Discussion Paper No. 11-004

What Drives WTP for Energy Efficiency when Moving?

Evidence from a Germany-wide Household Survey

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Economic Research

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Das Wichtigste in Kürze

Die politische Diskussion zur Steigerung der Energieeffizienz fokussiert sich zunehmend auf den Gebäudesektor. Zum einen entfallen etwa 30% des Gesamtenergieverbrauchs in Deutschland auf die Bereitstellung von Raumwärme und Warmwasser in Wohngebäuden. Damit trägt dieser Sektor in bedeutendem Maße zur Emission von Treibhausgasen und den damit verbundenen negativen externen Umwelteffekten bei. Da Emissionen aus dem Konsum dezentral erzeugter Wärme nicht durch das europäische Emissionshandelsystem (EU-ETS) abgedeckt sind, können wohl definierte und effektive Politikinstrumente zu einer tatsächlichen Reduktion von CO_2 Emissionen und damit zu einer Abschwächung von Externalitäten aus Verschmutzung beitragen. Zum anderen birgt das Vermieter/Mieter Dilemma weitere Gefahren ökonomischer Ineffizienzen im Gebäudesektor. Asymmetrische Informationen zwischen Eigentümern/Käufern bzw. Vermietern/Mietern bezüglich des energetischen Zustands einer Immobilie können zur adversen Selektion und damit zu Wohlfahrtsverlusten führen. Darüber hinaus entstehen Anreizprobleme, da das deutsche Mietrecht die Möglichkeit einer dauerhaften Umlage von Investitionen in energieeffiziente Technologien auf die Kaltmiete nicht ausreichend abbildet.

Trotz aller Förderinstrumente haben Investitionen in energieeffiziente Technologien auf der Nachfrageseite im Gebäudesektor bislang nicht die von politischer Seite angestrebte Höhe und Dynamik erreicht. Das Bundesministerium für Verkehr, Bau und Stadtentwicklung (BMVBS) schätzt, dass 75% der 17 Mio. Wohngebäude in Deutschland noch vor der Einführung der ersten Wärmeschutzverordnung errichtet wurden und weitestgehend unsaniert sind. Trotz eines geringfügigen Anstiegs der Sanierungsquote in den letzten Jahren, sind zwischen 1989 und 2006 weniger als 30% aller möglichen energetischen Sanierungsmaßnahmen durchgeführt worden. Empirische Studien zu Treibern und Hemmnissen einer energieeffizienten Sanierung fokussieren im Wesentlichen auf die Präferenzen selbstnutzender Eigentümer. Da beispielsweise mehr als die Hälfte der deutschen Haushalte in Mietverhältnissen lebt, besteht Forschungsbedarf hinsichtlich der Präferenzbildung in anderen Wohnstrukturen. Das Ziel dieser Arbeit ist es, Faktoren der Zahlungsbereitschaft für eine energieeffiziente Immobilie beim Wohnungswechsel zu bestimmen. Als Datengrundlage dient dabei eine Umfrage unter deutschen Haushalten, die mithilfe eines multinominalen diskreten Entscheidungsmodells analysiert wird. Die Schätzergebnisse lassen vermuten, dass die Zahlungsbereitschaft für energieeffizientes Wohnen bei Wohnungswechsel nicht hauptsächlich durch sozioökonomische Variablen wie das monatliche Nettoeinkommen der Haushalte oder den formalen Bildungsstand zu erklären ist. Vielmehr scheinen das Umwelt- und Energiebewusstsein den Nutzen aus einer Wohnung mit moderner Heiz- oder Dämmtechnologie zu bestimmen. Auch wenn die Ergebnisse Parallelen zur Zahlungsbereitschaft für nachhaltig produzierte Konsumgüter des alltäglichen Bedarfs aufzeigen, wird der Gebäudesektor im Allgemeinen nicht als bedeutender Sektor für den Klimaschutz wahrgenommen. Das heterogene Antwortverhalten hat damit wichtige Implikationen für effektive Politikinstrumente. Finanzielle Förderprogramme, wie beispielsweise die der KfW Bank sollten den Zugang zum Kapitalmarkt gewährleisten und gleichzeitig die Such- und Transaktionskosten für Konsumenten minimieren. Darüber hinaus bieten Informationsinstrumente wie der Energieausweis eine ökonomisch sinnvolle Alternative, asymmetrischer Information zwischen Anbietern und Nachfragern auf dem Immobilienmarkt entgegen zu steuern.

Non-technical summary

The political discussion on energy efficiency is focusing more and more on the building sector due to its susceptibility to potential market failures. In Germany, for example, about 30% of the total final energy consumption is used in private households, mainly for space and water heating. Hence, this sector contributes to a considerable amount of greenhouse gas emissions which cause negative external environmental effects. As the sector is absent in the European Union Emissions Trading System (EU ETS), well defined and effective policy instruments may help to reduce CO_2 emissions and mitigate pollution externalities. Moreover, the landlord/tenant-dilemma provides further sources of economic inefficiencies. Concretely, asymmetric information between sellers/tenants and buyers/hirers on the energy condition of a specific building may lead to adverse selection and thus result in economic welfare losses. Furthermore, incentive problems appear because the German landlord and tenant laws harm permanent shifting of (energy cost reducing) investments on rents.

Despite all funding programmes and information campaigns, the demand for energy-efficient technologies in the building sector has not significantly increased yet. According to the German Federal Ministry of Transport, Building and Urban Development, about 75% of the 17 million residential buildings in German had been built before the first Heat Insulation Ordinance was launched in 1977 and most of them have not been redeveloped yet. Between 1989 and 2006 less than 30% of all energy-efficient refurbishment possibilities were realized, notwithstanding a slight increase of the annual refurbishment quota during the last years.

Most empirical studies on barriers and drivers for energy efficiency in existing residential buildings focus on preferences of owner-occupiers. Since more than half of German households are tenants, an important research challenge is to extend the identification of possible drivers for energy efficiency in further living conditions. Using a discrete choice approach, this paper aims at deriving factors which increase the willingness to pay (WTP) for energy efficiency in an upcoming move. A multinominal logit model is used to analyse micro data of a survey among German households.

The estimation results suggest that the WTP is not mainly determined by socioeconomic attributes like household income or formal education, but rather by environmental concerns and energy awareness. Although there is evidence for similarities to research on WTP for green daily consumer goods, the building sector is not clearly perceived as an essential possibility to contribute to climate protection. The heterogeneity in demand within this sector has important implications for effective policy making. Financial programmes, for example, offered by KfW bank (Reconstruction Loan Corporation) should ensure access to capital markets, minimise information and transaction costs and reduce market asymmetries. Moreover, labelling instruments like the energy pass are useful to reduce asymmetric information between suppliers and demanders.

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Abstract

The political discussion on energy efficiency is focusing more and more on the building sector due to its susceptibility to potential market failures like the negative external pollution effects of CO_2 emission. Using a discrete choice approach, this paper aims at deriving factors which increase the willingness to pay (WTP) for energy efficiency in the case of an upcoming move. A multinominal logit model is used to analyse micro data of a survey among more than 200 German households. The estimation results suggest that the WTP is not mainly determined by socioeconomic attributes like household income or formal education, but rather by environmental concerns and energy awareness. Although there is evidence for similarities to research on WTP for green daily consumer goods, the building sector is not clearly perceived as an essential possibility to contribute to climate protection.

