this research. The DO file includes comments which describe the operations which are done by the program. The WoON 2018 dataset is generally available to the public, which makes this research perfectly replicable. In total, the raw dataset contains 67,523 observations and 927 variables. Around 64% (37,898) of the observations are homeowners, the rest are renters or unspecified. All groups but the homeowner group are dropped from the dataset. The following table gives an overview of the resulting homeowner subsample.

2.2 Descriptive analysis

TABLE 1: DESCRIPTIVE STATISTICS

Dutch Homeowner Profile				
Categorical variables	category	frequency	percentage	cumulative %
Age	17-24 y/o	422	1.11	1.11
(six classes)	25-34 y/o	4,299	11.34	12.46
	35-44 y/o	6,181	16.31	28.77
	45-54 y/o	8,272	21.83	50.59
	55-64 y/o	8,243	21.75	72.34
	65-74 y/o	6,883	18.16	90.51
	>75 y/o	3,598	9.49	100
Education level	Low	10,032	26.47	26.47
(three classes*)	Mid	12,243	32.31	58.78
	High	14,908	39.34	98.11
House is energy efficient	Agree	18,080	47.71	47.71
	Neutral	12,824	33.84	81.55
	Disagree	6,994	18.45	100
Continuous variables	mean	st. dev.	median	
Gross Household Income (in euro)	75,306	58,380	64,036	100
Total Net Worth (in euro)	259,144	893,832	143,210	100
Observations		37,898		100

* Uncounted if unknown

The age range of a homeowner respondent in the WoON 2018 survey which is most frequently seen is 45-64 years old. There are little homeowners who are under 25. There is a good mix of education levels with a skew towards higher educated people. Most of the homeowners agree that their house is energy efficient, with only 18.45% disagreeing to this question. The median household income and net worth of homeowners in this dataset is €64,036 and €143,210, respectively.

For the additional data cleaning process, observations were dropped if the education level of the respondent was unknown, if the response to satisfaction level or maintenance level were neutral, or if the answer to "willing to install energy efficient measures" was "don't know". Then, the relevant Likert scale variables (satisfaction level & maintenance level), now without neutral observations, are combined into a "disagree" (containing "slightly disagree" and "disagree") and "agree" (containing "slightly agree" and "agree") binary variable. The two available "yes" options for "willing to install energy efficient measures" are also combined to create a separate "no/yes" binary variable for use in the models. Additional adjustments are made to the byte values of the variables to make them represent generally a "no" for the reference value and generally a "yes" for the alternative value.

TABLE 2: KEY KNOWLEDGE AFTER DATA CLEANING REGARDING SUSTAINABLE MEASURES

Dutch Homeowner Profile				
Categorical variables	category	frequency	percentage	cumulative %
Willing to install sustainable measures	Yes, but only if it recoups the costs	16,581	61.55	61.55
	Yes, also if it does not recoup costs	4,378	16.25	77.81
	No	5,978	22.19	100
Observations		26,937	100	
Biggest reason for installing sustainable measures				
	Necessary due to maintenance	6,831	40.80	40.80
	Investment earns itself back	4,391	26.23	67.03
	To increase comfort	3,341	19.96	86.99
	Because of the environment	1,145	6.84	93.83
	Agreed to in the VVE	179	1.07	94.90
	House will be easier to sell	190	1.13	96.03
	Other reason	664	3.97	100
Observations		16,741	100	
Reasons for not installing sustainable measures (multiple answers possible: n = 7,788)	House is already energy efficient	3,244	41.65	33.75
	I can't afford it	1,143	14.68	11.89
	Savings are insufficient	1,014	13.02	10.55
	Do not know the possibilities	436	5.60	4.54
	Do not want construction	459	5.89	4.77
	VVE does not want it	152	1.95	1.58
	Have not gotten to it yet	1,768	22.70	18.39
	Have plans to move	401	5.15	4.17
	Other reason	996	12.79	10.36
Observations		9,613	123.43*	100

* Total response percentage compared to original sample size of 7,788.

Recouping costs is the major determinant in willingness to install sustainable measures. However, in the actual group which have done these measures, the reason is largely due to opportunity because of necessary maintenance. In the group which did not install sustainable measures, the largest share thinks their house is already energy efficient. The second most answered reason is that they have not gotten to it yet. This implies a certain laxness towards the necessity of installation, putting it off for later. Coupled with the reason of the group that did install sustainable measures, being that it was necessary due to maintenance, the actual decision of homeowners seems to primarily not be due to financial reasons, however this is a prerequisite to go forward with it.

TABLE 3: CROSS-TABULATION OF SUSTAINABLE MEASURES' STATISTICS OVER NET WORTH GROUPS

Dutch Homeowner Profile				
Categorical variables	category	below median	above median	total
Willing to install sustainable measures	Yes, but only if it recoups the costs	9,010	7,571	16,581
	Yes, also if it does not recoup costs	2,144	2,234	4,378
	No	2,291	3,687	5,978
Observations		13,445	13,492	26,937
Biggest reason for installing sustainable measures				
	Necessary due to maintenance	3,456	3,375	6,831
	Investment earns itself back	2,077	2,314	4,391
	To increase comfort	1,652	1,689	3,341
	Because of the environment	396	749	1,145
	Agreed to in the VVE	88	91	179
	House will be easier to sell	104	86	190
	Other reason	360	304	664
Observations		8,133	8,608	16,741
Reasons for not installing sustainable measures (multiple answers possible: n = 7,788)	House is already energy efficient	1,612	1,632	3,244
	I can't afford it	806	337	1,143
	Savings are insufficient	437	577	1,014
	Do not know the possibilities	262	174	436
	Do not want construction	201	258	459
	VVE does not want it	96	56	152
	Have not gotten to it yet	1,057	711	1,768
	Have plans to move	228	173	401
	Other reason	504	492	996
Observations		5,203	4,410	9,613

