Time, Price and Emissions: What Drives Sustainable Leisure Travel Choices?

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Dissertation written under the supervision of Professor Nuno Moreira da Cruz.

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Abstract (English)

Leisure travel in Europe is still dominated by air transport, even on routes where rail is a feasible alternative with lower CO_2 emissions. This gap between environmental concern and actual choices is a sustainability challenge: at the point of purchase, convenience and affordability often override pro-environmental preferences. This thesis examines how leisure travelers trade off travel time, ticket price, and CO_2 emissions when choosing between air and rail.

It tests how strongly these attributes shape mode choice, whether sensitivities differ by income, and whether moral norms predict selecting the lower-emission option. The thesis expects time and price to dominate decisions, with emissions as a secondary cue; higher income should reduce price sensitivity, and stronger moral norms should increase the propensity to choose rail.

Data come from an online stated choice experiment (N = 133). Respondents repeatedly chose between a fixed flight option and a varied rail option, enabling estimation of trade-offs under explicit time-price-emissions scenarios.

Results show that functional attributes are the primary drivers of mode choice: even moderate rail disadvantages in travel time or price reduce rail uptake. CO_2 information remains relevant but rarely offsets substantial time or cost penalties. Higher-income respondents exhibit weaker price sensitivity, while stronger moral norms are associated with greater rail selection without displacing the central role of time and price. Shifting leisure travelers from air to rail appears most plausible when rail is competitive on time and cost and when emissions information is salient at the moment of choice.

Keywords: travel behavior; sustainable customer behavior; air-rail mode choice; leisure travel; stated choice experiment; CO_2 emissions; moral norms; time-price trade-offs

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Abstract (Portuguese)

As viagens de lazer na Europa continuam a ser dominadas pelo avião, mesmo em rotas onde o comboio é uma alternativa viável e com emissões de CO_2 muito mais baixas. Esta discrepância indica que, no momento da compra, conveniência e preço frequentemente se sobrepõem às preferências pró ambientais. Esta dissertação analisa como viajantes de lazer ponderam tempo de viagem, preço do bilhete e emissões de CO_2 ao escolher entre avião e comboio.

Examina-se ainda se estas sensibilidades variam com o rendimento e se normas morais aumentam a probabilidade de escolher a opção de menor emissão. Assume-se que tempo e preço dominam a decisão e que as emissões funcionam como um sinal secundário; rendimentos mais altos deverão reduzir a sensibilidade ao preço.

Os dados provêm de um experimento de escolha declarada online (N = 133). Os participantes escolheram repetidamente entre uma opção fixa de voo e uma opção ferroviária sistematicamente variada, sob cenários explícitos de tempo, preço e emissões.

Os resultados mostram que atributos funcionais são determinantes: desvantagens moderadas do comboio em tempo ou preço reduzem a sua escolha. A informação sobre CO_2 permanece relevante, mas raramente compensa penalizações grandes de tempo ou custo. Participantes com maior rendimento exibem menor sensibilidade ao preço, e normas morais mais fortes associam-se a maior adesão ao comboio, sem deslocar o papel central de tempo e preço. A mudança do avião para o comboio é mais plausível quando o comboio é competitivo em tempo e custo e quando a informação de emissões é saliente.

Palavras-chave: comportamento de viagem; comportamento sustentável do cliente; escolha do modo aéreo-ferroviário; viagens de lazer; experimento de escolha declarada; emissões de CO_2; normas morais; compromissos entre tempo e preço

Título: Tempo, preço e emissões: o que influencia as escolhas sustentáveis em viagens de lazer?

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List of Abbreviations

ABG – Attitude behavior gap

AME – average marginal effects

CADM – Comprehensive Action Determination Model

CI – Confidence Interval

cp – ceteris paribus

H1 – Hypothesis 1

H2 – Hypothesis 2

H3 – Hypothesis 3

H4 – Hypothesis 4

IBG – Intention behavior gap

MN – Moral Norm Index

NAM – Norm Activation Model

OR – Odds Ratio

RQ 1 – Research Question one

RQ 2 – Research Question two

RQ 3 – Research Question three

SE – Standard Error

TPB – Theory of planned behavior

TRA – Theory of Reasoned Action

VBN – Value Belief Norm

WTP – Willingness to Pay

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1 Introduction

1.1 Background and relevance of sustainable consumer behavior

Climate change and environmental degradation are among the defining global challenges of the twenty-first century. Achieving the goals of the Paris Agreement requires that global greenhouse gas emissions be reduced by half before 2030 and reach net zero by the middle of the century (World Tourism Organization [UNWTO], 2023). As scientific evidence on climate impacts becomes more urgent, it is increasingly clear that substantial emission reductions are needed across all sectors of the economy, including those driven by private consumption (UNWTO, 2023).

Within this broader context, patterns of everyday consumption have gained prominence in public and academic debates on sustainability. Decisions about food, mobility, housing, leisure and apparel cumulatively drive a large share of energy use and resource demand. Sustainable consumer behavior is therefore widely seen as a key lever for reducing environmental pressures, alongside technological innovation and regulatory measures (White et al., 2019). It is commonly understood as consumer behavior that seeks to minimize negative environmental and social impacts over the life cycle of products and services, for example by reducing overall consumption levels, choosing more sustainable alternatives and using resources more efficiently in daily life (White et al., 2019).

At the same time, consumption is not only a source of environmental pressure but also a channel through which citizens express values and expectations towards companies and policy makers. Since the Brundtland Report introduced the concept of sustainable development in the late 1980s, sustainability has become an important reference point for international agendas such as the 2030 Agenda for Sustainable Development and its Sustainable Development Goals (World Commission on Environment and Development [WCED], 1987; Colaço et al., 2020). Market data indicate that spending on products positioned as sustainable has grown faster than conventional product categories, suggesting that a growing segment of consumers actively seeks to align purchasing decisions with social and environmental concerns (Colaço et al., 2020).

These developments have important implications for firms and other organizations. Companies in fast-moving consumer goods, apparel and services increasingly align their strategies with sustainability-related expectations and invest in purpose-driven brands that communicate environmental and social commitments to their customers (Colaço et al., 2020). Purpose-oriented positioning can strengthen emotional bonds, trust and loyalty, but it also exposes firms to greater scrutiny regarding the coherence between communicated values and actual business practices (Colaço et al., 2020). Understanding how consumers perceive and evaluate such efforts, and how these perceptions influence concrete choices, has therefore become a central concern for both marketing practice and sustainability policy (White et al., 2019).

Against this background, the analysis of consumer behavior toward sustainability is highly relevant for designing effective climate and sustainability strategies. It provides insights into how individuals respond to information, prices, convenience and broader value propositions when choosing between more and less resource-intensive options (White et al., 2019; Colaço et al., 2020). These insights are pertinent across many domains of consumption, including mobility and travel, where individual decisions can have particularly pronounced environmental impacts and where more sustainable alternatives are increasingly available (UNWTO, 2023). This thesis builds on this broader discussion by focusing on sustainable consumer behavior in the context of leisure travel, which will be introduced in more detail in the following section.

1.2 Sustainable travel and leisure mobility

Tourism has become one of the largest and fastest growing service industries worldwide. Recent global assessments estimate that tourism related activities account for about 8 to 10 percent of global greenhouse gas emissions when transport, accommodation and other consumption are taken into account (Lenzen et al., 2018; World Tourism Organization [UNWTO], 2023). A substantial share of this footprint arises from passenger transport, particularly air travel, which enables long haul journeys and short city breaks but is among the most carbon intensive modes of passenger transport (Goessling & Humpe, 2020; UNWTO, 2023).

Transport-related emissions from tourism have increased markedly over recent decades. A joint report by UNWTO and the International Transport Forum estimates that transport related tourism emissions grew by around 60 percent between 2005 and 2016 and represented roughly 5 percent of global CO_2 emissions in 2016 (UNWTO, 2023). Under current decarbonization efforts these emissions are expected to rise further towards 2030, which underlines the difficulty of reconciling the continued expansion of tourism with international climate targets (UNWTO, 2023).

Within this broader picture, leisure travel plays a central role. Holiday trips and visits to friends and relatives account for a large share of international and domestic tourism demand and are often discretionary journeys that could in principle be organized in different ways (Goessling & Dolnicar, 2023; UNWTO, 2023). For many routes, especially within Europe, travelers can realistically choose between air transport and lower emission alternatives such as rail, in particular on short and medium distance trips of a few hundred up to around 1,500 kilometers (Mehdizadeh et al., 2025).

In such situations, travelers weigh several attributes when deciding how to travel. Besides the destination and purpose of the trip, key factors include total travel time, ticket price, comfort and convenience, as well as the availability of direct connections or the need to change trains or planes (UNWTO, 2023; Mehdizadeh et al., 2025). In recent years, the climate impact of different transport modes has gained visibility in public debate and policy, supported by measures and campaigns that encourage a shift from air to rail where feasible, for example on short haul routes with competitive rail alternatives (Mehdizadeh et al., 2025).

For policymakers and transport providers, these developments raise important questions about the conditions under which leisure travelers are willing to choose lower emission options in their holiday mobility. Understanding how differences in travel time, ticket price and carbon emissions shape the choice between air and rail is particularly relevant in European markets where rail can serve as a viable alternative to air travel on many leisure routes (UNWTO, 2023; Mehdizadeh et al., 2025). This thesis addresses this context by focusing on leisure trips in Europe in which travelers can realistically choose between air travel and lower emission rail options.

1.3 Scope of the research

This thesis examines how differences in travel time, ticket price and carbon emissions influence the choice between air and rail for leisure trips in a European context. The central aim is to quantify these trade-offs for leisure travelers and to explore how they vary between traveler groups with different socio-economic characteristics and sustainability related orientations.

The analysis focuses on leisure trips where travelers can realistically choose between air travel and lower emission rail options on short and medium distance routes. Business travel and other transport modes, such as private car or coach, are only considered indirectly when discussing the broader implications of the findings.

The following Chapter reviews the relevant theoretical and empirical literature on sustainable consumption, tourism and travel mode choice, and develops the conceptual framework and research questions that guide the empirical analysis in this thesis.

2 Literature Review

Sustainable leisure travel sits at the intersection of broader debates on sustainability, consumption and travel behavior. This chapter first introduces key concepts of sustainability, sustainable development and sustainable consumption and links them to consumer behavior and leisure travel. It then outlines psychological approaches to sustainable behavior and examines how behavioral gaps, habits and contextual constraints shape travel decisions. Finally, it reviews empirical evidence on trade-offs between price, time, comfort and emission reductions in tourism and mobility and uses these insights to identify research gaps, define the contribution of this thesis and formulate the research questions and hypotheses that guide the empirical analysis.

2.1 Sustainability and sustainable consumption

2.1.1 Foundations of sustainability and sustainable development

The modern debate on sustainability is closely linked to the concept of sustainable development, as introduced by the World Commission on Environment and Development in the late 1980s. In Our Common Future, sustainable development is defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987). The definition highlights both the satisfaction of basic needs, particularly for poorer populations, and the existence of ecological limits that constrain economic activity and resource use (WCED, 1987).

Building on this definition, sustainability is commonly described as the integration of environmental, economic, and social objectives (WCED, 1987; United Nations, 2015). These principles are reflected in the 2030 Agenda and its 17 Sustainable Development Goals, which call for deep reductions in greenhouse gas emissions, more efficient resource use, and changes in production and consumption patterns (United Nations, 2015). Climate action and responsible consumption and production are explicitly recognized as core pillars through Sustainable Development Goals 13 and 12 (United Nations, 2015; Colaço et al., 2020).

Within this framework, sustainability provides the macro-level context for debates on how societies can reconcile human well-being with environmental limits. A central strand concerns the role of consumption patterns and everyday choices in driving environmental pressures and enabling more sustainable development pathways (United Nations Environment Programme

[UNEP], 2016; Colaço et al., 2020; White et al., 2019). The next subsection therefore turns to sustainable consumption and its link to individual consumer behavior.