JEL Classification: C25, D12, Q41.

Keywords: Energy efficiency; Multinominal logit model; Residential buildings; Willingness to pay.

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1 Introduction

The political discussion on energy efficiency is focusing more and more on the building sector due to its susceptibility to potential market failures. In Germany, for example, about 30% of the total final energy consumption is used in private households, mainly for space and water heating (cp. Hansen, 2009). Hence, this sector contributes considerably to greenhouse gas emissions which cause negative external environmental effects. As the sector is absent in the European Union Emission Trading System (EU ETS), well defined and effective policy instruments may help to reduce CO_2 emissions and mitigate pollution externalities. Moreover, the landlord/tenant-dilemma provides further sources of economic inefficiencies (cp. Mennel and Sturm, 2007). Concretely, asymmetric information between sellers/landlords and buyers/tenants on the energetic condition of a specific building may lead to adverse selection and thus result in economic welfare losses. Furthermore, incentive problems appear because the German landlord and tenant law harms a permanent shifting of (energy cost reducing) investments on rents.

In Germany, there is a long tradition on legal requirements for heat insulation and energy consumption in buildings. In 2002, the German Government launched the Energy Savings Ordinance (ESO 2002/EnEV 2002) in order to replace and combine the requirements of the Ordinance on Thermal Insulation (OTI/WSVO) and the Ordinance on Heating Equipment (OHE/HeizAnIV) which initially had been introduced in the late 1970s. ESO mainly establishes a maximum limit of primary energy consumption for space and water heating, and ventilation. Thereby, transmission losses which are generated during the production, transformation and distribution of energy outside of the building are incorporated. The ESO applies both for new buildings and existing buildings, in case of reconstruction and expansion, which regularly use energy for heating or cooling. In order to fulfil the requirements of the European Energy Performance of Buildings Directive (EPBD 2003), the ESO was revised several times in recent years (EnEV 2004, EnEV 2007, EnEV 2009). For example, EnEV 2007 complies with the European claim of an advanced labelling of energy consumption by introducing an energy pass. Since January 2009 building owners/sellers/landlords have to provide an energy pass in case of construction, selling or renting and must make it available to buyers/tenants interested in. The EPBD 2010 which came into force in July 2010, strengthens the importance of this instrument e.g. by adding further information (i.e. two packages of measures for energy saving refurbishment) and enhancing its publication requirements. Germany aims at implementing the EPBD 2010, should it not be covered by ESO 2009, by ESO 2012. In addition to ESO, the Renewable Energies Heat Act (REHA/EEWärmeG) determines that by no later than by 2014 14 percent of thermal heat has to be provided by renewable energy sources. Therefore, new private or public buildings have to provide for a part of their thermal energy demand by using renewables.

Despite all funding programmes and information campaigns, the demand for energy-efficient technologies in residential buildings has not significantly increased yet. According to the German Federal Ministry of Transport, Building and Urban Development (BMVBS), about 75% of the 17 million residential buildings in German had been built before the first Thermal Insulation Ordinance was launched in 1977 and most of them have not been redeveloped yet. Notwithstanding a slight increase of the annual refurbishment quota during the last years, between 1989 and 2006 less than 30% of all energy-efficient refurbishment possibilities were realised. Empirical economic

analyses (e.g. BMVBS, 2007; Jakob, 2007; Achtnicht, 2010; Stiess et al., 2010) detect a broad range of drivers for and barriers to energy efficiency in existing residential buildings. Most of these studies focus on owner-occupiers. Since, for example, more than the half of German households are tenants (cp. Gesis, 2009), an important research challenge is to extend the identification of possible drivers for energy efficiency in the case of an upcoming move. In fact, this paper aims at deriving factors which increase the willingness to pay (WTP) for energy efficiency in case of moving, using a discrete choice approach. A multinominal logit model is used to analyse micro data of a survey among German households.
The remainder of the paper is organised as follows: Section 2 gives a brief overview of literature on drivers for and barriers to energy saving measures in residential buildings as well as WTP studies for energy efficient technologies. Data and the underlying estimation strategy applied are described in section 3. The econometric results and their discussion are presented in section 4. The paper is concluded by a discussion about useful policy instruments for counteracting the market failures in this sector.

2 Literature background

The aim of this chapter is twofold. Firstly, a comparison of recently conducted surveys among owner-occupied single/semi detached houses is presented. Concretely, empirical evidence of the studies of BMVBS, 2007; Jakob, 2007; Achtnicht, 2010 and Stiess et al., 2010 is used to derive and discuss (self-perceived) drivers for and barriers to energy efficiency in residential buildings.[1] Secondly, the economic literature on WTP for energy efficiency in the building sector using a discrete choice approach is briefly summarised.

2.1 Drivers for and barriers to energy efficiency in residential buildings

Following the typology of Jakob 2007, drivers for and barriers to energy-efficient technologies in the building context can be divided into the following categories: building structure; universal regulative framework; financial prerequisites and economic utility; information and knowledge; socioeconomic attributes.

Building structure

Generally speaking, it can be assumed that the physical or technical conditions of the roof or the façade of dwelling houses neither impede energy-efficient refurbishment nor make it inevitable (see Jakob, 2007 for a discussion). On the one hand, from a technical point of view it is possible to live in a building without any insulation for quite a long time if no refurbishment activity is desired or planned. On the other hand, if building components are replaced at the end of their lifecycle new parts mostly are more energy-efficient due to the technological progress. The survey among Swiss owner-occupiers (cp. Jakob, 2007) points out that the physical or technical condition of the roof or the façade is a strong driver for taking refurbishment action but not necessarily for energy-efficient technologies, particulary in the case of façades. The other studies show little

[1] Annex 1 gives gives an overview on the main characteristics of these surveys.

Table 1: Drivers for and barriers to energy efficient renovation

	BMVBS 2007	Jakob 2007	Achtnicht 2010	Stiess et al. 2010
Building structure				
Routine maintenance (extension, renovation)	+	+	+	+
Technical conditions		−	○	○
Universal regulative framework				
Legal standards (e.g. protection of historical buildings)		○		○
Financial prerequisites and economic utility approach				
Uncertainty of profitability	−	○	−	−
Lack of financial resources	−	○	−	○
Payback period		○	○	○
High energy costs	+	+	+	+
Maintaining or adding real estate's value			○	+
Higher utility of increased living comfort		+	+	+
Information and knowledge				
Lack of information	○	○	○	○
Lack of knowledge	−	−		−
Socioeconomic attributes				
Income	−	○	−	○
Formal Education		○		○
Age		○	○	○
Technical interest		○		+
Environmental concerns	○	+	+	+

+ driver − barrier ○ no explicit impact

evidence for barriers with respect to the availability of suitable technologies. Furthermore, in case of extensions and alterations, German law (i.e. ESO) explicitly requires advanced energy-saving solutions. To conclude, the general building structure should rather be perceived as a driver than a barrier. The empirical results of the studies suggest that individuals are more likely to consider energy-efficient alternatives when there is need for refurbishment per se, i.e. at the end of the lifecycle of the current roof or façade.