From cross-tabulating the two different net worth groups, some preliminary indications can be seen. In the willingness to install variable, the below median net worth group is seen to be slightly more willing to install energy efficient measures if it recoups the costs. For the largest reason to install when a responded did install sustainable measures, the environment is a more frequent factor in the above median net worth group. Worthy to note is that the frequency of the people that did install energy efficient measures is higher in the above median net worth group. In the reasons for not installing sustainable measures, not being able to afford it is the third largest reason for below median net worth respondents, while it is the fifth largest reason in the above median net worth group. Again, the number of observations is notable. Below median net worth households are more frequent in this category. This gives the indication that above median net worth households indeed have more energy efficient measures installed, and that the larger below median net worth group is disproportionately affected by not being able to finance the energy efficient measures. An explanation of the increased frequency in "No"

answers to willingness to greenify in the above median net worth group is that this group already has more energy efficient measures installed, as portrayed in the data, and are therefore unwilling to increase the amount of sustainable measures in their home as they already possess a sufficient amount.

TABLE 4: KEY KNOWLEDGE AFTER DATA CLEANING REGARDING MODEL VARIABLES

Dutch Homeowner Profile				
Categorical variables	category	frequency	percentage	cumulative %
Reason no sustainable measures: I can't afford it*	No	6,645	85.32	85.32
	Yes	1,143	14.68	100
Observations		7,788	100	
Willingness to install sustainable measures**	Unwilling	5,978	22.19	22.19
	Willing	20,959	77.81	100
Satisfaction	Unsatisfied	248	0.92	0.92
	Satisfied	26,689	99.08	100
Energy efficient installations	No	16,741	62.15	62.15
	Yes	10,196	37.85	100
Built after 1985 (n = 26,684)	No	16,591	61.59	61.59
	Yes	10,093	37.47	99.06
Maintenance level	Badly maintained	1,000	3.71	3.71
	Well-maintained	25,937	96.29	100
Continuous variables	mean	st. dev.	median	
Total Net Worth (in euro)	264,245.60	883,659.80	146,223	
Observations		26,937	100	

*, ** Dependent variable for model 1 & 2, respectively

Table 4 shows the overview of the variables which will be used in the models. After data cleaning, the new median value of total net worth is €146,223. This value will be used in the two-way split of the key independent variable, which includes the group "below median net worth" (<=€146,223) and "above median net worth" (>€146,223). Also, the two dependent variables are seen to be skewed towards one answer, with "No" (base value) making up 85.32% of the Model 1 dependent variable and "Willing" (alternative value) making up 77.81% of the Model 2 dependent variable. Also, some control variables are subject to low frequencies of answers, specifically the control variables Satisfaction and Maintenance level. For satisfaction, only 0.92% of the total sample size reported that they are unsatisfied with their current living situation. For maintenance level, 3.71% of respondents reported that their house is badly maintained. This can cause reliability issues due to low sample size.

2.3 Binary logistic regression model

The impact of net worth category on greenifying measures is investigated by using a binary logistic regression model. This form of logistic regression is used when the dependent variable is dichotomous in nature (Train, 2001). All independent variables used in this method should either be metric or dichotomous. Because of these reasons, the binary logistic regression fits our data and goals the best.

Firstly, for sub-question 1, the inability to pay for sustainable measures is the central factor. Therefore, the variable "reason no sustainable measures – I can't pay it" is taken as the dependent variable, where a true value represents that the household's ability to pay is indeed the reason of no sustainable measures. For binary logistic regression, the probability of belonging to the "true" category for randomly selected observations are calculated with any combination of independent variables (Cohen et al., 2013).

This choice of dependent variable selects the subsample of people who did not install sustainable measures in their house by default. Next, the net worth groups variable is added as the key independent variable. Personal characteristics (age, education level & satisfaction) as well as house characteristics (household weight, house built after 1985 & house is well-maintained) are added as control variables. This results in the following model:

$$\log\left(\frac{P_{cannotafford}}{1-P_{cannotafford}}\right) = X_{networthgroup} + X_{personalfactors} + X_{housefactors}$$

This model will be known as Model 1.

Next, for sub-question 2, willingness to install greenifying measures is taken as the dependent variable for the model. A true value implies that the respondent is willing to install sustainable measures. The key variable is the net worth groups. The same independent and control variables are used as Model 1, with the addition of a house characteristic, namely if energy efficient measures are already installed. Note that this variable cannot be included in Model 1, due to the subsample in Model 1 only containing houses which do not have energy efficient measures installed. The model is then as follows:

$$\log\left(\frac{P_{willing}}{1-P_{willing}}\right) = X_{networthgroup} + X_{personalfactors} + X_{housefactors}$$

This model will be known as Model 2.

For categorical variables present (age & education level), factor variable conversion is done. This means that each category of the variable is converted to a dummy variable before being tested in the model.

3. RESULTS AND DISCUSSION

In this chapter, the results of the binary logistic regressions from Model 1 and 2 are presented in Table 4. The following discussion will answer the sub-questions chronologically. Model 1 and 2 are the same regarding the independent variables, yet have a different dependent variable. Model 1 seeks to statistically find a relationship between the financial ability of households to greenify their dwelling and, mainly, the net worth group a household belongs to. The personal factors as well as house factors are controlled for, which not only improves the explanatory power from the net worth group variable but could also provide interesting insights if they are deemed significant. Model 2 explores the relationship between the willingness to install these green measures into dwellings of households and the same independent variables. The final findings will then be summarized in Figure 2.