2.1.2 Sustainable consumption and consumer behavior

In the literature, sustainable consumption is commonly defined as the use of goods and services that satisfies current needs while reducing negative environmental impacts, particularly greenhouse gas emissions (UNEP, 2016). Related notions such as green, ethical, and responsible consumption emphasize different aspects of this idea. Ethical and responsible consumption, in particular, highlight the broader social consequences of consumption choices and the notion that consumers bear some responsibility for these consequences (Kollmuss & Agyeman, 2002; Colaço et al., 2020). Recent work on purpose-driven and sustainability-oriented consumption further suggests that many consumers increasingly seek products and services that reflect environmental and social values and view their spending as a way to support wider societal goals (Colaço et al., 2020).

From a behavioral perspective, sustainable consumption can be described as a specific form of consumer behavior in which environmental and social criteria are integrated into purchasing and usage decisions alongside more traditional considerations such as price, quality, convenience, and brand attachment (White et al., 2019). Rather than basing decisions on ecological motives alone, consumers typically evaluate sustainability-related attributes together with functional benefits, perceived risks, emotional meanings, and habits that structure everyday routines (Kollmuss & Agyeman, 2002; White et al., 2019).

In the context of this thesis, sustainable consumption is understood primarily in terms of environmentally and especially climate-relevant consumption decisions, while insights from responsible and purpose-driven consumption underline the role of individual choice and value alignment in shaping such decisions in leisure-related travel (UNEP, 2016; Colaço et al., 2020; White et al., 2019).

2.1.3 Sustainable consumer behavior in the context of leisure travel

Sustainable consumer behavior can be applied to tourism as sustainable travel behavior, meaning that travelers consider environmental impacts alongside experiential and practical aspects of travel decisions. Because transport is a major driver of tourism-related greenhouse gas emissions, mobility choices represent a particularly relevant domain in which sustainability objectives can conflict with convenience, travel time, and cost (Barr et al., 2010; Higham et al., 2016). At the same time, the sector's decarbonization requires substantial emission reductions, and current roadmaps explicitly emphasize the need to shift demand towards less emission-intensive transport modes where feasible (UNWTO, 2023).

In Europe, a central substitution potential exists between short-haul air travel and long-distance rail. For many leisure trips, rail constitutes a lower-emission alternative, yet it often differs from air travel in terms of travel time, connections, and ticket prices. Sustainable leisure travel can therefore be analyzed as a trade-off process in which travelers weigh functional attributes against environmental performance when choosing between air and rail. This thesis builds on this perspective and conceptualizes sustainable leisure travel behavior as a discrete mode-choice problem that focuses on the relative importance of travel time, ticket price, and CO_2 emissions in air versus rail choices.

2.2 Psychological Foundations of sustainable behavior

To understand why environmental concern does not consistently translate into sustainable travel choices, research draws on established behavioral theories. In the context of this thesis, these frameworks are primarily used to structure key psychological determinants of sustainable mode choice and to clarify how attitudes, norms, and perceived feasibility can shape decisions. The following sections summarize the most relevant mechanisms and highlight how attitudes, norms, and perceived feasibility can shape sustainable travel decisions.

2.2.1 Theory of Planned Behavior

The Theory of Planned Behavior (TPB) explains behavior as primarily driven by behavioral intentions, which are shaped by attitudes, subjective norms, and perceived behavioral control (Ajzen, 1991; Fishbein & Ajzen, 1975). Attitudes reflect an individual's overall evaluation of performing a behavior, subjective norms capture social expectations, and perceived behavioral control denotes the extent to which individuals feel capable of performing the behavior (Ajzen, 1991). Figure 1 summarizes these relationships and illustrates that perceived behavioral control can affect behavior both indirectly through intentions and directly when actual constraints limit action (Ajzen, 1991, 2011).

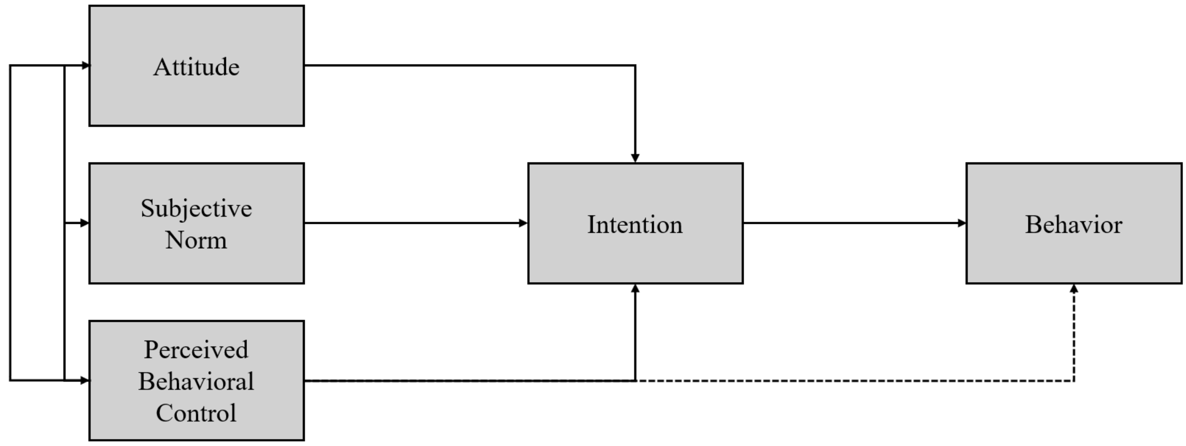

Figure 1 Theory of planned behavior. Own illustration based on Ajzen (1991).

In TPB, intentions are expected to predict behavior, while perceived behavioral control becomes particularly important in contexts where feasibility constraints are salient (Ajzen, 1991). This distinction is highly relevant for travel decisions, which are often shaped by factors such as schedules, connectivity, perceived reliability, and financial costs. Applied to sustainable travel decisions, TPB suggests that individuals are more likely to select lower-emission alternatives when they evaluate them positively, perceive social approval, and consider them feasible given their time and budget constraints.

Importantly, TPB highlights that intentions translate into behavior only when perceived behavioral control is sufficient; in travel contexts, binding constraints can therefore weaken the intention-behavior link (Ajzen, 2011). This perspective is taken up more explicitly in Section 2.3 when discussing attitude- and intention-behavior gaps and the role of contextual constraints.

2.2.2 Norm Activation Model and Value-Belief-Norm Theory

Norm-based approaches highlight that pro-environmental behavior is not only driven by instrumental considerations, but also by moral obligation. The Norm Activation Model (NAM) proposes that behavior is guided by personal norms, understood as feelings of moral responsibility to act (Schwartz, 1977). These personal norms are activated when individuals become aware of the negative consequences of a behavior and when they ascribe responsibility to themselves for addressing these consequences (Schwartz, 1977). In this view, pro-environmental action becomes more likely when people recognize environmental harm and perceive their own role in preventing it.

Building on this logic, Value-Belief-Norm (VBN) theory links moral motivation to more stable antecedents. VBN suggests that pro-environmental behavior is more likely when individuals hold self-transcendent values, endorse beliefs about environmental threats, and perceive that these threats conflict with valued goals, thereby strengthening personal norms (Stern, 2000; Stern et al., 1999). Compared to TPB, which focuses on intention formation, NAM and VBN emphasize that behavior can be driven by internalized moral standards even when sustainable options involve inconvenience or personal costs.

Applied to sustainable travel decisions, these frameworks imply that individuals with stronger personal norms and climate-related concern should be more willing to reduce emissions, particularly when they perceive air travel as environmentally harmful and feel personally responsible for mitigation (Schwartz, 1977; Stern, 2000). At the same time, the explanatory power of moral obligation is likely to depend on feasibility. Even strong personal norms may not translate into behavior when viable alternatives are perceived as unavailable or excessively costly, which reinforces the relevance of contextual constraints in travel mode choice.

2.2.3 Comprehensive Action Determination Model

While models such as the TPB and the VBN each focus on specific groups of determinants the Comprehensive Action Determination Model (CADM) integrates insights from intention-based and norm-based approaches by acknowledging that pro-environmental behavior can be shaped by deliberate decision-making, habitual processes, and situational constraints simultaneously (Klöckner, 2013). Rather than treating these mechanisms as competing explanations, CADM conceptualizes ecological behavior as the outcome of an intentional process (e.g., attitudes and intentions), a normative process (e.g., social and personal norms), a habitual process (e.g., heuristics and learned routines), and situational influences that enable or constrain action (Klöckner, 2013). Figure 2 illustrates these interacting pathways.

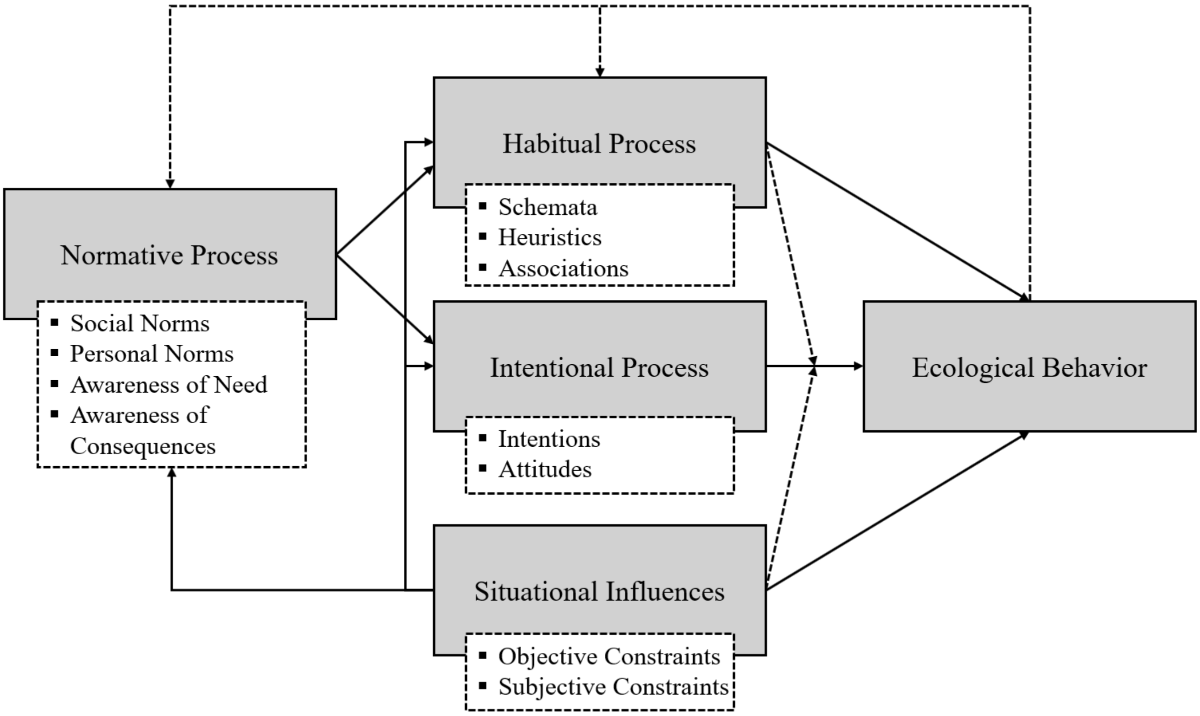

Figure 2 Comprehensive Action Determination Model (CADM). Own illustration based on Klöckner (2013).

A key contribution of CADM is that it explicitly captures why pro-environmental intentions may not translate into behavior in contexts where decisions are routinised or where constraints are binding. In travel, repeated mode choices can become habitual and therefore less responsive to new information or shifting preferences. At the same time, situational influences such as infrastructure, schedule availability, perceived reliability, and relative prices can limit feasible options and thereby weaken the effect of both intentions and personal norms (Klöckner, 2013). CADM is therefore particularly useful for sustainable travel behavior because it links psychological determinants to the practical realities of mobility, where convenience and feasibility frequently determine whether environmentally preferable options are chosen.

2.3 Behavioral Gaps and Contextual Factors

Building on the psychological approaches outlined in the previous section, values, attitudes, norms, and perceived behavioral control help explain sustainability-related intentions. However, empirical research consistently shows a gap between such intentions and actual behavior. In the context of holiday and air travel, studies on voluntary CO_2 offsetting indicate that passengers' real payment behavior falls markedly short of their expressed climate concern and stated willingness to pay (WTP) (Berger et al., 2022; Schwirplies et al., 2019).