Universal regulative framework

Due to the long tradition on legal requirements for thermal insulation and heating equipment in Germany, as discussed in the previous section, the universal regulative framework, e.g. the protection of historical monuments or local building regulations as far as possible, has been harmonised with regulations on energy efficiency. In the case of buildings of historic importance there might be a conflict of interests between energy efficiency and maintaining the original façade structure. Although the German legislature explicitly considers the specific characteristics of historical buildings (cp. dena, 2010), the Chamber of Architects criticises current refurbishment possibilities (cp.

Wagner, 2010). Unfortunately, not all studies explicitly point out this item. However, the results of Jakob (2007) and Stiess et al. (2010) suggest that the universal regulative framework is not perceived as a barrier.

Financial prerequisites and economic utility

It is reasonable to expect that economic motives like total investment costs, payback periods and cost-benefit analyses are the main challenges within the decision on energy efficient refurbishment. According to Jakob (2007), costs for refurbishment in a single family detached house on average account for 7-10% of the purchasing price and investments are profitable at a long-term mean real interest rate of 3-3,5%. The respective revenues (e.g. saved energy costs) then accrue for about 30-50 years. At the same time, uncertainty on future energy prices impedes exact calculation of payback periods. Furthermore, from an economic point of view, opportunity costs of energy efficient refurbishments like capital commitment have to be considered. Thus, an accurate specification of the individual utility calculation and preferences is required. Thompson (2002) shows that conventional investment calculation may underestimate the utility of energy efficient technologies because it does not incorporate potential surplus from an increased living comfort. This is in line with the argument of Jakob (2006) who emphasises the consideration of *co-benefits* (Jakob, 2006, p.174) like independence of high energy prices, the improvement of indoor climate and noise protection and the increased value of the building. Although there is empirical evidence for the dominance of financial and economic aspects in the decision process, some differences are observed in the four studies. Stiess et al. (2010) point out that less than the half of the respondents mentions economic reasons like the lack of financial resources or an used-up credit line. At the same time, more than 2/3 of the sample is not willing to take out a further loan for energy-saving measures. In most cases, a financing mix of savings, loans and funding is used. In the sample used by Jakob (2007), about one quarter of those who did not conduct an insulation of the façade or the roof between 1986 and 2000, explicitly states economic or financial barriers. Similar results are offered by BMVBS (2007). The BMVBS study points out that costs of energy-efficiency measures are overestimated by 40% on average. About one quarter of the sample perceives financial reasons as an important barrier. In contrast, about 60% of the sample used by Achtnicht (2010) perceive economic or financial restrictions as key barriers. Uncertainty about economic viability and payback periods are taken into account but in general do not prevent an energy efficient refurbishment. Most of the respondents expect a payback of their investment in terms of lower energy consumption and increasing energy prices within the next years. Even though they accept a certain bandwidth of payback periods, in most cases 15 years are regarded as the critical threshold (cp. Stiess et al., 2010). Not surprisingly, all studies underline the importance of concerns related to energy saving as a main driver for refurbishment activities. Furthermore, the studies show that *co-benefits* like the appreciation of the real estate and an increased living comfort are included in the decision.

Information and knowledge

In addition to financial restrictions, lack of information is often claimed as a central boundary condition for the diffusion of energy efficient technologies (cp. Zick, 2009). Even so, it is not obvious whether this paucity of information results from a real lack of information or rather from a dilemma of complexity (cp. Pöschk, 2009; Müller, 2010) with respect to the variety of single decisions (e.g. building materials, sources of energy, heating technologies, legal standards, funding programmes). Jakob (2007) assumes that there is no paucity of information with respect to quality and quantity but rather there is evidence for a lack of market transparency and also there are considerable costs of searching. The empirical studies do not provide unambiguous insights. On the one hand, Jakob (2007) and Achtnicht (2010) do not identify a lack of information, with respect to the quantity of potential information sources, as a main barrier for energy-efficient refurbishment. On the other hand, about 70% of the sample used by Stiess et al. (2010) feel uninformed about funding possibilites and programmes. This is in line with the findings of BMVBS (2007) showing that the energy saving potentials in buildings sector usually are underestimated, especially in contrast to other sectors like domestic appliances or transport. Furthermore, the majority of individuals are not well aware of its real energy consumption and, by that, their saving potentials. To sum up, individuals often miscalculate their own level of information and knowledge. This is why there rather is evidence for a lack of knowledge than for a lack of information which may result in inefficient decisions. With respect to future information programmes, the relevance of social networks has to be considered explicitly. For example, Stiess et al. (2010) show that consumer appreciate insights from on-one-on conversation with tradesmen, energy advisers, relatives or friends.

Socioeconomic attributes

Beginning with the hedonic pricing model by Rosen (1974), approaches to reveal preferences for (non-marketable) environmental goods are intensivly discussed in the economic literature.[2] There is still need for research on how socioeconomic attributes household like income, age, formal education and environmental concerns affect the decision process. Enneking et al. (2007) find evidence for heterogeneous consumer behaviour within the different fields of action like food, transport and living. For example, an individual living in a rural area, consuming green daily goods and using solar panels for water heating may not be willing to renounce the use of its private car to go to work although there is public transport. Thus, a specific consideration of consumer behaviour within the particular sector is essential in order to understand consumer preferences. Concretely, with respect to energy-efficiency in residential buildings, several approaches on how socioeconomic variables may influence the consumer decision seem plausible. On the one hand, young people may show a higher willingness to invest in energy-efficient refurbishment measures because they probably benefit from the positive effects for a long time. Moreover, loans can be repaid over a long period. Hence, monthly debits remain low. On the other hand, we can assume that mainly older people, when retired, are more likely to start refurbishment activities due to financial as well as time prerequisites. The effect direction of formal education can be interpreted ambivalently, too. One could expect that individuals with a higher formal (academic) education degree might evaluate cost-benefit calculation more precisely or due to income effects are more likely to invest in energy-efficient technologies. In contrast, technically active or interested persons like tradesmen who are faced with refurbishment activities and investment decisions during their daily

[2] For an overview of estimating the value of environmental goods refer to Phaneuf and Smith (2005) or Palmquist (forthcoming) and for hedonic pricing models see among others Brown and Rosen (1982), Bartik (1987) and Bajari and Benkard (2005).

work might attach more importance on these issues. In line with age and formal education, income effects can be discussed analogously. The impact of socioeconomic attributes is not entirely considered in all of the empirical studies. Basically, no clear age and formal education affects can be detected but rather environmental concerns seems to influence the WTP for energy-efficient refurbishment. As discussed in the previous section, household income restrictions may prevent the diffusion on appropriate technologies but not in the strong dimension that is often expected.