TABLE 4: PREDICTION RESULTS FOR MODELS 1 & 2, LOGICSTIC REGRESSION ESTIMATES

	Model 1	Odds Ratio	Model 2	Odds Ratio
Net worth group (0 = below median)	-0.677368***	0.5079522	0.0344555	1.035056
	(0.078921)		(0.0368263)	
Satisfaction (0 = unsatisfied)	-0.0202201	0.979983	0.9553758***	2.599647
	(0.2542879)		(0.1540818)	
Energy efficient installations (0 = No)			-0.4817333***	0.6177118
			(0.0338083)	
Age (reference = 17-24 y/o)				
25-34 y/o	0.3248669	1.383846	0.2126682	1.236974
	(0.293458)		(0.1999697)	
35-44 y/o	0.3810458	1.463815	0.1547199	1.167331
	(0.2918386)		(0.1972485)	
45-54 y/o	0.3546116	1.425627	-0.0570026	0.9445916
	(0.2910323)		(0.1950625)	
55-64 y/o	0.1285638	1.137194	-0.49535**	0.6093576
	(0.2940744)		(0.19452)	
65-74 y/o	-0.2753696	0.7592915	-1.254015***	0.2853568
	(0.3050531)		(0.1947922)	
Over 75 years old	-0.2654486	0.7668619	-2.315635***	0.0987034
	(0.3182621)		(0.1974502)	
Education level (reference = Low)				
Mid	-0.1498221	0.8608611	0.5172315***	1.677377
	(0.0922493)		(0.0405045)	
High	-0.3176805***	0.7278353	1.058231***	2.88127
	(0.0905806)		(0.0408383)	
Household Weight	0.0000526	0.9999474	-0.00045**	0.9995501
	(0.0003574)		(0.0001902)	
Built after 1985 (0 = No)	-0.7143745***	0.4894982	-0.0300367	0.9704099
	(0.071401)		(0.0346584)	
House is well-maintained (0 = No)	-0.9484028***	0.3873592	-0.0540845	0.947352
	(0.1307075)		(0.0881465)	
Constant	0.4184408	1.51959	0.7282141***	2.071378
	(0.3778636)		(0.2460736)	
Observations	7,707		26,684	
Nagelkerke R-squared	0.084		0.232	
Hosmer-Lemeshow chi-squared	9.53		6.89	

Note: Dependent variable is log of "Reason no sustainable measures – I can't afford it" for Model 1, and log of "Willing to install energy efficient measures" for Model 2.[2] Hosmer-Lemeshow chi-squared does not violate goodness-of-fit test for both models. Standard errors in parentheses with *** , **, * indicating significant at 1%, 5% and 10%, respectively. For the constant, Odds Ratio is estimated baseline odds. There was no issue of multicollinearity in both models.[3]

[2] Because of the skew in dependent variable answer frequencies, the two models suffer from high rates of sensitivity and specificity. A high rate of specificity (99.86%) and low rate of sensitivity (0.71%) is seen in Model 1, whereas Model 2 suffers from a low rate of specificity (29.69%) and a high rate of sensitivity (95.22%). Nevertheless, the models are decent in predicting actual outcomes. Model 1 correctly classifies 85.3% of observations, while Model 2 correctly classifies 80.7% of observations. For an overview of the classification statistics, please consult Table 2 in the appendices.

[3] To test for multicollinearity, the Variance Interest Factor (VIF) of the models are calculated. This shows the reliability of the results, where a value of over 10 strongly implies multicollinearity. A value of 5 is also sometimes taken as the limit for a more conservative indication of multicollinearity (Paul, 2006). Testing for multicollinearity with the VIF is a

In the results of Model 1, belonging to the higher net worth group results in an odds ratio of 0.508, meaning that the odds of a "yes" answer to the reason for not installing sustainable measures being financing is almost halved in the above median net worth group compared to below median net worth group. This result is significant on the 1% level. This indicates that when a house does not have sustainable measures installed, the odds for it being that way due to finances is higher in the below median net worth group. As this is a large reduction in odds, one can assume the less fortunate financial situation one finds themselves in to be a barrier for the adoption of sustainable measures.

Further, the higher educated a person is, the less likely they are to have finances be a constraining factor. This is to be expected, as increasingly educated people have more net worth on average (Maggiulli, 2020). However, age group does not seem to significantly be a reason for not being able to afford sustainable measures. The most intense relative decreases in odds are found in whether the house is built after 1985 and if the house is well-maintained. If a house is built after 1985, the odds of finances being a reason are significantly lower than if it were not built after 1985. The same logic applies to when a house is not well-maintained. Therefore, the reason a person could not afford sustainable measures is dependent on the net worth group, and more broadly, the personal characteristics of that person.

Therefore, to answer sub-question 1 "*How important is the inability to pay for greenifying measures for lower net worth Dutch homeowners compared to higher net worth Dutch homeowners?",* the inability to pay is indeed a significant determining factor in the overall ability for a homeowner to install sustainable measures.