To understand why pro-environmental orientations do not consistently translate into sustainable travel choices, two complementary perspectives are particularly relevant. First, evidence on attitude- and intention-behavior gaps highlights that stated preferences may diverge from actual behavior. Second, habits and situational factors such as price, time, availability, and infrastructure can override intentions in practice.

2.3.1 Behavioral Gaps

In environmental psychology, ABG and IBG describe the systematic discrepancy between environmentally friendly attitudes or stated intentions and actual behavior. People may report concern about climate change or a preference for sustainable options, yet in concrete decision situations they frequently choose conventional, emissions-intensive alternatives (Blake, 1999; Kollmuss & Agyeman, 2002). This discrepancy is often labelled a value-action gap and helps explain why strong environmental values do not automatically result in consistent sustainable behavior (Carrington et al., 2010).

Meta-analyses confirm that environmental attitudes are significantly associated with behavior, but typically only to a moderate extent, leaving substantial variance unexplained (Bamberg & Möser, 2007; Klöckner, 2013). This reinforces the relevance of additional determinants, particularly contextual constraints, when explaining sustainable travel behavior.

The IBG captures the difference between explicitly stated behavioral intentions and their later realization. Although intentions are a strong proximal predictor of behavior, their translation into action is systematically attenuated by additional factors, meaning that intentions are necessary but not sufficient for consistent pro-environmental behavior (Bamberg & Möser, 2007; Carrington et al., 2010; Klöckner, 2013).

In travel and sustainable tourism, such gaps are documented consistently. A systematic review finds that tourists evaluate sustainable forms of travel and environmental measures positively, whereas behaviors such as choosing lower-emission transport modes or using green add-on services occur less frequently than would be expected from reported attitudes and intentions (Wut et al., 2023). Evidence from aviation offsetting shows a similar pattern, while many passengers report a positive WTP in surveys, booking data indicate that only a small share actually purchases offsets and that average payments remain well below stated WTP (Diederich & Goeschl, 2014; Schwirplies et al., 2019).

2.3.2 Habits and structural contextual factors

Habits and structural contextual factors are discussed as central reasons why environmental attitudes and intentions translate only partially into actual behavior (Klöckner, 2013; Kollmuss & Agyeman, 2002). Habits are automated behavioral patterns that develop through repeated execution in stable situations and are often carried out with little conscious deliberation (Verplanken & Aarts, 1999). Accordingly, habits can weaken the influence of attitudes and intentions, especially for frequently repeated actions (Klöckner, 2013).

In mobility and travel, such routines are particularly pronounced. Many individuals use the same modes of transport and routes over long periods, even if they evaluate environmentally friendly alternatives positively (Gardner & Abraham, 2008; Klöckner, 2013). Tourism research also indicates stable preferences for destinations, transport modes, or providers that serve as reference points in planning. Such routines reduce the likelihood that lower-emission options are actively considered and contribute to the fact that environmental concern results only in limited changes in travel behavior (Kollmuss & Agyeman, 2002; Wut et al., 2023).

Beyond habits, structural contextual conditions shape what is feasible. Diekmann and Preisendörfer (2003) distinguish between low-cost and high-cost behavioral situations and argue that pro-environmental attitudes lose much of their effect when behavioral change involves noticeable financial costs or losses in comfort. In tourism, ticket prices, household budgets, and relative price differences between conventional and lower-emission offers are therefore key obstacles to more sustainable travel decisions (Wut et al., 2023). Available travel time is another important restriction, as longer travel times of more sustainable alternatives are accepted only to a limited extent, particularly when holiday duration is short (Gardner & Abraham, 2008; Wut et al., 2023).

Infrastructure and the design of available offers further shape actual behavior. Where high-speed trains, night trains, or reliable long-distance coach services are absent or perceived as unattractive, air travel often remains the pragmatic choice despite higher emissions (Diekmann & Preisendörfer, 2003; Klöckner, 2013). Evidence from voluntary climate action in travel and aviation also shows that uptake of offsetting or climate surcharge schemes depends on the specific setting, including surcharge size, payment simplicity, and information clarity (Diederich & Goeschl, 2014; Schwirplies et al., 2019).

Taken together, this evidence suggests that habits and contextual factors in travel are closely intertwined. Habits shape which options travelers notice and consider, while prices, time constraints, infrastructure, and offer design determine which alternatives appear realistic and acceptable (Klöckner, 2013; Wut et al., 2023). Understanding sustainable travel decisions therefore requires linking attitudes and intentions with established routines and structural conditions, which motivates the subsequent focus on functional-environmental trade-offs in mode choice.

2.4 Value perception and Trade-offs in sustainable decisions

Sustainable travel decisions often involve high behavioral costs, as lower-emission options can imply higher prices, longer travel times, or reduced comfort. Building on the contextual constraints discussed in Section 2.3.2, this section focuses on how travelers evaluate concrete trade-offs between functional attributes and emission reductions in sustainable mode-choice decisions. This is particularly salient in air-rail contexts, where the lower-emission alternative typically comes with tangible disadvantages in time and/or price.

The VBN framework provides a starting point for understanding why some individuals nevertheless accept such sacrifices. It posits that altruistic and biospheric values shape environmental beliefs and perceived responsibility, which activate personal norms of morally required action (Stern, 2000). Empirical work indicates that stronger personal norms and a salient environmental identity are associated with a higher willingness to accept financial costs or losses of convenience in order to reduce one's environmental footprint (De Groot & Steg, 2009; Loeschel et al., 2013; Van der Werff et al., 2013; Whitmarsh & O'Neill, 2010). These factors influence how strongly sustainability is weighted relative to functional criteria in concrete decision situations.

Against this background, sustainability-related travel decisions can be described as an evaluation of functional and ecological benefits. Functional considerations include monetary costs, travel time, and service quality (e.g., comfort and reliability), whereas ecological considerations relate to emission reductions and to self-related moral outcomes such as feeling responsible and avoiding guilt (Kollmuss & Agyeman, 2002; Steg et al., 2014). A characteristic feature of the climate context is that functional disadvantages are immediate and individually experienced, whereas ecological benefits are spatially and temporally distant and therefore less tangible.

In this context, WTP for climate protection measures is often used as a summary indicator of individual trade-offs. WTP for emission reductions or CO_2 offsetting indicates the extent to which individuals are prepared to allocate financial resources to mitigate climate damages (Diederich & Goeschl, 2014; Loeschel et al., 2013). Studies on the demand for climate protection report on average positive but rather limited WTP, alongside substantial heterogeneity between individuals (Loeschel et al., 2013). In aviation, evidence on voluntary CO_2 offsetting and price premiums for lower-emission options suggests that WTP is present, yet actual payments in real decision situations tend to remain low and only a share of passengers makes use of such offers (Berger et al., 2022; Brouwer et al., 2008; Schwirplies et al., 2019).

The perception of these trade-offs is shaped by both individual and contextual factors. On the individual level, values and personal norms, environmental knowledge, and trust in the effectiveness of proposed measures are relevant, particularly because emission information is not always easily interpreted (De Groot & Steg, 2009; Stern, 2000). In the travel domain, trust in certifications, providers, and offset projects is repeatedly linked to a higher willingness to accept price premiums (Brouwer et al., 2008; Schwirplies et al., 2019). On the contextual level, the size and framing of the surcharge, the type of trip, as well as socio-economic conditions such as income and travel purpose influence whether an additional amount is perceived as reasonable or excessive (Berger et al., 2022; Diederich & Goeschl, 2014; Loeschel et al., 2013). Overall, the evidence suggests that the willingness to sacrifice price, time, and comfort for emission reductions depends on how travelers evaluate these trade-offs, which provides the reference frame for interpreting empirical findings on WTP and choice behavior in tourism.

2.5 Contribution of the thesis

2.5.1 Summary of key insights

Sustainable leisure travel can be understood as a specific form of sustainable consumption in which ecological criteria, in particular greenhouse gas emissions, are evaluated alongside functional aspects such as price, travel time and comfort. The literature on TPB, NAM, VBN and CADM shows that attitudes, social and personal norms, perceived behavioral control, values and habits are central psychological determinants of such decisions (Ajzen, 1991; Klöckner, 2013; Schwartz, 1977; Stern, 2000).

At the same time, empirical studies report substantial discrepancies between environmental attitudes, intentions and actual behavior. Many consumers and travelers express strong environmental concern and support for sustainable options, yet only a subset of possible pro-environmental actions is implemented in everyday life (Blake, 1999; Kollmuss & Agyeman, 2002, Wut et al., 2023). Research on mobility and tourism highlights that habits and structural contextual factors, including prices, available time, infrastructure and offer design, limit the translation of pro-environmental intentions into concrete travel choices (Diekmann & Preisendörfer, 2003; Gardner & Abraham, 2008). Overall, the literature suggests that WTP for voluntary climate action exists but remains limited in magnitude and uptake, particularly in aviation (Loeschel et al., 2013; Brouwer et al., 2008; Diederich & Goeschl, 2014; Schwirplies et al., 2019).

2.5.2 Research gaps

Three main gaps in this literature are relevant for the present thesis.

First, many studies focus either on environmental attitudes and norms or on economic WTP, while fewer analyses quantify how differences in travel time, ticket price and emissions jointly shape mode choice when travelers face a concrete choice between air travel and a lower emission rail option on leisure routes. Existing work on climate related WTP in tourism and aviation often examines additional payments such as voluntary offsets or surcharges rather than the combined evaluation of time, price and emission attributes in travel mode choice (Brouwer et al., 2008; Berger et al., 2022).

Second, the reviewed studies indicate that the willingness to choose more sustainable options varies across individuals and depends on income, trip characteristics and personal circumstances (Diekmann & Preisendörfer, 2003; Loeschel et al., 2013). However, there is still limited quantitative evidence on how such heterogeneity manifests itself when travelers choose between air and rail on leisure trips, especially with regard to differences between shorter and longer travel situations within Europe.

Third, normative and psychological approaches, in particular NAM, VBN and CADM, suggest that pro-environmental values, personal norms and environmental identity can increase the willingness to accept higher costs or longer travel times for climate protection (De Groot & Steg, 2009; Whitmarsh & O'Neill, 2010; Van der Werff et al., 2013; Klöckner, 2013). Empirical studies that integrate these constructs directly into models of air rail choice for leisure travel are rare. The additional explanatory contribution of sustainability related attitudes and values beyond functional attributes and socio-economic variables is therefore not well established in this specific context.

2.5.3 Contribution, research questions and hypotheses

Against this background, the thesis contributes to the literature by analyzing how differences in travel time, ticket price and carbon emissions influence leisure travelers choices between air and rail and how these trade-offs vary between traveler groups with different socio-economic characteristics and sustainability related orientations. The empirical analysis focuses on leisure trips in Europe where travelers can realistically choose between air travel and lower emission rail options and combines functional attributes, namely time, price and emissions, with information on income and sustainability related attitudes. In doing so, the thesis links insights from TPB, NAM, VBN and CADM with empirical evidence on WTP and climate related travel decisions.