2.2 Demand and WTP for energy-efficient technologies in residential buildings

Apart from the analysis of potential drivers for and barriers to energy efficiency in residential buildings, empirical work aims at deriving the WTP for energy-efficient technologies in households. Cameron (1985) was among the first who focused on energy conservation retrofits like storm windows and insulation. Micro data of 1761 owner-occupied single-family dwellings in the US obtained from the National Interim Energy Consumption (NIECS)(1978/78) was used to estimate the individual utility of appropriate technologies. The estimation results suggest that the demand for energy-efficient technologies increases if the household income and energy prices rise. Furthermore, Cameron concludes that funding schemes like grants or tax refunds do not foster refurbishment activities significantly. Poortinga at al. (2003) study the willingness to accept of different energy-saving measures among Dutch households. They conclude that technical measures to save energy generally are more accepted than changes of consumer habits or behaviour. Moreover, individuals prefer to save energy within the household instead of losing their flexibility in the transport sector e.g. by using public transport. Interestingly, the amount of energy that is saved by implementing a certain measure is not among the most important criteria when choosing a specific alternative. Furthermore, Poortinga et al. (2003) show that individuals with high environmental concerns are more likely to accept energy-saving measures and attach more value to their savings potentials. Sociodemographic variables like age, number of household members, income and formal education do influence the way of energy-saving but do not have an impact on the acceptance of certain measures. Younger people are more likely to reduce their energy consumption within the household than older people. Moreover, there is evidence that families are more willing to accept changes in behaviour within the household than to give up their flexibility in the individual transport sector. As opposed to this, single-households with high incomes clearly prefer technological measures instead of changing their consumption behaviour. Banfi et al. (2008) derive the marginal WTP for energy-saving measures among tenants and owner-occupiers. During the choice experiment, the respondents (hypothetically) chose between a refurbishment alternative and the status quo. In detail, they focus on different types of windows, level of insulation of the external façade, ventilation and the price of the refurbishment activity. They point out that individuals in older buildings show a higher WTP for windows (about 13% of the rental or purchase price[3]) and external façade insulation (about 6 to 7%), whereas ventilation systems are intensively discussed by individuals living in newer buildings (WTP is about 4 to 12% of the rental or pur-

[3] These prices are average prices, i.e. CHF 650,000 and CHF 686,000 for new and existing single family houses and 2030 and CHF/month 1,330 for flats in new and in existing buildings (Banfi et al., 2008, p.11).

chase price) (Banfi et al., 2008, p.11). These findings are referred to the differences in the building structure and a decreasing marginal WTP with rising efficiency levels. Moreover, we can assume that household income of individuals living in newer buildings is higher and thus, WTP for ventilation systems might be higher. In addition, the WTP in most cases is higher than the costs. This result can be interpreted in two ways. One the one hand, individuals in fact are looking for energy-efficient houses but there is no appropriate offer in the housing market. On the other hand, WTP derived from the (hypothetical) choice experiment could be overestimated. Van Oel et al. (2009) use a similar approach to analyse consumer preferences for retrofit measures. They show that individuals in older buildings pay more attention to façade insulation measures which protect the existing external building structure. According to Poortinga et al. (2003), technical solutions like solar boilers or heating pumps are preferred to changes in heating behaviour, for example zoning. Similar to the findings in the previous section, individuals do not accept payback periods longer than 14 years. Interestingly, a higher household income does not change the acceptance of payback periods but rather fosters the willingness to invest in energy-efficient household appliances. As expected, the use of energy-efficient technologies is raising with routine maintenance. Van Oel et al. (2009) conclude that extensions and renovations are more likely when there is a change in the use of living space, e.g. when children move out and leave their parents' house. Due to this fact older people seem to be more interested in certain approaches to reduce energy consumption by refurbishment activities. Furthermore, environmental concerns are identified as a strong driver. Kwak et al. (2010) use micro data among a survey of 500 household decision maker in urban areas of Korea. They conducted a choice experiment to derive the WTP for windows, facąde and ventilation refurbishment measures and observed a higher WTP for windows and ventilation systems than for insulation of the facąde. The estimation results of the nested logit model suggest that the marginal willingness to pay for increasing the number of glazing of their windows and their variety are USD 18.2. For increasing the thickness of facąde of 1 mm is USD 1.2 and for establishing a ventilation system is USD 12.4 (Kwak et al., 2010, p.677). Henzelmann et al. (2010) conducted a survey among real estate managers in Germany, Austria and Switzerland in order to analyse the importance of sustainability in this investment sector. More than 70% of the individulas in the survey are willing to spend more money on sustainable real estates. The additional WTP on average is about 9%. The managers associate sustainability with a long-term conservation of value and a reduction of energy and maintenance costs rather than environmental concerns. Interestingly, 86% of the tenants would accept higher rents for sustainable homes, on average 4.5%.

3 Empirical Analysis

3.1 Data

The data used for the discrete choice analysis in this paper is based on a subsample of a larger survey among German households. It was collected by the GfK (Gesellschaft für Konsumforschung), a professionell market research institution in order to guarantee its quality. In June 2009, a face-to-face interview was conducted among 1,257 household decision makers. In a first stage, individuals fulfilling the required subsamples were recruited by telephone interviews. Afterwards, in a sec-

Table 2: Summary of demographic variables and living conditions of the sample

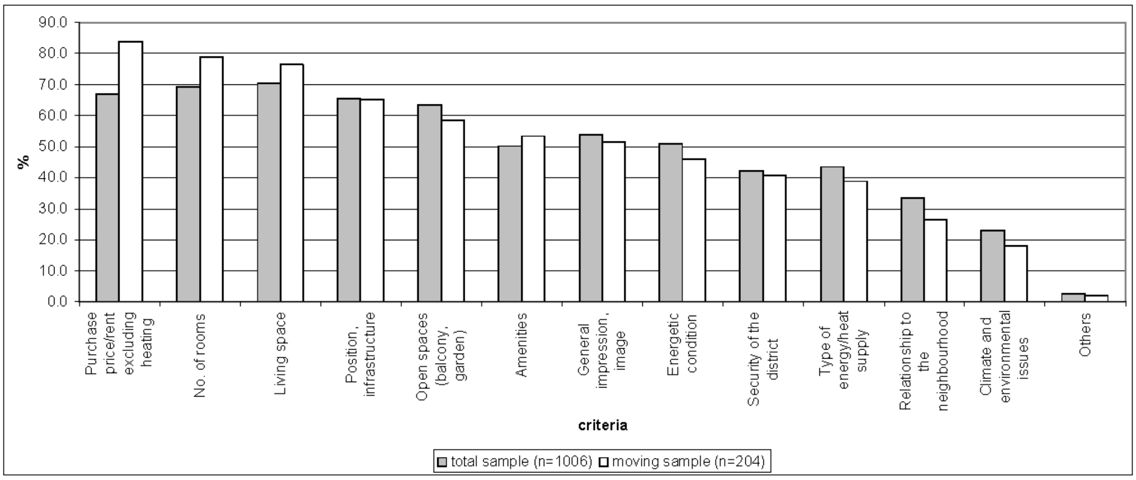
Survey Question	**Percent**
sample size: n=204	100.0
Demographics	
Gender	
Male	47.1
Female	52.9
Age	
18-25	11.3
26-35	25.0
36-45	27.5
46-55	21.6
56-65	9.8
> 65	4.9
Formal education	
Without any school degree	1.0
Secondary modern school	24.0
High school degree	45.1
Academic high school degree	16.2
University or college degree	13.7
Net income of the household per month	
Less than €1,000	17.7
€1,000-1,499	23.0
€1,500-1,999	23.0
€2,000-2,499	16.7
€2,500-3,499	14.7
> €3,500	4.9
Household members	
1	45.6
2	28.4
3-5	26.0
Living conditions	
Ownership structure	
Tenants	78.0
Owner-occupiers	22.0
House type	
Single-family detached house	9.3
Semidetached house	9.3
Row house	7.4
Multi-family house	67.7
High-rise building	4.4
Other	2.0