From Model 2, it is seen that net worth category does not significantly influence the willingness to install energy efficient measures. However, in older generations, willingness to install decreases as the person ages. This is in line with previous EU-based literature, as increased age is associated with a negative opinion on climate-related changes to housing (Michelsen & Madelener, 2011). Due to the large share of owner-occupied housing belonging to middle-aged or elderly, as seen in the frequency of ages in Table 1, the increase in the amount of greenifying measures in this section of the housing stock could prove to be a more gradual process. As the outflow of elderly owner-occupied property towards younger generations takes place on one side, the movement of young generations to older generations also causes the 'unwillingness' to diminish over time on the other. Note that this is the case only if the opinions on greenifying measures are kept as people age, and not explicitly linked to age as the sole variable.

recommended method when using logistic regression (Midi et al., 2010). The highest VIF value of the independent variables is wholly contained in the factor variable of "age", where all categories of this factor variable have a VIF of over 5. However, when using age as a scale variable, the VIF of any category from this variable does not exceed 5. This means that it can be said that the age variable does not influence other separate variables. The other VIF values of variables in the models do also not exceed 5, and it can therefore be assumed that the independent variables in the model do not suffer from multicollinearity.

Interestingly, increasingly higher educated people have a large increased willingness to install. This is a difference from the literature, where education level is seen as generally non-significant to slightly positively significant (van der Borgh, 2020; Kastner & Stern, 2015). Being satisfied with one's house also increases the likelihood of being willing to install by a large factor compared to being unsatisfied.

The satisfaction of homeowners in the Dutch housing market has not seen a significant increase with the adoption of sustainable measures (Asses, 2015). Dutch homeowners tend to find larger, more expensive and well-maintained houses located in a neighborhood which they prefer more important than a house's energy efficiency. This is counter-intuitive to our results, where a higher satisfaction of the house increases willingness to install. It could be the case that this relationship only works one way. So, while a person is satisfied with their house, they are more inclined to install sustainable measures, however the addition of these measures to the house do not cause an increase in satisfaction. This gives credibility to the argument that greenifying is a financial decision, as savings will increase but satisfaction will not.

Maintenance level of the home does not seem to influence the willingness. If a house already has energy efficient measures installed, the willingness to install new measures is lower. Further, as household weight increases, the willingness to install sustainable measures decreases. This shows that the willingness to install sustainable measures is not a factor of net worth group outright, but a factor which is more dependent on the personal situation and characteristics of a person.

To answer sub-question 2 "*Is there a difference between the net worth categories of Dutch homeowners regarding willingness to install sustainable measures?",* the willingness to install sustainable measures is not dependent on the net worth group of a person. It relies more on socio-economic characteristics, and the general attitude towards greenifying is positive across the populace.

Financial incentives are a key component in the decision-making process of a Dutch homeowner to greenify. In general, 61.6% of homeowners from the final sample are willing to install sustainable measures but only if it recoups the costs. Net worth group does not seem to be a factor in the willingness to install, as discussed previously. However, the biggest reason homeowners eventually decide to greenify is that their house needed maintenance anyway (40.8%). Financial incentives are also a main decision factor for homeowners (26.23%), as expected from the willingness, yet 'pulling the trigger' on the decision is described better by opportunism from necessary maintenance rather than a conscious financial decision. In the reasons for not installing, this indication continues as most of the responses of people living in unsustainable homes (not having energy efficient measures installed while also not purporting to live in a sustainable house already) is that they "have not gotten to it yet" (22.7%). Not

being able to afford it is the second largest reason (14.68%), which as discussed previously, is primarily present in the lower net worth category. However, the factuality of 'already living in a sustainable house' is disputed (de Groot & Ryszka, 2019). A large part of the respondents who purport this is in fact not living in a sustainable house. As many homeowners do not know the energy labeling system, and therefore do not know what label their house has, the information gap could cause data reliability issues.

Inaction is seen to be a large constraint in the installation of energy efficient measures from these numbers. Even when the possibilities are available, many homeowners do not proactively install energy efficient measures but rather wait until necessary maintenance makes it attractive to do so. The results show a divide between willingness, availability and decision to install. Not knowing the possibilities of installation is a relatively small factor in the Netherlands as seen in the survey data.

To answer the last sub-question "*What is the importance of financial incentives for Dutch homeowners in installing greenifying measures?"* it can be said that financial incentives are a prerequisite factor in installing greenifying measures. The willingness is related to this, as most respondents would not install sustainable measures if it did not earn itself back financially. However, even when these financial incentives are present, factors such as inaction are the main deterrent in taking the eventual greenifying decision.

An example of where the homeowner is deterred by willingness to install greenifying measures is when the construction activities would be too disruptive for a homeowner to want to act. Even though they might have the ability in terms of funds to greenify, their general distaste to the process itself causes them to not take the decision to greenify in the end. However, this situation is not very prevalent, as the general attitude towards greenifying is positive.

An example of a homeowner being deterred by ability is when a household is in a financially perilous situation. The homeowner could have no money available for renovations, even though they might be willing to do so. For subsidies to be given, the project must be finished, but they cannot finish the project if the funds are unavailable in the first place. Taking out loans is generally not done, as only a small percentage (11.59%) of homeowners do this for greenifying purposes (see Table 1 in the appendices). Most other loans are generally not with favorable conditions. This disallows a greenifying decision to be made due to finances.

An example where a homeowner has the willingness and the ability to greenify, but does not take the eventual decision, is inaction. A homeowner could have the situation where their house is energy inefficient, have the funds available and are willing to do construction, but think their house's maintenance level is of sufficient satisfaction to them that they put it off to a later date. When

maintenance needs arise, they use the opportunity to install energy efficient measures as maintenance must be done either way.