The main research question follows from the first research gap and from the literature on attribute-based choice in sustainable travel. It brings together the three core attributes travel time, ticket price and emissions that repeatedly appear as key determinants in previous studies. The main research question of this thesis, research question one, RQ1, is: *How do differences in travel time, ticket price and carbon emissions affect leisure travelers choices between air and lower emission rail options in Europe?*

Hypothesis one (H1), supports this overarching question by translating the idea of attribute-based choice into a testable expectation about behavior. H1 assumes that travelers take emissions, travel time and ticket price into account as central decision criteria. H1 states that: *When travelers choose between an air option and a lower emission rail option, the probability of choosing rail increases with the relative reduction in CO_2 emissions and decreases with additional travel time and higher ticket prices of rail compared to air.*

Building on the literature on low cost and high cost situations and on climate related WTP, the second research gap concerns differences between income groups. Budget constraints and the perceived affordability of price premiums are repeatedly mentioned as reasons why some travelers are more willing than others to choose sustainable options. This motivates a second research question that focuses on income heterogeneity. Research question two, RQ2, is: *How does income moderate the effect of ticket price differences on the choice between air and rail, given differences in travel time and emissions?*

Hypothesis two (H2), specifies this idea and links it directly to the three attributes time, price and emissions. H2 states that: *For given differences in travel time and emissions, higher income* *is associated with lower sensitivity to ticket price differences between air and rail, thereby increasing the probability of choosing the lower-emission rail option.*

A third line of argument in the literature concerns trip distance and the limited acceptance of longer travel times. Studies on mobility and tourism suggest that the willingness to switch from air travel to lower emission options such as rail is particularly sensitive to travel time on longer routes (Gardner & Abraham, 2008; Wut et al., 2023). This consideration is reflected in the third research question. Research question three, RQ3, is: *How does travel time influence leisure travelers willingness to choose lower-emission rail options over air travel in air-rail trade-off situations?*

Hypothesis three (H3), translates this argument on the acceptance of longer travel times into a testable statement. H3 states that: *The negative effect of travel time differences on choosing rail increases disproportionately as the time disadvantage grows.*

The psychological and normative approaches reviewed in Section 2.2 also indicate that functional attributes and socio-economic variables do not fully capture the determinants of sustainable travel decisions. VBN and CADM highlight the additional role of pro-environmental values, personal norms and related attitudes (Stern, 2000; Klöckner, 2013). This leads to a fourth hypothesis that complements the three research questions by adding a normative dimension to the explanation of travel mode choice. Hypothesis four (H4), states that: *Travelers with stronger pro-environmental moral norms (or sustainability orientation) are more likely to choose rail over air, controlling for travel time, ticket price, emissions, and income.*

Taken together, these research questions and hypotheses connect the literature on sustainable consumption, psychological determinants of environmental behavior and trade-offs in sustainable travel decisions with the specific context of leisure travelers choices between air and rail in Europe and provide the analytical framework for the empirical analysis in the following chapter.

3 Methodology

3.1 Research design

This thesis adopts a quantitative, cross-sectional research design to examine leisure travelers mode choices between air and rail under varying conditions of travel time, ticket price, and carbon emissions. The empirical analysis is based on primary data collected through an online survey incorporating a stated choice experiment. This research design is well suited to the analysis of sustainable travel behavior, as it allows for the systematic variation of key decision attributes and enables the investigation of trade-offs that are difficult to observe in real-world travel decisions.

The use of a stated preference approach is motivated by both conceptual and practical considerations. Revealed preference data on travel behavior typically do not provide sufficiently detailed and comparable information on how travelers jointly evaluate time, monetary costs, and environmental impacts, and are often constrained by existing supply-side and infrastructural conditions. In contrast, stated choice experiments allow the construction of hypothetical yet realistic decision scenarios and facilitate a targeted analysis of how changes in specific attributes affect the probability of choosing lower-emission transport options.

The empirical design is closely aligned with the theoretically derived research questions and hypotheses developed in Chapter 2. In particular, the chosen approach enables the integration of functional attributes of travel alternatives with socio-economic characteristics and sustainability-related attitudes of travelers. This allows for an analytical framework that combines insights from economic choice theory with psychological perspectives on pro-environmental behavior.

The analysis focuses on leisure travel within a European context. Compared to business travel, leisure travel decisions are less strongly shaped by institutional constraints, making individual preferences and trade-offs between functional and environmental criteria more salient. This focus contributes to greater internal validity by reducing heterogeneity associated with mandatory or professionally driven travel decisions.

Overall, the chosen research design provides a structured and theoretically grounded framework for analyzing sustainable travel behavior and offers a robust basis for empirically testing the proposed hypotheses.

3.2 Data collection and sampling

Data was collected through a standardized online survey implemented via Qualtrics. This allowed for a structured questionnaire design as well as the consistent presentation of the integrated stated choice experiments under uniform survey conditions. Conducting the survey online further enabled the efficient reach of a heterogeneous group of respondents.

The survey was distributed through personal networks, university and work-related mailing lists, as well as social media channels. Participation was voluntary and not financially incentivized. At the beginning of the survey, participants were informed about the purpose and procedure of the study and provided informed consent for the anonymous use of their responses for scientific research purposes. Data collection took place between December 10th and December 19th 2025.

In total, 210 questionnaires were submitted. Only fully complete questionnaires were included in the empirical analysis. In addition, responses with a completion time clearly below a plausible minimum threshold of 120 seconds were excluded, as they indicated insufficient engagement with the survey content. Also, respondents residing outside Europe were excluded. After applying these exclusion criteria, the final analytical sample comprises **n = 133** respondents.

The resulting sample includes individuals with diverse socio-demographic characteristics, particularly with respect to age, income, and travel experience. This heterogeneity is central to the objectives of the study, as it enables the analysis of differences in preferences and evaluation patterns in the context of sustainable travel decisions. A detailed description of the sample characteristics is provided in the results section.

3.3 Survey and choice experiment design

The survey was structured to capture individual travel behavior alongside stated choice decisions and sustainability-related orientations. To ensure consistency in responses, the survey followed a clearly defined and logically ordered sequence of thematic sections.

The survey began with the collection of demographic information, followed by questions on current and past leisure travel behavior. Its central component consisted of a stated choice experiment in which participants repeatedly chose between two hypothetical travel alternatives. The survey concluded with items measuring sustainability-related attitudes and behavioral orientations.

The stated choice experiment was constructed to reflect realistic leisure travel decision situations. In each choice task, participants were presented with two alternatives representing an air travel option and a lower-emission rail option. The alternatives varied systematically with respect to travel time, ticket price, and carbon emissions, while all other travel characteristics were held constant. The attributes of the air travel alternative remained fixed across all choice tasks, whereas the attributes of the rail alternative were systematically varied. Participants were asked to indicate which of the two options they would choose under the specified conditions.

Overall, the survey and choice experiment design enable the systematic elicitation of travel mode choices together with contextual information on travel behavior and sustainability-related orientations within a coherent data collection framework. This design provides the basis for the subsequent empirical analysis of sustainable travel behavior.

3.4 Construct and variables

The central dependent variable of the study is travel mode choice as observed in the stated choice experiment. In each decision task, participants indicated whether they preferred the air travel alternative or the rail travel alternative. These binary choice outcomes form the basis of the empirical analysis of preferences between the two transport modes. As each participant completed multiple choice tasks, the dataset contains repeated observations per individual, allowing for the analysis of trade-offs between attributes of the travel alternatives.

The main explanatory variables at the choice level are the attributes describing the travel alternatives, namely travel time, ticket price, and carbon emissions. As described in Section 3.3, the attributes of the air travel alternative remained constant across all choice tasks, whereas the attributes of the rail alternative were systematically varied. The attribute information is used in the empirical analysis to capture differences in the evaluation of functional and environmental characteristics between the two transport options.

In addition to the stated choices, the survey collected information on participants' current and past leisure travel behavior. These variables relate, among other aspects, to the frequency of leisure travel, typical travel distances and durations, and the use of different modes of transport. They serve to characterize individual travel experience and allow for the consideration of heterogeneity in baseline travel behavior across respondents.

Furthermore, sustainability-related attitudes and orientations were measured to capture individual differences in environmental concern and responsible consumption tendencies. The corresponding constructs were operationalized using multiple Likert-type items capturing general pro-environmental orientations that are not restricted to specific travel situations. To analyze, the respective items are aggregated into composite measures, following standard practice in behavioral and consumer research. Higher values indicate stronger sustainability-related orientations. The internal consistency of these measures is assessed as part of the empirical analysis.

In addition, basic socio-demographic characteristics were collected, including age, gender, place of residence, and monthly net income. These variables are used to describe the sample and to control for individual characteristics that may influence travel mode choice and the evaluation of trade-offs between time, cost, and environmental impacts.

3.5 Analytical methodology

The stated choice experiment data are analyzed using a binary logistic regression model to explain respondents' mode choice between rail and air. In each choice task, respondents select exactly one of two alternatives. The dependent variable therefore captures whether the rail option was chosen:

$$RailChoice_{i,t} = \begin{cases} 1 & \text{if respondent } i \text{ chooses rail in task } t \\ 0 & \text{if respondent } i \text{ chooses air in task } t \end{cases}$$

Because the decision is binary, the probability of choosing rail is modelled as:

$$Pr(RailChoice_{i,t} = 1) = \frac{1}{1 + \exp\left(-RailScore_{i,t}\right)}$$

The term $RailScore_{i,t}$is the linear predictor capturing the relative attractiveness of rail compared with air. In the experimental design, the air alternative is fixed across all choice tasks and serves as a constant reference, while the rail attributes vary across tasks. Therefore, the key explanatory variables are defined as rail minus air differences:

$$\Delta Time_{i,t} = Time_{i,t}^{rail} - Time^{air}$$

$$\Delta Price_{i,t} = Price_{i,t}^{rail} - Price^{air}$$

$$\Delta CO2_{i,t} = CO2_{i,t}^{rail} - CO2^{air}$$

Positive values indicate that rail performs worse than air on the respective attribute (longer travel time, higher price, higher emissions). Negative values indicate a relative advantage of rail.

Baseline model

The baseline model links rail choice to the three attribute differences and to individual characteristics:

$$RailScore_{i,t} = \beta_0 + \beta_1 \Delta Time_{i,t} + \beta_2 \Delta Price_{i,t} + \beta_3 \Delta CO2_{i,t} + \gamma' \mathrm{X}_i + \delta' \mathrm{S}_i$$

$\mathbf{X}_i$is a vector of socio-demographic and travel background control variables (e.g., age, gender, place of residence, income, and indicators capturing typical leisure travel patterns). $\mathbf{S}_i$captures sustainability-related orientations measured in the questionnaire using multiple statements on a five-point agreement scale. To keep the analysis parsimonious and to measure constructs more reliably, conceptually related statements are aggregated into indices. The moral norm index MN_i, for example, is computed as the mean across the corresponding items, where higher values indicate a stronger moral norm in the context of climate-relevant travel decisions. Internal consistency of the constructed indices is assessed using Cronbach's alpha and reported in the results section. Logistic regression coefficients are estimated on the log-odds scale. Inference therefore focuses on coefficient signs and statistical significance, holding other variables constant (ceteris paribus, cp), while substantive magnitudes are additionally communicated using predicted probabilities and (average) marginal effects for representative covariate values.

Since each respondent completes multiple choice tasks, observations are not independent within individuals. The model is estimated as a pooled logit model and standard errors are clustered at the respondent level.

Hypothesis testing

H1 is tested using the coefficient β_3. Because $\Delta CO2$is defined as rail minus air, a preference for lower emissions implies a negative β_3.

H2

To test H2, the model includes the main effect of income and an interaction between the price difference and income, while the remaining control variables stay included:

$$RailScore_{i,t} = \beta_0 + \beta_1 \Delta Time_{i,t} + \beta_2 \Delta Price_{i,t} + \beta_3 \Delta CO2_{i,t} + \beta_4 Income_i + \beta_5(\Delta Price_{i,t} \times Income_i) + \boldsymbol{\gamma}'\mathbf{X}_i + \boldsymbol{\delta}'\mathbf{S}_i$$

A positive β_5 indicates that the negative effect of a rail price premium is weaker at higher income levels.

H3

H3 is tested by adding a quadratic term for the time difference, while all other variables remain included:

$$RailScore_{i,t} = \beta_0 + \beta_1 \Delta Time_{i,t} + \beta_2 \Delta Price_{i,t} + \beta_3 \Delta CO2_{i,t} + \beta_6 (\Delta Time_{i,t})^2 + \boldsymbol{\gamma}'\mathbf{X}_i + \boldsymbol{\delta}'\mathbf{S}_i$$

A negative β_6 is consistent with the assumption that large time disadvantages of rail reduce rail choice disproportionately.

H4

H4 tests whether respondents with stronger pro-environmental moral norms are more likely to choose rail over air, controlling for travel time, ticket price, emissions, and income. The model therefore includes the main effect of the moral norm index, while the remaining control variables stay included:

$$RailScore_{i,t} = \beta_0 + \beta_1 \Delta Time_{i,t} + \beta_2 \Delta Price_{i,t} + \beta_3 \Delta CO2_{i,t} + \beta_7 MN_i + \gamma' X_i + \delta' S_i$$

A positive β_7 indicates that respondents with stronger moral norms are more likely to choose rail over air, ceteris paribus. The substantive magnitude of the H4 effect is additionally interpreted using predicted probabilities and marginal effects for representative values of moral norms.