ond stage, individuals have been visited at their homes for a computer based personal consultation (CAPI method) which was used to collect and save the relevant information. The interviews on average took about 50 to 60 minutes. The underlying questionnaire consists of five parts. It contains questions on attitudes towards the environment (part 1), the household's energy use (part 2), housing conditions and attitudes towards energy efficiency (part 3), the choice experiments on green electricity, domestic appliances (i.e. TV) and decentralised heat consumption (part 4) as well as sociodemographic information (part 5). The question for the analysis of WTP when moving itself is a section of part 3. It should be taken into account that only participants who explicitly consider the possibility of moving within the next five years were asked about their preferences on energy efficiency in case of moving (about 20% of the entire sample). Hence, after cleaning up the data $N = 204$ observations can be used for the estimation. Table 2 summarizes socio demographic characteristics and housing conditions of the subsample. The table shows that mostly young singles with low incomes are those who plan to move within the next years. As expected, tenants are more flexible than owner-occupiers. About 2/3 of the movers lives in multi-family buildings.

3.2 Descriptive findings

Figure 1 provides an overview of the importance of different choice attributes in future living conditions perceived by the entire sample and by the potential movers. Monetary concerns like the

Figure 1: Importance of choice attributes in future living conditions

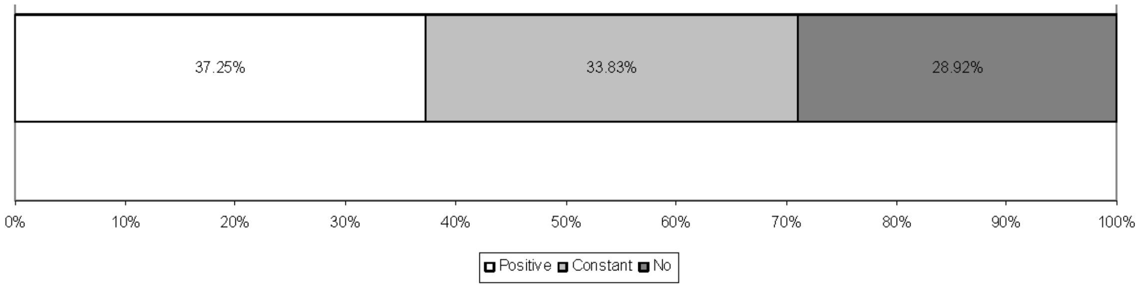


purchase price or rent exclusive of heating are discussed as the most important decision criteria among potential movers. Moreover, living space and the number of rooms seem to be very important. In contrast, energy-efficiency related concerns like the energy condition of the building, the type of energy/heat supply or climate and environmental issues only play a subordinate role. Although financial issues like purchase price are the most important criteria among potential movers, there is no link to energy efficiency in most cases.

If policy aims at strengthening the role of energy efficiency in buildings and foster refurbishment activities it is important to understand how WTP for respective technologies differs among individuals. An important research question is whether it is possible to identify certain population groups which clearly differ in response behaviour. This might help to adjust economic or political instruments accurately.

It should be noted that no real WTP for energy efficiency when moving can be derived from the underlying survey. The individuals are not asked about the total amount of money they are willing to pay but rather if they were willing to accept a higher purchase price/rent exclusive of heating for an energy-efficient building. Concretely, they can chose among the options: (1) Yes, as long as the building is affordable[4], (2) Yes, if the rent including heating in total does not rise/ if expected future saved energy costs equal to the increase of purchase price[5], and (3) No increase of purchasing prices/rent is accepted (WTP=0)[6]. As presented in figure 2, the descriptive analysis show heterogeneous response behaviour: 37.25% of the sample state a positive WTP for energy efficiency, whereas 28.92% of the individuals state a WTP=0. The remaining 33.83% of the sample choose option 2. Although energy efficiency is not considered to be among the most important decision criteria, more than a third of the sample states an increased WTP for advanced technologies. Thus, these individuals seem to value explicitly *co-benefits* like living comfort, ease of use, noise protection or environmental concerns.

Figure 2: WTP for energy efficiency in residential buildings



3.3 Model and Estimation

A multinominal logit model (MNLN) is used to estimate the drivers for an increased willingness to pay for energy efficiency in residential buildings when moving. This rather simple discrete choice model seems appropriate for the WTP analysis, also because no alternative-specific or generic variables are included in the regression (cp. Brownstone and Train, 1999). An important assumption of the MNLM is the independence of irrelevant alternatives (IIA) (cp. Train, 2009). This assumption requires that the Odds-ratio (P_{nk}/P_{nl}) for individual n of choice alternatives k and l is independent of the introduction or change of other choice alternatives. From a theoretic point of view this assumption seems to be satisfied because the response spectrum of the underlying question on WTP for energy efficiency covers all reasonable choice alternatives. Beyond that, from a empirical point of view hypothesis tests like Hausman test or Small-Hsiao Test provide support for the IIA in the models. In the following, the estimation strategy, the choice of regressors and their expected impacts are briefly discussed. In order to analyse the factors that drives WTP for energy efficiency when moving, in a first step, three models with different focus of explanatory variables are specified. Table 3 provides an overview of the variables entering the three models.
Model 1 includes standard sociodemographic variables like the monthly net household income,

4 in the following labelled as "positive WTP"
5 in the following labelled as "constant WTP"
6 in the following labelled as "no WTP"

Table 3: Definition of variables

Variable name	Definition	Percent
sample size: n=204		100.0
Model 1		
hh_income_upto1000	Net income of the household per month < €1,000	17.7
hh_income_from3500	Net income of the household per month > €3,500	4.9
age_upto30	Age up to 30 years	24.0
age_from61	Age from 61 years	7.8
educ_basic	Without any school degree, secondary modern school degree	25.0
educ_degree	University or college degree	13.7
female	Female	52.9
Model 2		
rural_area	place of residence with less than 20,000 inhabitants	30.4
east	Eastern Germany (without Berlin)	13.7
children	Household with children < 18 years	25.0
owner_new	Person is planning to buy property	17.7
accom_energy	Energy condition stated among the three most important criteria when moving	68.1
accom_baserent	Rent excluding heating bills or purchase price among the three most important criteria when moving	17.7
epc_attitude	assessment of energy pass as an appropriate instrument	65.7
tec_int	Technical interest	50.0
en_price	Person assumes a sharp increase in energy prices within the next years	45.1
Model 3		
env_buyer	Durability, greenness, regional origin and energy consumption as the most important consumer product attributes	39.2
env_politics	Environmental and climate policy among the two most important political challenges	20.6
env_science	Technology and science can not solely resolve environmental problems	36.8
env_lifestand	no willingness to accept a reduction of living status for enhancing environmental protection	64.7
env_rules	Environmental protection through binding public standards (e.g. taxes, prohibitions)	46.1
env_dailycon	increased wtp for green daily consumer goods	45.1