Specifically relating to net worth groups, a lower net worth household can be typified as one having less access to the greenifying ability necessary for taking energy efficient measures. For the willingness to install energy efficient measures, there is no difference between the two net worth groups. Inaction is however a pivotal factor in the decision to greenify. The final findings relating to net worth groups are summarized in the following figure on the next page.

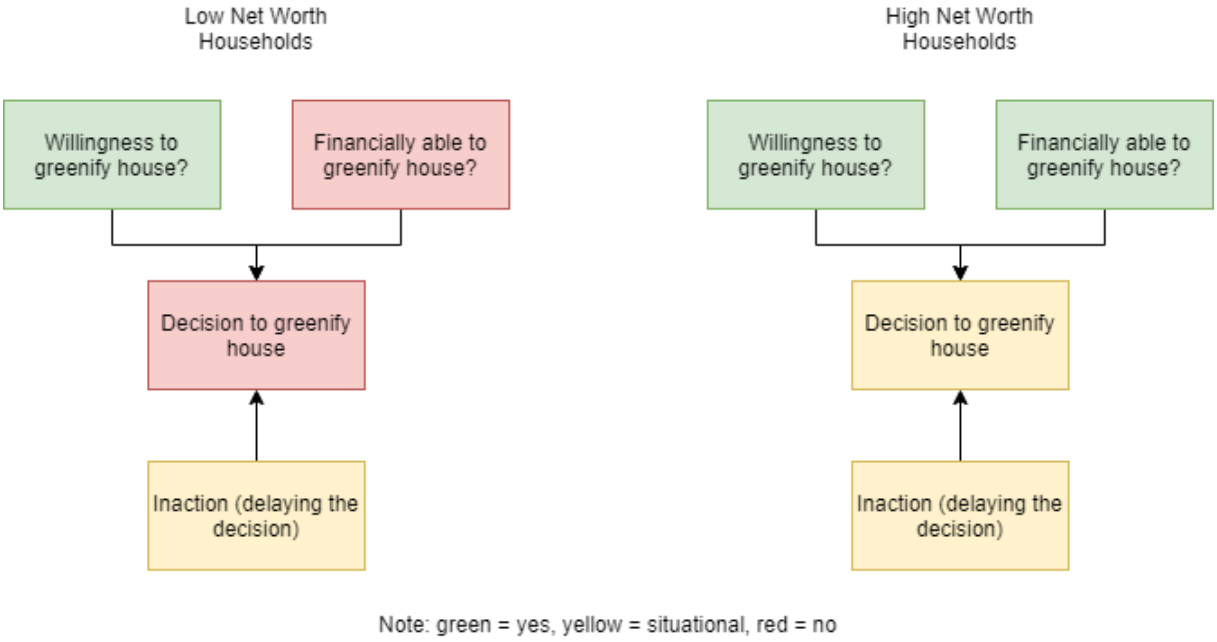

Figure 2. Final findings regarding the greenifying process for Dutch owner-occupied property.

Based on this information, the central research question "*What is the impact of net worth group on the greenifying process of Dutch owner-occupied property?*" can be answered. The impact of net worth group is important, as being in a higher net worth group is a prerequisite for the greenifying ability of a household. However, this decision is mainly hindered by inaction where a homeowner prefers waiting until maintenance needs arise to take the opportunity to install sustainable measures. When the homeowner does not wait for the maintenance needs, the reasons to greenify are mostly found in positive financial outcomes due to savings in the long run.

4. CONCLUSION

In this study, the effect of net worth group on greenifying ability has been investigated using multiple sub-questions which utilize a binary logistic regression method as well as supporting literature. From these methods, it is seen that the impact of net worth group on greenifying process of Dutch homeowners is significant. Belonging to a higher net worth group is thought to decrease financial barriers, which should cause a person to take greenifying measures more readily. However, the eventual decision seems to be one dominated by opportunity rather than initiative, where households mostly turn to sustainable measures when their house needs renovations anyway. Willingness to install sustainable measures is not different between net worth groups, however the above median net worth group has a higher percentage of the energy efficient housing stock. Willingness is a prerequisite factor in the eventual greenifying decision, and generally characterized as positive throughout the Dutch homeowner population.

As the Dutch policy measures for private homeowners are not enough in promoting the adoption of energy efficient measures, the suggestion to Dutch policymakers is to provide a better support system in installing these measures, especially financial ones, to increase adoption in homeowners of lower financial standing. The suggestions in the former literature such as tax relief by having better energy labels by Vringer et al. (2016) can however cause more inequality between socio-economic groups as those in the lower echelons do not have the immediate financial capability for greenifying.

Because the financial reasons in Dutch homeowner greenifying are leading for the decision, the suggestion can be given to Dutch policymakers that their efforts in the greenifying of Dutch homeowners' housing stock is best spent in the lower net worth category by means of increased financial incentives. This could include subsidies which are given before the improvement to the house is started rather than a subsidy after the project is finished to decrease the initial cost barrier. This focus should be specified towards existing housing stock rather than new builds, as the current focus towards new builds is already causing near-zero emissions. The emissions savings potential in the existing stock is large yet underutilized by current policy.

Also, policymakers should increase their efforts in spurring enthusiasm among the populace for installing greenifying measures. Most decisions are made based on necessary maintenance, where homeowners will put off the decision if it is not necessary, even when they have the ability and willingness to greenify. This includes an increased focus on the elderly population, where the mindset toward greenifying is less positive than their younger counterparts. Examples might include campaigns showing the personal benefit rather than the benefit 'at large', as homeowners tend to be motivated based on their personal situation more than the collective situation. The financial benefits would be leading.