3.6 Ethical considerations

Ethical principles were considered throughout the design and implementation of the study. Data was collected through an anonymous online survey, and no personally identifiable information was recorded at any stage of the research process. Participation in the study was entirely voluntary, and respondents were free to discontinue the survey at any time without providing a reason and without any negative consequences.

At the beginning of the survey, participants were informed about the purpose of the study, the general structure of the questionnaire, and the intended use of the collected data for academic research purposes. Informed consent was obtained prior to participation, and only respondents who explicitly agreed to these conditions were able to proceed with the survey.

The study did not involve any form of deception, manipulation, or sensitive questioning beyond the collection of basic socio-demographic information. All items related to travel behavior, sustainability-related attitudes, and the hypothetical decision scenarios presented in the stated choice experiment were designed to minimize potential discomfort or psychological burden for participants. No vulnerable populations were specifically targeted.

The collected data were stored securely and used exclusively for the purpose of this research. Access to the raw data was restricted to the author of the thesis. Data analysis and reporting are conducted exclusively at an aggregated level, ensuring that individual respondents cannot be identified from the presented results.

Overall, the study complies with commonly accepted ethical standards for social science research involving human participants, including the principles of voluntary participation, informed consent, anonymity, and responsible data handling.

4 Results

4.1 Descriptive & exploratory analysis

After the data cleaning procedure documented in Chapter 3.2, the final analytical sample comprises N = 133 complete cases for the variables used in the empirical analysis. The development of case numbers across the successive filtering steps is reported by Figure 3.

Cleaning flow

step	n
Raw export	210
Valid response_id	208
Finished (completed)	164
Duration > = 120s	144
Europe only	139
Complete cases for analysis vars	133

Figure 3 Data cleaning flow

The sample mainly consists of respondents aged 26 - 40 years (51.1%), followed by the 18 - 25 age group (33.1%). The groups 41 - 60 and over 60 each account for 7.5%, while under 18 represents 0.8%. Regarding gender, 64.7% of respondents are male and 35.3% are female. Most respondents report living in Germany (88.0%), with additional shares from Austria (6.8%) and other European countries including Portugal (5.3%). A compact overview of these sample characteristics is provided in Figure 4.

Sample descriptives (N respondents = 133)

variable	category	n	pct
Age group	18-25	44	33.100
Age group	26-40	68	51.100
Age group	41-60	10	7.500
Age group	Over 60	10	7.500
Age group	Under 18	1	0.800
Gender	Female	47	35.300
Gender	Male	86	64.700
Place of residence	Austria	9	6.800
Place of residence	Germany	117	88
Place of residence	Other European Country	6	4.500
Place of residence	Portugal	1	0.800

Figure 4 Sample Description

With respect to travel behavior, 58.6% of respondents indicate having taken more than five leisure or holiday trips during the past three years. 21.1% report four to five trips and 18.8% report two to three trips. For medium distance leisure travel within Europe, self reported prior mode use is distributed across several categories: 33.8% report that they mostly fly, 26.3% state that they almost always fly, and 27.8% indicate choosing plane and train about equally often. In contrast, 9.8% report that they mostly take the train, and 2.3% state that they almost always take the train.

For the analysis of choice decisions, the seven choice tasks (q26, q28, q30, q33, q35, q37, q39) were reshaped into long format, resulting in seven observed decisions per respondent. The dependent variable is coded as a binary indicator (1 = rail chosen, 0 = flight chosen). The alternative attributes are taken from the experimental design and entered as differences between the rail and air options (time, price, and CO_2 emissions). The resulting choice dataset therefore contains 931 observed decisions (133 respondents × 7 tasks). For regression models that include income as a covariate, respondents selecting "Prefer not to say" are treated as missing and are removed via listwise deletion. Consequently, the number of observations used in these models decreases to 882 (126 respondents × 7 tasks).

In addition to the choice variables, two index constructs are derived from Likert type items. First, the Moral Norm index (MN) is constructed from four items (Q15_a to Q15_d) by mapping response categories to a numeric scale from 1 (Strongly Disagree) to 5 (Strongly Agree) and then averaging across items at the respondent level. Scale reliability is reported using Cronbach's alpha, which equals 0.895. The corresponding item statistics are reported in Figure 5. Second, a preference or attitude index is constructed analogously from three items (Q16_a to Q16_c), Cronbach's alpha equals here 0.838, and is also reported in Figure 5. Both indices are subsequently used as continuous predictors in the regression models.

Moral norm (MN; reliability (Cronbach's alpha = 0.895)

Item	n	raw.r	std.r	r.cor	r.drop	mean	sd
mn1	133	0.864	0.870	0.808	0.765	2.617	1.013
mn2	133	0.851	0.852	0.775	0.735	2.639	1.068
mn3	133	0.900	0.895	0.853	0.805	2.549	1.164
mn4	133	0.873	0.871	0.810	0.767	2.549	1.097

Preference/attitude index reliability (Cronbach's alpha = 0.838)

Item	n	raw.r	std.r	r.cor	r.drop	mean	sd
att1	133	0.856	0.860	0.746	0.682	3	1.094
att2	133	0.892	0.890	0.815	0.744	3.105	1.137
att3	133	0.858	0.857	0.739	0.677	3.271	1.129

Figure 5 Cronbach` s Alpha Analysis

4.2 Hypothesis Test

The hypothesis tests are based on pooled logistic regression models explaining the choice of rail (1) versus air (0) in the stated choice experiment. All inference relies on respondent-level clustered standard errors (HC1). The final analytical sample comprises 126 respondents with seven choice tasks per respondent, this yields 882 observations in the models including controls.

H1

Consistent with H1, all three attribute differences in the choice tasks are negatively associated with the probability of choosing rail. For the centered time difference (ΔTime), the coefficient is $\beta = -0.742$ ($p < 0.001$). For the price difference (ΔPrice), the estimate is $\beta = -0.025$ ($p < 0.001$). For the emissions difference (Δ CO_2), the estimate is $\beta = -0.006$ ($p < 0.001$). The corresponding predicted-probability profiles for each attribute are reported in the appendix (Figure 15 - 17).

H2

To test H2, an interaction term between the price difference and income is added. The interaction effect is positive and statistically significant ($\beta = 0.0029$, $p = 0.045$). The likelihood ratio test against the baseline model also indicates a significant improvement in model fit when including the interaction term ($p = 0.049$). The implied predicted probabilities across the price difference for low versus high income (10th and 90th percentiles) are shown in Figure 6.

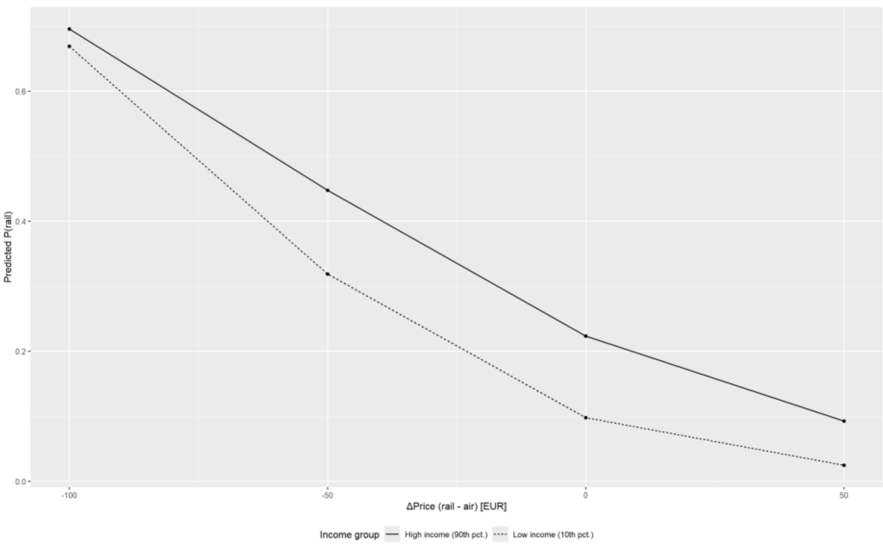

Figure 6 Predicted probability of choosing rail across ΔPrice for low vs. high income.

H3

For H3, the model includes both the linear centered time difference and its quadratic term ($\Delta Time^2$). The quadratic term is negative and statistically significant ($\beta = -0.106$, $p = 0.003$). The likelihood ratio test against the baseline model confirms a significant improvement in model fit ($p = 0.007$). Predicted probabilities across the time difference implied by the quadratic specification are displayed in Figure 7.

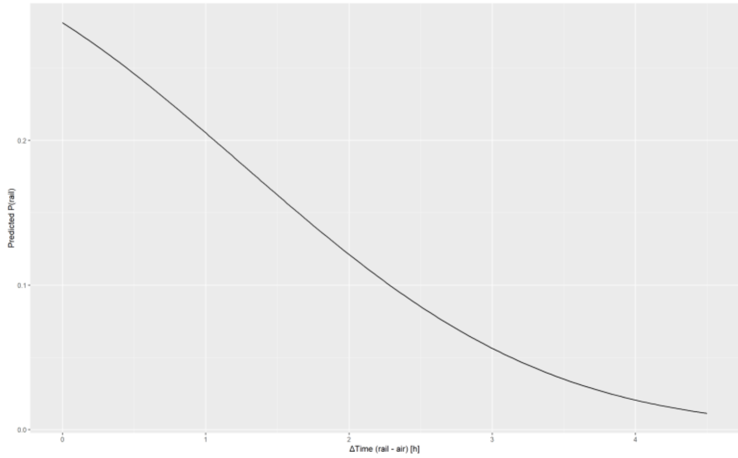

Figure 7 Predicted probability of choosing rail across ΔTime

H4

To test H4, the MN is added to the baseline model. The coefficient on MN is positive and statistically significant ($\beta = 0.527$, $p < 0.001$). The likelihood ratio test against the baseline model indicates a strong improvement in model fit when including MN ($p < 0.001$). Predicted probabilities across the observed range of the MN index are shown in Figure 8.

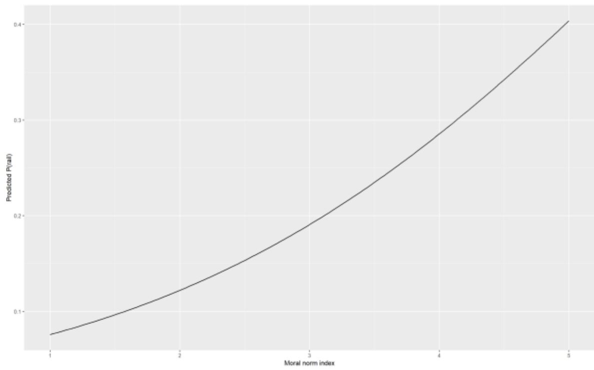

Figure 8 Predicted probability of choosing rail across the moral norm index (MN).

4.3 Regression Model

Building on the model specification described in Chapter 3.5, travel mode choices are estimated using pooled binary logit models. Standard errors are clustered at the respondent level to account for repeated observations from multiple choice tasks per individual. Figure 9 reports three specifications. A baseline model including the attribute differences between the rail and flight alternatives (ΔTime, ΔPrice, ΔCO_2) and control variables, a specification that additionally includes the MN, and a full model that further adds a quadratic time term and an interaction between price and income.