age, formal education and sex. Even though the analysis of drivers for and barriers to energy-efficient refurbishment in section 2 does not provide unambiguous insights on the importance of financial restrictions, a lower probability of choosing option (1) or (2) is expected in households with low incomes, especially if residence time is short or uncertain. In contrast to green daily consumer goods one might assume that household income has a stronger effect in the sector of sustainable buildings e.g. due to the remarkable front up investment in case of house purchase. With respect to age effects, on the one hand older people in addition to investment/revenue concerns may do not want to change routine behaviour and familiarise with new technologies. One the other hand, as pointed out in the previous section, older people, e.g. when retiring, are more interested to deal with retrofit measures. Formal education effects are assumed to have the same impact as in the refurbishment decision. Furthermore the model controls for potential gender effects. While women may generally pay more attention on green daily goods one might assume that men are more interested in energy efficiency attributes like façade insulation or heating technologies.

Model 2 focuses on the influence of current living conditions and housing preferences on WTP for energy efficiency when moving. Market power within the building sector in rural areas differs from urban districts where housing alternatives are scarce. Because of a wide range of offers and moderate prices, individuals in rural areas may pay more attention on energy condition of their future home. In addition, the model controls for potential differences between Eastern and Western Germany. Furthermore it is likely that preferences for energy efficiency among families with children differ from households without children. Likewise, individuals who consider the energy condition or the rent excluding heating costs as the most important housing attributes in the case of an upcoming move may behave differently from other subpopulation groups. Moreover, variables controlling for the attitude towards the energy pass and technical interest as well as expected changes in energy prices are included.

The importance of environmental concerns and knowledge as well as the buying behaviour with respect to daily consumer goods is captured by Model 3. One might argue that individuals who pay attention on consumer good attributes like durability, sustainability, regional origin and low energy consumption are more likely to accept higher purchase prices or rents for energy efficient buildings. Similar effects are expected for individuals who show a higher WTP for green daily consumer goods. Furthermore, variables controlling for environmental concerns are included to identify if individuals consider energy-efficient buildings as a possibility to make a contribution to climate protection.

In a second step, powerful variables of the Models 2 and 3 are linked with the basis model of standard sociodemographic variables (Model 4 and 5).

4 Results

The estimation results are presented in Tables 4 and 5. The coefficients $\beta 1, 1$ to $\beta 3, 23$ (Table 4) or $\beta 1, 1$ to $\beta 3, 16$ (Table 5) measure the impact of a certain regressor on response probabilities in relation to the base category "constant WTP" and are displayed as log-Odds-ratios. For example, $\beta 1, 1$ measures the influence of a low household income on the choice of alternative "positive WTP" in relation to the base category "constant WTP". Likewise, $\beta 3, 1$ captures the impact of a

Table 4: Estimation results Part I

Variable		**Model 1**		**Model 2**		**Model 3**	
hh_income_upto1000	$\beta1,1$	0.801*	(0.479)				
	$\beta3,1$	0.704	(0.519)				
hh_income_from3500	$\beta1,2$	−0.711	(0.790)				
	$\beta3,2$	−0.928	(0.892)				
age_upto30	$\beta1,3$	0.178	(0.403)				
	$\beta3,3$	−0.486	(0.470)				
age_from61	$\beta1,4$	1.750**	(0.850)				
	$\beta3,4$	1.482*	(0.876)				
educ_degree	$\beta1,5$	−0.164	(0.526)				
	$\beta3,5$	0.123	(0.534)				
educ_basic	$\beta1,6$	−0.227	(0.434)				
	$\beta3,6$	−0.076	(0.449)				
female	$\beta1,7$	0.042	(0.346)				
	$\beta3,7$	0.074	(0.369)				
rural_area	$\beta1,8$			−0.715*	(0.405)		
	$\beta3,8$			−0.818*	(0.457)		
east	$\beta1,9$			0.112	(0.577)		
	$\beta3,9$			0.994*	(0.568)		
children	$\beta1,10$			−0.051	(0.402)		
	$\beta3,10$			0.130	(0.457)		
owner_new	$\beta1,11$			0.069	(0.457)		
	$\beta3,11$			−0.157	(0.537)		
accom_energy	$\beta1,12$			0.108	(0.463)		
	$\beta3,12$			0.281	(0.516)		
accom_baserent	$\beta1,13$			−0.046	(0.375)		
	$\beta3,13$			0.040	(0.420)		
epc_attitude	$\beta1,14$			−0.005	(0.389)		
	$\beta3,14$			−0.911**	(0.409)		
tec_int	$\beta1,15$			0.415	(0.345)		
	$\beta3,15$			0.219	(0.385)		
en_price	$\beta1,16$			−0.047	(0.357)		
	$\beta3,16$			1.326***	(0.397)		
env_buyer	$\beta1,17$					−0.118	(0.372)
	$\beta3,17$					−0.143	(0.386)
env_politics	$\beta1,18$					−0.815*	(0.442)
	$\beta3,18$					−0.321	(0.456)
env_science	$\beta1,19$					0.750*	(0.385)
	$\beta3,19$					0.540	(0.405)
age_lifestand	$\beta1,20$					0.470	(0.377)
	$\beta3,20$					0.129	(0.389)
env_rules	$\beta1,21$					0.325	(0.369)
	$\beta3,21$					0.186	(0.383)
env_dailycon	$\beta1,22$					1.066***	(0.381)
	$\beta3,22$					−0.801*	(0.424)
_cons	$\beta1,23$	−0.099	(0.330)	0.128	(0.494)	−0.969	(0.420)
	$\beta3,23$	−0.240	(0.350)	−0.374	(0.544)	−0.103	(0.395)
N		204		204		204	
log likelihood		−216.694		−205.370		−205.042	
McFadden's R-sq		0.028		0.079		0.081	