Further research should focus on groups other than homeowners, as they are still a significant part of the Dutch housing market. Additionally, research on what sparks homeowners to eventually decide to install energy efficient measures should be conducted to better imply solutions towards inaction. The study identifies a divide between willingness to install, availability (mostly financial) of installing, and the actual decision to undertake the installation sustainable measures.

A limitation of the study is that it only contains homeowners, and not renters. As renters are a large part of the population, the conclusion posed here based on the homeowners' perspective is not the final solution to the problem of combating greenifying lag in the housing sector. Due to a large share of the Dutch rental market belonging to housing corporations, further research could explore the options between the Dutch policymakers and the housing corporations to find possibilities for increasing uptake of energy efficient installations on a broader scale in the rental sector.

Another limitation is the lack of variables which can cause omitted variable bias. This is due to unavailability in the data. For example, a basic control variable like gender was not included in the survey and could therefore not be controlled for. Further, the conclusions of the study are based on answers to survey data where some answers might not represent the factual situation. Some variables in the survey data are susceptible to low answer frequencies, which may lead to incorrect conclusions which cannot be generalized to the population. The combination of the willingness group to a general "No" and "Yes" answer for the regression does not give the ability to distinguish between the "Yes" group of which finances matter to the willingness and the group in which finances do not matter.

REFERENCES

Asses, T. (2015). (thesis). *Duurzaam en Comfortabel Wonen*. Retrieved from https://frw.studenttheses.ub.rug.nl/1636/1/Asses2411180.pdf

Boot, P.A., 2009. Energy efficiency obligations in the Netherlands - a role for white certificates? *TNO Publications*. Available at: http://resolver.tudelft.nl/uuid:f9e095dc-3d88-4f94-abfc-aa8c9d0fbbc4 [Accessed June 27, 2021].

Bradshaw, W., Connelly, E.F., Cook, M.F., Goldstein, J. & Pauly, J., 2005. The costs and benefits of green affordable housing. *Cambridge (MA): New Ecology*.

Caird, S. & Roy, R., 2010. Adoption and Use of Household Microgeneration Heat Technologies. *Low Carbon Economy*, 01(02), pp.61–70.

CBS, 2019. WoonOnderzoek Nederland (WoON). *Centraal Bureau voor de Statistiek*. Available at: https://www.cbs.nl/nl-nl/onze-diensten/methoden/onderzoeksomschrijvingen/korte-onderzoeksbeschrijvingen/woononderzoek-nederland--woon-- [Accessed June 25, 2021].

Cohen, J., Cohen, P., West, S.G. and Aiken, L.S., 2013. *Applied multiple regression/correlation analysis for the behavioral sciences*. Routledge.

de Groot, C. & de Waal, L., 2020. Vooral de rijken kunnen groene nieuwbouwhuizen betalen. *RTL Nieuws*. Available at: https://www.rtlnieuws.nl/economie/opinie/artikel/4985581/nieuwbouw-duur-woningmarkt-huizenprijzen-duurzaam-eisen [Accessed June 25, 2021].

de Groot, C. & Ryszka, K., 2019. *Verduurzamen van huizen loopt stuk op misvattingen*. Available at: https://economie.rabobank.com/publicaties/2019/november/verduurzamen-van-huizen-loopt-stuk-op-misvattingen/ [Accessed June 29, 2021].

Diekmann, A. & Preisendörfer, P., 2003. Green and Greenback: The Behavioral Effects of Environmental Attitudes in Low-Cost and High-Cost Situations. *Rationality and Society*, 15(4), pp.441–472.

Ebrahimigharehbaghi, S. et al., 2019. Unravelling Dutch homeowners' behaviour towards energy efficiency renovations: What drives and hinders their decision-making? *Energy Policy*, 129, pp.546–561.

EIB, 2018. Klimaatbeleid en de gebouwde omgeving. *Klimaatbeleid en de gebouwde omgeving: van ambities naar resultaten*. Available at: https://www.eib.nl/pdf/EIB-notitie_Klimaatbeleid_en_de_gebouwde_omgeving.pdf [Accessed June 29, 2021].

EST, 2011. Trigger points: a convenient truth Promoting energy efficiency in the home. *EST GD Trigger Points report 2011*. Available at: https://btckstorage.blob.core.windows.net/site621/EST%20GD%20Trigger%20Points%20report%202011%5B1%5D.pdf [Accessed June 30, 2021].

Eurostat, 2018. Energy consumption in households. *Energy consumption in households - Statistics Explained.* Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Energy_consumption_in_households [Accessed June 27, 2021].

Filippidou, F., Nieboer, N. & Visscher, H., 2017. Are we moving fast enough? The energy renovation rate of the Dutch non-profit housing using the national energy labelling database. *Energy Policy*, 109, pp.488–498.

Ganti, A., 2021. Net Worth. *Investopedia*. Available at: https://www.investopedia.com/terms/n/networth.asp [Accessed June 29, 2021].

IPCC, 2014. Summary for Policymakers. Available at: https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_summary-for-policymakers.pdf [Accessed June 28, 2021].

Itard, L. & Klunder, G., 2007. Comparing environmental impacts of renovated housing stock with new construction. *Building Research & Information*, 35(3), pp.252–267.

I&O Research, 2019. Duurzaam denken is nog niet duurzaam doen. *I&O Research*. Available at: https://www.ioresearch.nl/actueel/duurzaam-denken-is-nog-niet-duurzaam-doen/ [Accessed June 29, 2021].