Pooled Logistic Regression: Rail choice (clustered SE at respondent level)

	Dependent variable:		
	Rail choice (1 = rail, 0 = flight)		
	Baseline	+ Moral norm (MN)	Full model
	(1)	(2)	(3)
ΔTime (rail - air) [h] (centered)	-0.742***	-0.772***	-0.755***
	(0.079)	(0.082)	(0.084)
$\Delta Time^2$ (quadratic; centered)			-0.112***
			(0.037)
ΔPrice (rail - air) [EUR]	-0.025***	-0.026***	-0.034***
	(0.002)	(0.003)	(0.005)
Income (ordinal)	0.249	0.203	0.286*
	(0.160)	(0.153)	(0.157)
ΔPrice × Income			0.003**
			(0.002)
ΔCO2 (rail - air) [kg]	-0.006***	-0.006***	-0.005***
	(0.002)	(0.002)	(0.002)
Moral norm index (MN; q34 only)		0.527***	0.536***
		(0.125)	(0.127)
Controls included	Yes	Yes	Yes
Quadratic time term included	No	No	Yes
Price × Income interaction included	No	No	Yes
SE clustered by respondent	Yes	Yes	Yes
Observations	882	882	882
Log Likelihood	-426.349	-411.755	-405.685
Akaike Inf. Crit.	892.697	865.510	857.370

Note: *p<0.1; **p<0.05; ***p<0.01
Cluster-robust standard errors (HC1) at respondent level. ΔTime is centered; centering does not change the slope interpretation.

Figure 9 Pooled Logistic Regression: Rail choice (clustered SE at respondent level)

Across all specifications, the coefficient on the time difference between rail and air (ΔTime, centered) is negative and statistically significant at the 1% level. The price difference (ΔPrice) is also consistently negative and statistically significant ($p < 0.01$). The emissions difference (ΔCO_2) similarly exhibits a negative and statistically significant coefficient. In the specification including moral norm (Model 2), the MN is positive and statistically significant ($p < 0.01$). This association remains in the full model (Model 3). In addition, the quadratic time term ($\Delta Time^2$, centered) is negative and statistically significant ($p < 0.01$). Income is positive and statistically significant at the 10% level in the full model, while the interaction term ΔPrice × Income is positive and statistically significant at the 5% level.

Model fit statistics are summarized in the appendix tables. Figure 10 reports the log-likelihood, AIC, BIC, pseudo R^2 measures, and the Brier score across specifications. The metrics vary systematically with model complexity, in particular through changes in the log-likelihood and AIC. For instance, the m_full specification reports LogLik = −405.685 and AIC = 857.370, while the additional specification including the attitude index (m_full_att) reports LogLik = −399.825 and AIC = 847.651.

Model fit statistics

model	n_obs	logLik	AIC	BIC	McFadden_R2	Tjur_R2	Brier
m_attr	931	-502.239	1,012.478	1,031.823	0.182	0.231	0.178
m_base	882	-426.349	892.697	988.341	0.305	0.327	0.156
m_h2	882	-424.404	890.807	991.234	0.309	0.330	0.156
m_h3	882	-422.728	887.456	987.882	0.311	0.334	0.155
m_h4	882	-411.755	865.510	965.936	0.329	0.353	0.150
m_full	882	-405.685	857.370	967.360	0.339	0.364	0.148
m_full_att	882	-399.825	847.651	962.423	0.349	0.374	0.146

Figure 10 Model fit statistics

To provide an additional scale-free interpretation, Figure 11 reports odds ratios for the full model, together with 95% confidence intervals based on clustered standard errors. For ΔTime, the odds ratio is 0.470 (95% CI: 0.399 to 0.555; $p < 0.001$). For ΔPrice, the odds ratio is 0.966 (95% CI: 0.957 to 0.976; $p < 0.001$), and for Δ CO_2 it is 0.995 (95% CI: 0.992 to 0.998; $p = 0.0005$). The moral norm index yields an odds ratio of 1.710 (95% CI: 1.333 to 2.193; $p < 0.001$). For the interaction ΔPrice × Income, the odds ratio is 1.003 (95% CI: 1.000 to 1.006; $p = 0.028$).

Odds ratios (full model; clustered SE-based 95% CI)

term	OR	CI_low	CI_high	p_value
ΔTime (rail - air) [h] (centered)	0.470	0.399	0.555	0
ΔPrice (rail - air) [EUR]	0.966	0.957	0.976	0
ΔCO2 (rail - air) [kg]	0.995	0.992	0.998	0.0005
Income (ordinal)	1.331	0.978	1.811	0.069
Moral norm index (MN; q34 only)	1.710	1.333	2.193	0.00002
ΔPrice × Income	1.003	1.000	1.006	0.028

Figure 11 Odds ratios (full model; clustered SE-based 95% CI)

Finally, Figure 12 reports average marginal effects (AME) for selected predictors from the full model, again using clustered standard errors. For ΔTime, the AME is −0.108 (SE = 0.010; 95% CI: −0.126 to −0.089; $p < 0.001$). For ΔPrice, the AME equals −0.004 (SE = 0.0003; 95% CI: −0.004 to −0.003; $p < 0.001$). For Δ CO_2, the AME is −0.001 (SE = 0.0002; 95% CI: −0.001 to −0.0004; $p = 0.0002$). The MN has a positive AME of 0.080 (SE = 0.018; 95% CI: 0.045 to 0.115; $p < 0.001$).

Average marginal effects (full model; clustered SE)

factor	AME	SE	z	p	lower	upper
ΔCO2 (rail - air) [kg]	-0.001	0.0002	-3.702	0.0002	-0.001	-0.0004
Moral norm index (MN; q34 only)	0.080	0.018	4.503	0.00001	0.045	0.115
ΔPrice (rail - air) [EUR]	-0.004	0.0003	-14.329	0	-0.004	-0.003
ΔTime (rail - air) [h] (centered)	-0.108	0.010	-11.335	0	-0.126	-0.089

Figure 12 Average marginal effects (full model; clustered SE)

5 Discussion

This chapter interprets the empirical findings reported in Chapter 4 and derives their theoretical and practical implications. The discussion focuses on the role of functional trade-offs, heterogeneity in price sensitivity, and moral norms in shaping sustainable mode choice.

5.1 Interpretation of findings

Regarding **RQ1**, the results indicate that the choice between air and rail in the context of European leisure travel is primarily shaped by functional trade-offs. In the pooled logit models, larger disadvantages of rail in travel time and ticket price are associated with a significantly lower probability of choosing rail (ΔTime: $\beta = -0.742$, $p < 0.001$; ΔPrice: $\beta = -0.025$, $p < 0.001$; see Chapter 4 and Figure 9). Substantively, this suggests that travelers anchor their decisions in immediately experienced costs, particularly convenience and financial burden. At the same time, the emissions difference is also negative and statistically significant (Δ CO_2: $\beta = -0.006$, $p < 0.001$), indicating that emissions information is not irrelevant in the choice context, even though it appears secondary to time and price. This interpretation is consistent with the AME, which show a substantially larger average change in choice probability for ΔTime (AME ≈ −0.108) than for ΔPrice (AME ≈ −0.004) and Δ CO_2 (AME ≈ −0.001; see Figure 12). Overall, the pattern aligns with the tension documented in the literature between pro-environmental intentions and the situational costs of sustainable options, as discussed in research on the ABG (e.g., Blake, 1999; Kollmuss & Agyeman, 2002). The findings therefore point less to a pure value-driven decision and more to a trade-off in which ecological benefits matter, but often compete with highly salient functional disadvantages.

Turning to **RQ2**, the analysis examines whether income moderates the effect of price differences. The positive and statistically significant interaction between the rail price difference and income (ΔPrice × Income: $\beta = 0.0029$, $p = 0.045$; see Chapter 4.3) implies that price premiums for rail reduce the likelihood of choosing rail less strongly among higher income respondents, cp. That this heterogeneity is not only statistically detectable but also substantively meaningful is supported by model comparisons and the predicted probabilities shown in Figure 6. Substantively, the result is consistent with an affordability mechanism. For travelers facing tighter budget constraints, price premiums are a more binding contextual factor that limits the uptake of more sustainable options. Importantly, this does not imply that higher income travelers are inherently more sustainable. Rather, the monetary disadvantage associated with rail is less restrictive for them, which leaves greater scope for other motives to affect the decision.

With regard to **RQ3**, the focus shifts to travel time and the question of whether its influence is proportional or whether acceptance limits emerge. The significant negative quadratic term ($\Delta Time^2$: $\beta = -0.106$, $p = 0.003$; see Chapter 4.3) indicates non-linear time sensitivity, which is further supported by the likelihood ratio test relative to the baseline model ($p = 0.007$). Substantively, this pattern can be interpreted as evidence of an acceptability threshold. Moderate time disadvantages of rail may still be manageable for leisure travelers, whereas larger time gaps reduce the attractiveness of rail disproportionately. Figure 7 illustrates this pattern through predicted probabilities. From a behavioral perspective, the non-linearity can be read as a feasibility mechanism, even when rail is morally or environmentally attractive, a strongly perceived time loss may become the dominant contextual factor that prevents the translation of pro-environmental preferences into actual choices. This interpretation is consistent with the role of contextual constraints and perceived behavioral costs emphasized in integrated behavioral models, including the TPB and the CADM (Ajzen, 1991; Klöckner, 2013).

In addition to the three research questions, **H4** extends the explanatory perspective by introducing a normative dimension. The MN is positively and highly significantly associated with choosing rail ($\beta = 0.527$, $p < 0.001$), and its inclusion improves overall model fit substantially (see Chapter 4.3). The odds ratio (OR = 1.710) and the AME (≈ 0.080) further indicate that moral norms contribute meaningfully beyond functional attributes. This evidence is consistent with norm-based approaches such as the NAM and the VBN, which argue that personal norms can motivate climate relevant behavior (Schwartz, 1977; Stern, 2000). At the same time, the joint pattern of effects suggests that moral motivation does not replace the cost logic, time and price remain strongly influential. Substantively, this implies that moral norms are most likely to become behaviorally effective when functional disadvantages remain within an acceptable range. Sustainable mode choice therefore appears to result from the interaction of motivation and context, where normative orientations increase willingness to choose rail, while travel time and price define the boundaries of that willingness.

Taken together, the findings support a layered interpretation of sustainable leisure travel behavior. First, functional trade-offs dominate the air rail choice, second, price sensitivity varies systematically with income, and third, moral norms add explanatory power beyond functional attributes. This interpretation provides the immediate basis for deriving the theoretical and practical implications discussed in the next section.

5.2 Implications

Building on the empirical patterns summarized in Chapter 4 and interpreted in Section 5.1, the following implications highlight what these results suggest for theory and future research.

5.2.1 Theoretical Implications

Addressing the gaps identified in Section 2.5.2, the study models air-rail leisure mode choice as a joint outcome of attribute trade-offs, socio-economic heterogeneity, and normative orientations, consistent with an integrated perspective beyond purely psychological or purely economic accounts.

First, the results address the gap related to the simultaneous empirical assessment of core attributes in the air-rail trade-off by quantifying the combined influence of travel time, ticket price, and emissions. All three attribute differences are significant in the expected direction (see Chapter 4). For theory, the relative salience of these attributes is particularly consequential. The marginal effects indicate a clear hierarchy, with time dominating price and emissions in substantive impact (see Figure 12). Substantively, this supports the assumption discussed in the literature review that functional costs are particularly salient at the moment of choice, whereas ecological benefits may be considered but often recede behind immediately experienced convenience and financial burden. From this perspective, the findings can also be interpreted as empirical support for the ABG argument, according to which pro-environmental orientations may be widespread, but their behavioral expression remains strongly contingent on situational costs and constraints (Blake, 1999; Kollmuss & Agyeman, 2002).

Second, the results speak to the gap on heterogeneity by showing that the evaluation of monetary disadvantages is not uniform across travelers. The positive ΔPrice $\times$ Income interaction indicates that rail price premiums deter higher-income travelers less strongly (see Chapter 4.3). Theoretically, this supports accounts that distinguish low-cost and high-cost situations, as affordability does not appear merely as a background characteristic but systematically shapes the behavioral impact of monetary trade-offs. In this context, socio-economic resources can be understood as a moderator that determines the extent to which sustainable alternatives are perceived as financially feasible. A central nuance thereby becomes visible. Observed differences in sustainable travel behavior should not be interpreted exclusively as reflecting differences in environmental preferences, but also partly as reflecting differences in travelers' financial room for maneuver.