Standard errors in parentheses * p<0.10 ** p<0.05 *** p<0.01

Table 5: Estimation results Part II

Variable		**Model 1**		**Model 4**		**Model 5**	
hh_income_upto1000	$\beta 1, 1$	0.801*	(0.479)	0.959*	(0.522)	0.913*	(0.497)
	$\beta 3, 1$	0.704	(0.519)	0.579	(0.590)	0.560	(0.565)
hh_income_from3500	$\beta 1, 2$	−0.711	(0.790)	−0.705	(0.851)	−1.030	(0.808)
	$\beta 3, 2$	−0.928	(0.892)	0.039	(0.973)	−0.302	(0.934)
age_upto30	$\beta 1, 3$	0.178	(0.403)	0.064	(0.444)	0.148	(0.417)
	$\beta 3, 3$	−0.486	(0.470)	−0.355	(0.520)	−0.356	(0.500)
age_from61	$\beta 1, 4$	1.750**	(0.850)	1.865**	(0.937)	1.542*	(0.879)
	$\beta 3, 4$	1.482*	(0.876)	1.778*	(0.966)	1.699*	(0.921)
educ_degree	$\beta 1, 5$	−0.164	(0.526)	−0.439	(0.562)	−0.307	(0.547)
	$\beta 3, 5$	0.123	(0.534)	0.318	(0.595)	0.431	(0.578)
educ_basic	$\beta 1, 6$	−0.227	(0.434)	−0.123	(0.499)	0.019	(0.462)
	$\beta 3, 6$	−0.076	(0.449)	−0.038	(0.518)	−0.242	(0.493)
female	$\beta 1, 7$	0.043	(0.346)	0.246	(0.380)	0.115	(0.365)
	$\beta 3, 7$	0.074	(0.369)	0.373	(0.414)	0.303	(0.404)
env_dailycon	$\beta 1, 8$			1.214***	(0.395)	1.139***	(0.371)
	$\beta 3, 8$			−0.834*	(0.470)	−0.800*	(0.440)
epc_attitude	$\beta 1, 9$			−0.026	(0.435)	0.077	(0.411)
	$\beta 3, 9$			−1.156***	(0.418)	−1.186***	(0.431)
en_price	$\beta 1, 10$			−0.012	(0.390)	−0.052	(0.371)
	$\beta 3, 10$			1.301***	(0.418)	1.165***	(0.398)
env_politics	$\beta 1, 11$			−1.084**	(0.481)		
	$\beta 3, 11$			−0.366	(0.501)		
env_science	$\beta 1, 12$			0.814**	(0.397)		
	$\beta 3, 12$			0.544	(0.441)		
env_lifestand	$\beta 1, 13$			0.425	(0.391)		
	$\beta 3, 13$			0.024	(0.429)		
rural_area	$\beta 1, 14$			−0.472	(0.422)		
	$\beta 3, 14$			−0.644	(0.453)		
east	$\beta 1, 15$			−0.056	(0.629)		
	$\beta 3, 15$			0.987*	(0.579)		
_cons	$\beta 1, 16$	−0.099	(0.330)	−0.995	(0.630)	−0.796	(0.529)
	$\beta 3, 16$	−0.240	(0.350)	−0.285	(0.667)	−0.056	(0.540)
N		204		204		204	
log likelihood		−216.694		−183.479		−191.692	
McFadden's R-sq		0.028		0.177		0.141	

Standard errors in parentheses * p<0.10 ** p<0.05 *** p<0.01

low household income on choosing alternative "no WTP" in relation to the base category "constant WTP". These results are used to discuss the impact of the variables and the statistical power of the models. Thereafter, in order to facilitate the economic interpretation of the estimation results, marginal effects[7] are discussed (Table 6).

Estimation results show that sociodemographic variables alone can not explain the heterogeneity in response behaviour. The statistical power of model 1 remains low (log likelihood: -216.694; McFadden's R-sq: 0.028). Only individuals older than 61 years and low income households show different response behaviour. Neither (formal) education nor gender effects can be identified.

In contrast, model 2 suggests that information on current living conditions and housing preferences are more useful to explain decision behaviour and increase the statistical power of the discrete choice model (log likelihood: -205.370; McFadden's R-sq: 0.079). Living in small rural towns with less than 20,000 inhabitants and living in Eastern Germany changes the response behaviour significantly. Moreover, the expectation of a sharp increase in future energy prices (45.1% of the sample) has a strong impact ($p < 0.01$) on preferences for energy efficiency when moving. Surprisingly, the probability of a high WTP decreases if individuals expect higher future energy prices and if they doubt that technical or scientific progress solely can mitigate pollution externalities.

As model 3 suggests, variables on environmental concerns are more helpful than sociodemographics to explain the heterogeneity, too (log likelihood: -205.042; McFadden's R-sq: 0.081). The estimation results provide strong evidence that an increased WTP for green daily consumer goods increases the probability of a higher WTP for energy efficiency in residential buildings. Thus, similarities of preferences on sustainability within these two sectors can be assumed. Furthermore, the response behaviour differs if individuals consider environmental and climate protection among the two most important political challenges (20.6% of the sample) and do not believe that technology and science solely can resolve environmental problems.

To conclude, the estimation results of these models suggest that the heterogeneity of preferences and WTP for energy efficiency can not just be derived from sociodemographic differences. Information on housing preferences and environmental concerns seem to be quite useful to predict decision behaviour. In order to obtain a more extensive estimation of preferences and to validate the robustness of the findings powerful variables of models 2 and 3 are linked to the basic model. The results are presented in table 5. Interestingly, the impact of sociodemographic variables remains similar to the results in model 1. Moreover, the estimation results of models 4 and 5 strengthen the role of environmental concerns and housing preferences. There is strong evidence that an increased WTP for green daily consumer goods and a positive attitude towards the energy pass lead to higher utility obtained from energy efficiency. Furthermore, the effects of expected energy prices and the role of technology and science in environmental and climate protection remain significant. The estimation of marginal effects is used to precise the estimation results and facilitate their economic interpretation (Table 6). In order to maintain the table as clear as possible, it contains only significant results.

[7] Marginal effects are estimated as marginal effects at the mean (MEM) and average marginal effects (AME) by using Stata 10.0 post-estimation commands *mfx* and *margeff*. *mfx* is Stata's standard command and measures the effect of a marginal change for the mean individuum and therefore at the mean of every explanatory variable. Especially when using *dummy* variables, the economic interpretation may remain questionable. In contrast, AME provides an estimate of the average of the marginal effect for every individual (cp. Bartus 2005).

Table 6: Marginal effects

		Model 1 margeff	Model 1 mfx	Model 2 margeff	Model 2 mfx	Model 3 margeff	Model 3 mfx	Model 4 margeff	Model 4 mfx	Model 5 margeff	Model 5 mfx
hh_inc_upto1000	Pr(wtp=p)										
	Pr(wtp=c)	−14.85**	−15.44*					−14.49**		−14.77***	
	Pr(wtp=n)										
age_upto30	Pr(wtp=p)										
	Pr(wtp=c)										
	Pr(wtp=n)	−11.05**									
age_from61	Pr(wtp=p)										
	Pr(wtp=c)	−25.92***	−26.80***					−26.36***	−34.37***	−25.14***	−29.65***
	Pr(wtp=n)										
rural_area	Pr(wtp=p)										
	Pr(wtp=c)			16.71**	18.37**						
	Pr(wtp=n)										
east	Pr(wtp=p)										
	Pr(wtp=c)										
	Pr(wtp=n)			18.15*	20.66*			17.49*	24.47**		
epc_attitude	Pr(wtp=p)										
	Pr(wtp=c)										
	Pr(wtp=n)			−17.14***	−12.86**			−19.30***	−20.62**	−21.37***	−23.19***
en_price	Pr(wtp=p)			−14.14**	−17.05**			−10.62*		−10.48*	− 9.22*
	Pr(wtp=c)			−11.10*	−14.02*			−11.24*	−22.90***		−19.30**
	Pr(wtp=n)			25.24***	31.07***			21.86***	31.47***	20.49***	28.52***
env_politics	Pr(wtp=p)					−13.10*	−7.42*	−16.36**	−9.84*		
	Pr(wtp=c)							15.10*			
	Pr(wtp=n)										
env_science	Pr(wtp=p)										
	Pr(wtp=c)					−13.65**	−14.00*	−13.37**	−15.18*		
	Pr(wtp=n)										
env_dailycon	Pr(wtp=p)					31.07***	27.32***	31.53***	30.98***	30.92***	30.89***
	Pr(wtp=c)										
	Pr(wtp=n)					−25.50***	−23.38***	−23.22***	−22.70**	−22.70***	−24.45***

wtp=p: positive WTP(1), wtp=c: constant WTP(2), wtp=n: no WTP(3)   * p<0.10 ** p<0.05 *** p<0.01