Jakob, M., 2006. Marginal costs and co-benefits of energy efficiency investments. *Energy Policy*, 34(2), pp.172–187.

Kastner, I. & Stern, P.C., 2015. Examining the decision-making processes behind household energy investments: A review. *Energy Research & Social Science*, 10, pp.72–89.

Kim, P., Aldrich, H. & Keister, L., 2004. Household Income and Net Worth. *Handbook of Entrepreneurial Dynamics: The Process of Business Creation*, pp.49–61.

Maggiulli, N., 2020. The Average Net Worth by Age and Education Level. *Of Dollars And Data*. Available at: https://ofdollarsanddata.com/average-net-worth-by-age-and-education/ [Accessed June 28, 2021].

Marlisa, L., 2021. Het duurt nog tot 2055 voordat de gemiddelde koopwoning energielabel A heeft – Flevoland loopt voorop, Zeeland bungelt onderaan. *Business Insider Nederland*. Available at: https://www.businessinsider.nl/energielabel-jaar-per-provincie/ [Accessed June 27, 2021].

Marijnissen, H., 2018. Een groene toekomst is er alleen voor de rijken: de eco-elite. *Trouw*. Available at: https://www.trouw.nl/nieuws/een-groene-toekomst-is-er-alleen-voor-de-rijken-de-eco-elite~b4847e15/ [Accessed June 25, 2021].

Michelsen, C.C. & Madlener, R., 2011. Homeowners' Preferences for Adopting Residential Heating Systems: A Discrete Choice Analysis for Germany. *SSRN Electronic Journal*.

Midi, H., Sarkar, S.K. & Rana, S., 2010. Collinearity diagnostics of binary logistic regression model. *Journal of Interdisciplinary Mathematics*, 13(3), pp.253-267.

Milieucentraal, 2021a. *Energielabel voor woningen*. Available at: https://www.energielabel.nl/woningen/ [Accessed June 27, 2021].

Milieucentraal, 2021b. Energiesubsidiewijzer. *Verbeterjehuis*. Available at: https://www.verbeterjehuis.nl/energiesubsidiewijzer/ [Accessed June 30, 2021].

Ministerie van Economische Zaken en Klimaat, 2021. Het Akkoord. *Klimaatakkoord*. Available at: https://www.klimaatakkoord.nl/klimaatakkoord [Accessed June 25, 2021].

Nijhoff, M.G., 2010. thesis. Available at: https://research.tue.nl/files/125628073/Duurzame_Gebiedsontwikkeling_M_G_Nijhoff_2010_verslag_.pdf [Accessed June 30, 2021].

Paul, R.K., 2006. Multicollinearity: Causes, effects and remedies. *IASRI, New Delhi*, 1(1), pp.58-65.

PBL, 2013. Nederland voldoet aan de Kyoto-verplichting uitstoot broeikasgassen. *PBL Planbureau voor de Leefomgeving*. Available at: https://www.pbl.nl/publicaties/nederland-voldoet-aan-de-kyoto-verplichting-uitstoot-broeikasgassen [Accessed June 29, 2021].

Poterba, J. (1984) Tax Subsidies to Owner-Occupied Housing: An Asset-Market Approach. *The Quarterly Journal of Economics*, 99: 729–752.

Rijksoverheid, 2019. *Cijfers over Wonen en Bouwen 2019*. Available at: https://www.woononderzoek.nl/nieuws/Cijfers-over-Wonen-en-Bouwen-2019/85 [Accessed June 27, 2021].

RTL Nieuws, 2017. 'Armen en huurders betalen veel meer aan verduurzaming'. *RTL Nieuws*. Available at: https://www.rtlnieuws.nl/geld-en-werk/artikel/3772116/armen-en-huurders-betalen-veel-meer-aan-verduurzaming#:~:text=Mensen%20met%20weinig%20geld%20en,en%20huurders%20dat%20vaak%20niet. [Accessed June 25, 2021].

Saheb, Y., Bódis, K., Szabo, S., Ossenbrink, H. & Panev, S., 2015. Energy renovation: the trump card for the new start for Europe. *European Commission-Joint Research Centre-Institute for Energy and Transport, JRC Science and Policy Reports*.

Schleich, J., 2019. Energy efficient technology adoption in low-income households in the European Union – What is the evidence? *Energy Policy*, 125, pp.196–206.

Train, K., 2001. Properties of Discrete Choice Models. *Discrete Choice Methods with Simulation*, pp.11–33.

van der Borgh, S., 2020. *Een mindset tot residentiële verduurzaming*. Thesis. Available at: https://frw.studenttheses.ub.rug.nl/3384/1/Masterthesis%20Stefan%20van%20der%20Borgh%20-%20Een%20mindset%20tot%20residentiele%20verduurzaming.pdf [Accessed June 28, 2021].

Wilson, C., Crane, L. & Chryssochoidis, G., 2015. Why do homeowners renovate energy efficiently? Contrasting perspectives and implications for policy. *Energy Research & Social Science*, 7, pp.12–22.