Third, the findings address the gap related to psychological and normative drivers in concrete choice settings by demonstrating that moral norms add explanatory power beyond functional attributes and income. Moral norms are positively associated with choosing rail and improve model fit even when attributes and income are controlled for (see Chapter 4 and Appendix). This evidence is consistent with norm-based approaches such as the NAM and VBN theory, which posit that personal norms can motivate climate-relevant behavior beyond instrumental considerations (Schwartz, 1977; Stern, 2000). Taken together, moral norms shift preferences toward rail, while time and price continue to bound feasible choices. This is consistent with integrated models in which motivation and context jointly determine behavior. Theoretically, this points to integrated models in which motivation and context jointly determine whether sustainable preferences translate into behavior, for example within the TPB or the CADM (Ajzen, 1991; Klöckner, 2013).

Fourth, the significant non-linear time effect yields an additional theoretical implication regarding the operation of feasibility mechanisms in leisure travel behavior. The negative quadratic term indicates that time disadvantages do not operate proportionally, but are associated with a disproportionately stronger decline in acceptance as time gaps become larger. This renders convenience as a constraint more precisely, as the results suggest threshold-like dynamics. Substitution towards rail appears particularly plausible where time losses remain within what travelers perceive as acceptable, while larger time gaps strongly limit the uptake of more sustainable options. This also implies a methodological refinement for theory development, as strictly linear specifications of travel time effects may understate key behavioral patterns when acceptability thresholds are empirically relevant. Taken together with the remaining findings, this supports a layered explanation of sustainable mode choice in which attribute trade-offs, resources, and normative orientations jointly shape behavior, while the context plays a decisive role in determining whether norms and attitudes become behaviorally effective.

5.2.2 Practical Implications

The findings suggest that efforts to promote more sustainable mode choice in the leisure travel context should prioritize the central barriers that emerge as particularly relevant in the estimated models, most notably travel time and price. Given the strong and non-linear time effect (see

Chapter 4.3 and Figure 7), it appears likely that interventions reducing the time disadvantage of rail, or lowering the perceived time burden, could have comparatively high leverage. This includes measures that shorten end-to-end journey times, reduce transfer and waiting times, and improve reliability on key corridors where rail can, in principle, compete with air. The non-linearity further points to a clear prioritization logic. Substitution from air to rail is most plausible on routes where rail is only moderately slower, whereas large time gaps are likely to be associated with a disproportionately strong decline in acceptance. Under such conditions, information-based and appeal-oriented measures alone are unlikely to have more than limited effects as long as the functional disadvantages remain unchanged.

Second, the results highlight affordability as a central practical constraint. The negative price effect combined with the significant interaction between the price difference and income (see Chapter 4.3 and Figure 6) indicates that rail price premiums may be particularly binding for more price-sensitive, lower-income groups. This suggests that measures aimed at reducing rail price premiums, as well as simplifying and increasing the transparency of fare systems, constitute relevant levers to lower both financial and cognitive entry barriers. At the same time, the weaker price sensitivity at higher income levels implies that complementary levers related to comfort, service, and convenience may be more effective in this segment, as price is less likely to represent the primary decision boundary.

Third, while the emissions difference is statistically relevant, its comparatively smaller marginal effect relative to time and price suggests that emissions information is most likely to function as an additional decision cue (see Chapter 4.2 and Figure 12). This supports the case for an integrated design of booking and information environments in which rail options are not only framed as lower-emission alternatives, but are simultaneously presented as functionally competitive. Practically, this includes a consistent door-to-door presentation of total travel time, clear information about connection quality, and transparent pricing rules. Formats that communicate time, price, and emissions jointly and in a comparable manner can make visible those decision situations in which rail is both environmentally advantageous and practically acceptable.

Fourth, the positive effect of moral norms indicates that normative motivation can be addressed as an additional driver, while its behavioral effectiveness remains contingent on contextual conditions. Since the MN exhibits an independent association with choosing rail even when functional attributes are controlled for (see Chapter 4.3 and Appendix), communication strategies that appeal to personal responsibility and climate-related consequences may increase the propensity to choose rail. At the same time, the continued strength of time and price effects suggests that normative appeals are unlikely to reliably compensate for pronounced contextual barriers. Overall, the findings therefore support a combined approach in which structural improvements in travel time and price create the conditions under which informational and norm-based interventions can become behaviorally effective. A shift towards rail appears particularly plausible where competitive rail offerings are paired with clear information and supportive choice framing, rather than relying primarily on stand-alone awareness campaigns.

5.3 Limitations and future research

The findings should be interpreted in light of several limitations that primarily affect external validity and the transferability of the estimated trade-offs. Because the analysis relies on a stated choice experiment (see Chapter 3), the estimated preference parameters cannot be equated straightforwardly with realized booking behavior. In particular, hypothetical bias and the well-documented gap between attitudes and behavior in sustainability-related contexts may affect the magnitude of the estimated effects. In addition, as described in Chapter 3, the sample is not intended to be representative of European leisure travelers. Recruitment through networks and the strong concentration in specific countries and demographic groups may induce selection patterns and thus limit the generalizability of the results. Moreover, the experiment deliberately focuses on a reduced set of attributes. Real-world decision components such as reliability, transfer burden, or door-to-door considerations are not varied systematically, implying that the relative importance of time, price, and emissions may shift in more realistic choice settings. Finally, the reported associations should be interpreted as average effects, as unobserved heterogeneity is captured only to a limited extent and missing information on specific variables can reduce the effective sample in certain specifications. The psychological constructs are also based on self-reports and index construction, so that measurement error and social desirability cannot be fully ruled out.

These limitations also suggest clear avenues for future research. A natural extension is to validate the estimated trade-offs using revealed preference data or more incentive-compatible designs, which would allow a more informed assessment of how closely the results approximate actual behavior. Extending the attribute set to include real-world determinants, particularly reliability, door-to-door travel time components, and intramodality-related aspects, would further help to specify the conditions under which substitution towards rail becomes practically acceptable. Larger and more diverse samples across multiple countries and demographic groups would strengthen external validity and enable systematic comparisons across contexts. From a modeling perspective, more flexible approaches such as mixed logit or latent class models could capture preference segments and unobserved heterogeneity more systematically. Finally, a stronger integration of contextual costs with psychological determinants, such as habits, perceived control, or environmental identity, appears promising to identify more precisely the conditions under which normative motivation becomes behaviorally effective and when structural barriers dominate sustainable travel choices.

6 Conclusion

This thesis examined how leisure travelers in Europe choose between air travel and lower-emission rail options when facing explicit trade-offs in travel time, ticket price, and CO_2 emissions. Using an online stated-choice experiment, the analysis provides quantitative evidence that mode choice in a leisure context is shaped primarily by functional costs, while environmental information plays a secondary but non-negligible role. In doing so, the thesis contributes to the literature on behavioral gaps and contextual constraints by showing how strongly convenience and affordability condition the uptake of lower-emission alternatives in a concrete air-rail choice setting.

Across model specifications, functional attributes dominate air-rail mode choice, rail becomes substantially less attractive as relative time and price disadvantages increase, whereas larger emissions savings increase rail choice with a smaller substantive magnitude. Importantly, preferences are not uniform. Income moderates price sensitivity, with higher-income respondents being less deterred by rail price premiums, suggesting that financial feasibility meaningfully shapes observed heterogeneity in rail uptake. Moreover, time penalties are not valued linearly. The quadratic time term indicates an acceptability threshold beyond which additional rail travel time reduces the probability of choosing rail disproportionately.

Beyond these functional drivers, the findings support H4 by showing that moral norms provide independent explanatory power for choosing rail even when functional attributes and income are controlled for. At the same time, their behavioral relevance remains bounded by feasibility, reinforcing an integrated account of sustainable mode choice in which behavior reflects the joint influence of motivational factors and contextual costs rather than either mechanism alone.

The practical implications therefore prioritize reducing rail's time and price disadvantages as the primary levers for increasing rail uptake, while information and norm-based measures can act as supportive complements (see Chapter 5.2.2). Finally, the limitations discussed in Chapter 5, including the stated-preference nature of the design, the sample composition, and the restricted attribute set, suggest clear directions for future research, such as validation with behavioral data and extensions that incorporate additional real-world determinants of travel choice.

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Appendices

A Survey

Introduction

Welcome to my survey and thank you for taking part.

My name is Frederik Lambrecht and this study is part of my master's thesis in Management at Católica Lisbon School of Business and Economics.

I examine customer behavior in the context of sustainable travel, especially how people choose between flying and lower emission rail options for leisure trips within Europe.

Your answers are anonymous, voluntary and will be used only for academic research. There are no right or wrong answers, so please answer according to your personal impressions.

If you have any questions, you can contact me at:

s-flambrecht@ucp.pt

Travel Behavior

Q1: During the past 3 years, how often have you gone on leisure or holiday trips of at least one overnight stay?

() 1 time or less

() 2-3 times

() 4-5 times

() more than 5 times

Q2: When you think about your main leisure or holiday trips in the past 3 years, which distance category fits best for the majority of your trips (one-way distance)?

() Mostly short trips (up to about 500 km one way)

() Mostly medium distance trips (about 500 – 1,200 km one way)

() Mostly long distance trips (more than 1,200 km one way)

Q3: For these main leisure or holiday trips, what is the typical duration of one trip?

() 1-2 nights

() 3-4 nights

() 5-7 nights

() 8- 14 nights

() more than 14 nights

Q4: For these main leisure or holiday trips in the past 3 years, which means of transport did you use most often for the longest part of the journey?

() Mainly plane

() Mainly train (rail)

() Mainly car

() Mainly lang distance coach / bus

Q5: Now think about medium-distance leisure trips within Europe, roughly 500–1,200 km one way, where you could in principle choose between a flight and a train (rail) service. In general, which option do you personally tend to choose?

() I almost always fly

() I mostly fly

() I choose plane and train about equally often

() I mostly take the train

() I almost always take the train

Q6: Now think specifically of medium-distance leisure trips within Europe, roughly 500–1,200 km one way, for example routes such as Hamburg–Munich, Cologne–Paris or Lisbon–Madrid. In general, how do you evaluate the following aspects of plane compared to train (rail)?

Plane much better | Plane somewhat better | No clear Difference | Train somewhat better | Train much better

1. Total travel time

2. Ticket price

3. Comfort during journey

4. Planning reliability / predictability

5. Environmental impact

6. Perceived safety aspect

Travel Choice Experiment

In this part of the survey, we ask you to make a series of hypothetical travel choices between a flight and a train (rail) service. Please imagine that you are planning a medium-distance leisure trip within Europe – roughly 500–1,200 km one way – similar to the trips you usually take for holidays.

The trip is for leisure purposes (for example a holiday, visiting friends or family) and lasts about 5–7 nights. You travel with the people you usually travel with on such trips.

In each question, you will see two travel options for the same trip:

- one flight, and
- one train (rail) service.

The origin and destination, travel dates, accommodation and activities at the destination are the same for both options.

The two options differ only in:

- total travel time (door-to-door),
- ticket price per person, and
- CO_2 emissions per person for the whole round trip.

In the following questions, CO_2 emissions are shown in kilograms of CO_2 per person for the entire round trip. A lower value means a lower contribution to climate change. For all options, we also indicate how many percent lower the emissions are compared to the flight option, for example "about 80 percent less than the flight".

Please base your choice on this information and indicate which option you would personally choose.

The following example illustrates the type of choice you will see. Please imagine you are planning the medium-distance leisure trip within Europe described above. You can choose between the following two travel options:

EXAMPLE

	Option 1: Flight	**Option 2: Train (rail)**
Total travel time (door-to-door)	4.5 hours	6.0 hours
Ticket price (per person)	220 €	170 €
CO_2 emissions (per person)	280 kg CO_2	56 kg CO_2 (about 80% less than the flight)

Question: Which option would you choose for this trip?

() I would choose Option 1: Flight

() I would choose Option 2: Train (rail)

In the next questions, you will see several travel choices similar to the example.

In each question, please again assume that you are planning the same type of medium-distance leisure trip within Europe as described above. The only differences between the two options are again: total travel time (door-to-door), ticket price per person, and CO_2 emissions per person. For each question, please indicate which option you would personally choose.

Q7: Which Option would you choose?