The choice probability for alternative "constant WTP" is decreasing significantly about 15%[8]if the monthly net income of the household is smaller than €1,000. The results suggest that these individuals tend to choose alternative "positive WTP". Moreover, households with incomes above €3,500 per month more often choose alternative (2), but these two findings are not significant. However, one might conclude that smaller financial resources tend to rise the awareness of energy efficiency in the flat- or house-hunting process. Energy costs are a higher burden for low income classes. Thus, reducing the monthly energy costs by using efficient technologies and being independent of future increases in energy prices sensitises these households for a higher WTP for energy-efficient buildings. In contrast, other attributes like historical buildings with high ceilings, large windows and an open design may have priority in high income households. For high income classes, the costs for space and water heating are relatively lower in such a way that they are probably more likely to accept higher energy costs if the building meets their aestetic requirements. As opposed to these argument, the estimation of marginal effects suggests that individuals in Eastern Germany are significantly less likely (about 18%) to accept higher prices for efficient buildings than their western counterparts which might be explained by difference in income distributions. This is why no clear income effects can be derived from the models. With respect to age similar effects can be derived. Older individuals significantly rarely choose alternative "constant WTP" (around -26%) and therefore more often state a higher or no WTP. Although model 1 suggests that young persons are less likely to choose alternative (3) (-11%) these findings do not remain significant in models 4 and 5.

In contrast, variables on environmental concerns and housing preferences provide valuable insights. For example, the energy pass plays an important role. Individuals who consider the energy pass as an important and useful instrument are less likely (-17% to -21%) to choose WTP=0. Energy-conscious households trust in this instrument and therefore are more likely to accept higher purchase prices or rents. From an investor or landlord point of view these findings suggest that energy-conscious individuals are willing to accept higher front up investments or rents if advanced energetic conditions are certified credibly. This is in line with the findings of Henzelmann et al. (2010) showing that 86% of the respondents accept higher rents for sustainable buildings. As already discussed, the effects of expectations on future energy prices are somewhat unexpected. All three models controlling for this variable suggest that the expectation of a sharp increase in energy prices for the self used energy source (in most cases gas and oil) negatively influences the probability of accepting a high WTP for energy-efficient technologies (about -10% to -14%), although especially in these cases appropriate front up investments could reduce energy costs in the long term. A possible explanation for the decision behaviour might be uncertainty and risk aversion. Although these households expect higher future energy costs they may implicitly value the risk of other market trends and therewith lower profitability of energy-efficient technologies, too. So, if this value is high they probably will not adjust their WTP. Furthermore, one might conclude that financial restrictions or uncertainty about the future household income have important impacts on the decision.

The effects of environmental concerns on the WTP are heterogenous. On the one hand estimation results suggest that individuals who do not believe that scientific and technological progress

[8] Here and in the following, the discussion is based on the estimated AME resulting from the *margeff* command.

is sufficient to mitigate negative environmental and climate externalities and therefore stress the meaning of self-commitment, are significantly less likely to choose option (2) (-13%) and might be more likely to accept a higher WTP. Thus, for these individuals the building sector provides the possibility to self-contribute to climate protection. On the other hand, the part of the sample which considers environmental and climate protection among the most important political challenges, has a significant lower probability (about -13% to -16%) of stating a "positive WTP". It remains an open question if individuals explicitly avoid the building sector as potential sector to strengthen climate protection or if they consider politics to be responsible for the diffusion of energy-efficient technologies in residential buildings. Parallels can be drawn to the WTP for green daily consumer goods. If individuals are willing to pay more for daily consumer goods it is also more likely (+30%) that they accept higher purchase prices or rents for sustainable buildings as long as these are affordable to them.

5 Conclusion

The empirical analysis suggests that various factors determine preferences for energy efficiency in residential buildings when moving. However, both the studies on drivers for and barriers to energy-efficient refurbishment activities and the results presented in this paper show that the heterogeneity in response behaviour on WTP for appropriate technologies can not fully be explained by financial restrictions. Thus, political instruments to strengthen the diffusion of energy-efficient technologies and foster retrofit and refurbishment activities should not focus solely on subsidies and funding programmes. Financial programmes like for example offered by KfW bank (Reconstruction Loan Corporation) should ensure the access to capital markets, minimize information and transaction costs and reduce market asymmetries. Moreover, labeling instruments like the energy pass are useful to reduce asymmetric information between suppliers and demanders. Enhancing the publication requirements and introducing an official certification system as required in EPBD 2010 are economically reasonable extensions of this instrument. Furthermore, it is important to tackle the paucity of information on own energy consumption, investments costs and saving potentials. Networks consisting of energy advisers, tradesmen and one-on-one conversation with relative and friends who are familiar with energy efficiency play a key role to foster knowledge on energy consumption in buildings. In addition, investment incentives in energy-efficient refurbishment can be encouraged if building owners are allowed to rise the rent without heating costs permanently afterwards. In order to guarantee planing security, respective adjustments of the landlord and tenant law are necessary.

Because of the sector's absence in the European Union Emission Trading System (EU ETS), a reduction of energy use for decentralised heat generation in the building sector is likely to reduce CO_2 emissions. It should be noted that binding refurbishment obligations e.g. for old buildings violate the criterion of cost efficiency and do not necessarily lead to maximal CO_2 abatement because these instruments ignore abatement costs. Therefore, emissions trading systems or energy taxes are more powerful to fulfil environmental and climate targets. If policy aims at mitigating external effects of pollution resulting from decentralised heat consumption in residential buildings, energy taxes based on the CO_2 intensity of the energy source might be an appropriate instrument.

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A Appendix

Table A.1: Main characteristics of compared empirical studies on barriers to and drivers for energy efficiency in residential buildings

	BMVBS 2007	Jakob 2007	Achtnicht 2010	Stiess et al. 2010
Type of interview	not reported	written surevey	CAPI	CAPI and BUS method
Subjects	house owners, house management	self-occupied single house owners	household decision makers with respect to energy consumption related concerns	self-occupied single and double house owners
Number of observations	$n = 1,000$	$n = 360$	$n = 1,257$	$n = 1,008$
Time	February and July, 2007; August and September 2007	2001/2002 and mid-2004	June, 2009	January until March, 2009
Country	Germany	Switzerland	Germany	Germany