TABLES

APPENDIX TABLE 1: PREVALENCE OF GREEN LOANS

	category	frequency	percentage	cumulative %
Loan type	Green loan	150	11.59	11.59
	Non-green loan	1,144	88.41	100
	Observations	1,294	100	

APPENDIX TABLE 2: CLASSIFICATION STATISTICS

	category		percentage
Model 1			
	Sensitivity	Pr(+| D)	0.71%
	Specificity	Pr(-|~D)	99.86%
	Positive predictive value	Pr (D| +)	47.06%
	Negative predictive value	Pr(~D| -)	85.38%
	False + rate for true ~D	Pr(+| ~D)	0.14%
	False – rate for true D	Pr(-| D)	99.29%
	False + rate for classified +	Pr (~D| +)	52.94%
	False – rate for classified -	Pr(D| -)	14.62%
	Correctly classified		85.30%
Model 2			
	Sensitivity	Pr(+| D)	95.22%
	Specificity	Pr(-|~D)	29.69%
	Positive predictive value	Pr (D| +)	82.62%
	Negative predictive value	Pr(~D| -)	63.90%
	False + rate for true ~D	Pr(+| ~D)	70.31%
	False – rate for true D	Pr(-| D)	4.78%
	False + rate for classified +	Pr (~D| +)	17.38%
	False – rate for classified -	Pr(D| -)	36.10%
	Correctly classified		80.70%

APPENDICES

Appendix 1: STATA syntax of the used DO-file

```
// Clear all previous data from memory
clear all

// Browse to right folder containing dataset
cd C:/Users/Emilian/Downloads

// Use WoON2018 dataset
use "WoON2018_e_1.0.dta"

//Drop observations of renters
drop if eighuura != 1

// Descriptive analysis of core dataset
tab leeftijd
tab vltoplop3
tab zuinigstel1

// Drop unknowns/neutrals from data
drop if twoning == 3
drop if investenerg == 4
drop if vltoplop3 == 9
drop if tonderho == 3

// Get new median for net worth
sum vermogh_r, d

// Create new binary variables
gen vermogen2categ = 0 if vermogh_r <= 146223
replace vermogen2categ = 1 if vermogh_r > 146223

gen twoning2categ = 1 if twoning == 1 | twoning == 2
replace twoning2categ = 0 if twoning == 4 | twoning == 5

gen tonderho2categ = 1 if tonderho == 4 | tonderho == 5
```

```
replace tonderho2categ = 0 if tonderho == 1 | tonderho == 2

gen investenerg2cat = 0 if investenerg == 3
replace investenerg2cat = 1 if investenerg == 1 | investenerg == 2

// Modify data for easier interpretation/make data useable
replace redgeenem2 = 0 if redgeenem2 == 1
replace redgeenem2 = 1 if redgeenem2 == 2

replace redgeenem2 = 2 if redgeenem2 == 0
replace redgeenem2 = 0 if redgeenem2 == 1
replace redgeenem2 = 1 if redgeenem2 == 2

replace enerzmaat6 = 3 if enerzmaat6 == 1
replace enerzmaat6 = 0 if enerzmaat6 == 2
replace enerzmaat6 = 1 if enerzmaat6 == 3

// More descriptives after cleaning
tab investenerg
tab belangener
tab tonderho2categ
tab twoning2categ
tab enerzmaat6
tab leeftijd
tab redgeenem2
tab investenerg2cat
tab nieuwb
tab typleen2
tab typleen3
tab redgeenem1
tab redgeenem2
tab redgeenem3
tab redgeenem4
tab redgeenem5
tab redgeenem6
tab redgeenem7
tab redgeenem8
```

```
tab redgeenem9
sum vermogh_r, d

// Logit: is the reason for not installing financial? n/y - Subq 1
logit redgeenem2 vermogen2categ twoning2categ i.leeftijd i.vltoplop3 hweegwon nieuwb
tonderho2categ
logit redgeenem2 vermogen2categ twoning2categ i.leeftijd i.vltoplop3 hweegwon nieuwb
tonderho2categ, or

// Hosmer-Lemeshow chi-squared; goodness-of-fit test
estat gof, group(10)

// Sensitivity/Specificity
estat classification

// Model statistics for seeing Nagelkerke's R-squared
fitstat

// VIF test for multicollinearity
reg redgeenem2 vermogen2categ twoning2categ i.leeftijd i.vltoplop3 hweegwon nieuwb
tonderho2categ
vif
reg redgeenem2 vermogen2categ twoning2categ leeftijd i.vltoplop3 hweegwon nieuwb
tonderho2categ
vif

// Importance of finances in installing
tab investenerg vermogen2categ
tab belangener vermogen2categ
tab redgeenem1 vermogen2categ
tab redgeenem2 vermogen2categ
tab redgeenem3 vermogen2categ
tab redgeenem4 vermogen2categ
tab redgeenem5 vermogen2categ
tab redgeenem6 vermogen2categ
tab redgeenem7 vermogen2categ
tab redgeenem8 vermogen2categ
```

```
tab redgeenem9 vermogen2categ

// Logit: willingness to install? n/y - Subq 2
logit investenerg2cat vermogen2categ twoning2categ enerzmaat6 i.leeftijd i.vltoplop3 hweegwon
nieuwb tonderho2categ
logit investenerg2cat vermogen2categ twoning2categ enerzmaat6 i.leeftijd i.vltoplop3 hweegwon
nieuwb tonderho2categ, or

// Hosmer-Lemeshow chi-squared; goodness-of-fit test
estat gof, group(10)

// Sensitivity/Specificity
estat classification

// Model statistics for seeing Nagelkerke's R-squared
fitstat

// VIF test for multicollinearity
reg investenerg2cat vermogen2categ twoning2categ enerzmaat6 i.leeftijd i.vltoplop3 hweegwon
nieuwb tonderho2categ
vif
reg investenerg2cat vermogen2categ twoning2categ enerzmaat6 leeftijd i.vltoplop3 hweegwon nieuwb
tonderho2categ
vif
```