	Option 1: Flight	**Option 2: Train (rail)**
Total travel Time (door-to-door)	4.5 hours	6.0 hours
Ticket price per Person	220.00€	120.00€
CO_2 emissions (per person)	280 kg CO_2	56 kg CO_2 (about 80% less than the flight)

() I would choose Option 1: Flight

() I would choose Option 2: Train (rail)

Q8: Which Option would you choose?

	Option 1: Flight	**Option 2: Train (rail)**
Total travel Time (door-to-door)	4.5 hours	7.5 hours
Ticket price per Person	220.00€	170.00 €
CO_2 emissions (per person)	280 kg CO_2	186 kg CO_2 (about 40% less than the flight)

() I would choose Option 1: Flight

() I would choose Option 2: Train (rail)

Q9: Which Option would you choose?

	Option 1: Flight	**Option 2: Train (rail)**
Total travel Time (door-to-door)	4.5 hours	9.0 hours
Ticket price per Person	220.00€	120.00€
CO_2 emissions (per person)	280 kg CO_2	112 kg CO_2 (about 60% less than the flight)

() I would choose Option 1: Flight

() I would choose Option 2: Train (rail)

Q10: Which Option would you choose?

	Option 1: Flight	**Option 2: Train (rail)**
Total travel Time (door-to-door)	4.5 hours	6.0 hours
Ticket price per Person	220.00€	220.00€
CO_2 emissions (per person)	280 kg CO_2	28 kg CO_2 (about 90% less than the flight)

() I would choose Option 1: Flight

() I would choose Option 2: Train (rail)

Q11: Which Option would you choose?

	Option 1: Flight	**Option 2: Train (rail)**
Total travel Time (door-to-door)	4.5 hours	7.5 hours
Ticket price per Person	220.00€	270.00€
CO_2 emissions (per person)	280 kg CO_2	28 kg CO_2 (about 90% less than the flight)

() I would choose Option 1: Flight

() I would choose Option 2: Train (rail)

Q12: Which Option would you choose?

	Option 1: Flight	**Option 2: Train (rail)**
Total travel Time (door-to-door)	4.5 hours	4.5 hours
Ticket price per Person	220.00€	270.00€
CO_2 emissions (per person)	280 kg CO_2	112 kg CO_2 (about 60% less than the flight)

() I would choose Option 1: Flight

() I would choose Option 2: Train (rail)

Q13: Which Option would you choose?

	Option 1: Flight	**Option 2: Train (rail)**
Total travel Time (door-to-door)	4.5 hours	4.5 hours
Ticket price per Person	220.00€	220.00€
CO_2 emissions (per person)	280 kg CO_2	56 kg CO_2 (about 80% less than the flight)

() I would choose Option 1: Flight

() I would choose Option 2: Train (rail)

Moral Norm

In this part of the survey, we ask about your views and feelings regarding the environmental impact of travel. Please answer spontaneously. There are no right or wrong answers.

Response scale for all items:

1 = Strongly Disagree | 2 = Disagree | 3 = Neither agree nor disagree | 4 = Agree | 5 = Strongly agree

Q14: Please indicate how much you agree or disagree with the following statements.

a) Protecting the environment is important to my in my everyday life

b) I See myself as someone who is concerned about environmental and climate issues

c) Living in an environmentally friendly way is an important part of who I am.

Q15: The following statements refer specifically to leisure travel and its impact on the climate. Please indicate how much you agree or disagree.

a) When I travel for leisure, I feel a moral obligation to reduce my contribution to climate change.

b) If a lower emission rail option is available for a leisure trip within Europe, I feel I should choose it, even if it takes more time.

c) I would feel guilty if I chose to fly for a leisure trip within Europe and ignored the climate impact.

d) It would bother me if I did not take CO_2 emissions into account when deciding how to travel for leisure.

Q16: Now think again of medium-distance leisure trips within Europe – roughly 500–1,200 km one way – as described earlier. Please indicate how much you agree or disagree with the following statements.

a) For medium-distance leisure trips within Europe, choosing the train instead of flying is generally a good option for me.

b) I personally like the idea of travelling by train instead of flying for such trips.

c) If train and flight had similar departure times and were both available, I would usually prefer the train for such leisure trips.

Demographics

Q17: Which age group are you in?

() under 18 years

() 18-25 years

() 26 – 40 years

() 41 – 60 years

() Over 60 years

Q18: What is your Gender

() Female

() Male

() Non-binary / third Gender

() Prefer not to say

Q19: Where do you live?

() Germany

() Austria

() Portugal

() Other European Country

() Country outside Europe

Q20: What is your approximate net monthly household income (after taxes), from all sources?

() Less than 1,500€

() 1,500€ - 2,999€

() 3,000€ - 4,999€

() 5,000€ or more

() Prefer not to say

End of Survey (Completion Message)

Thank you very much for taking part in this study.
If you have any questions, you can reach me at: s-flambrecht@ucp.pt
Your answers have been saved; you can now close this browser window.

B Additional Figures

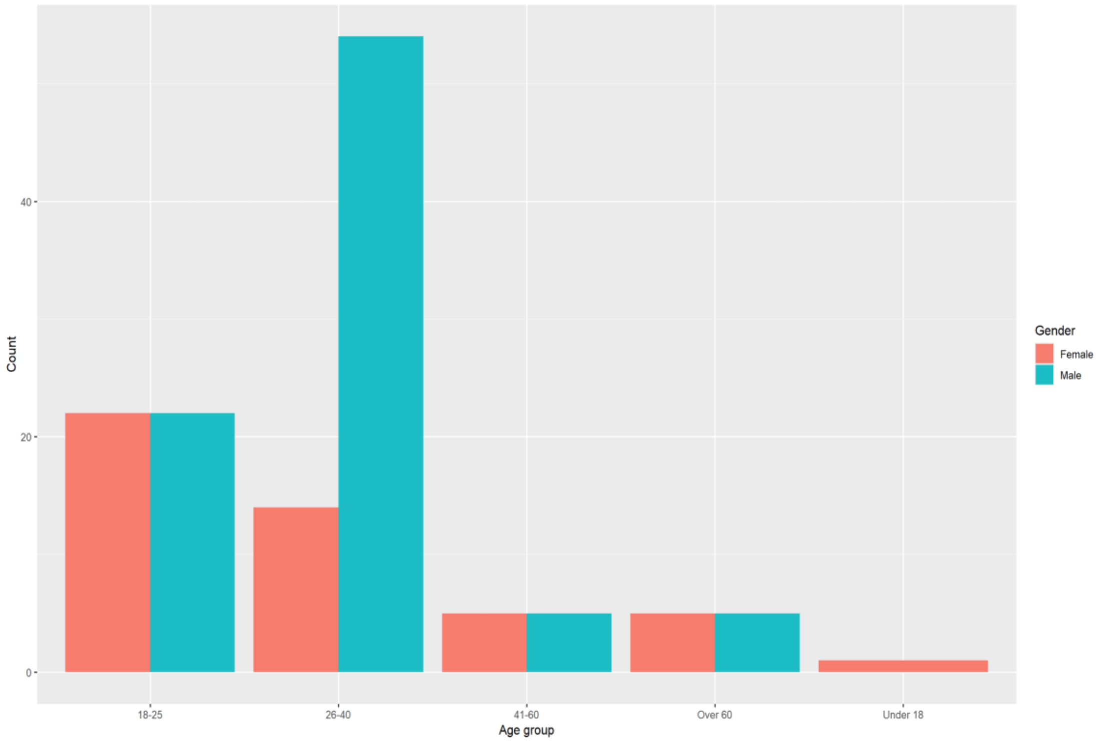

Figure 13 Respondents Overview

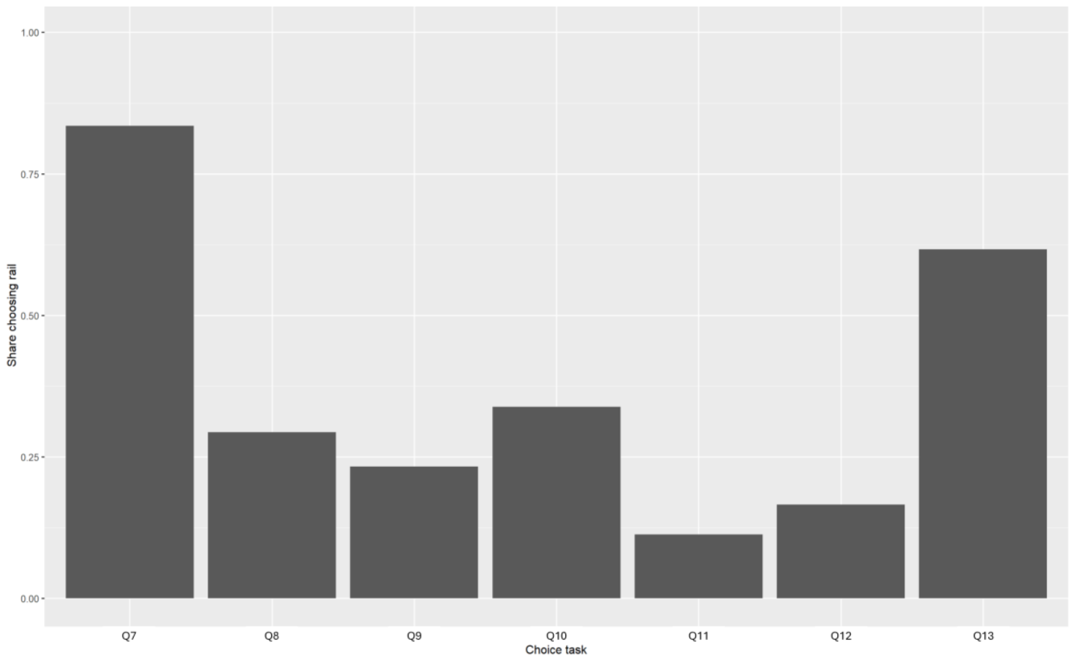

Figure 14 Experiment Answers Overview

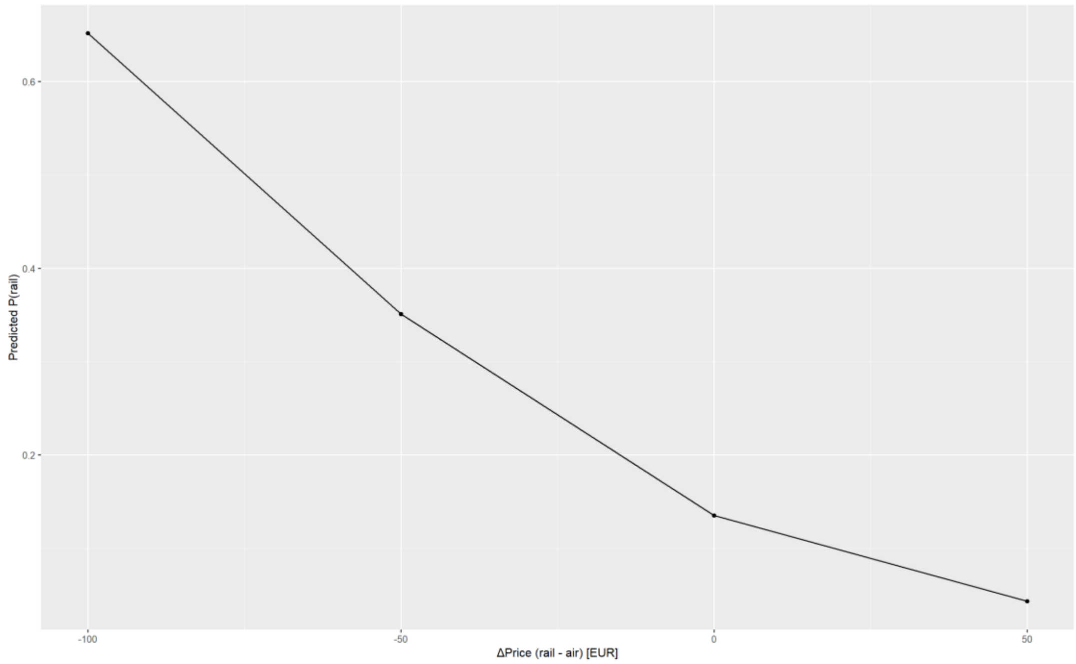

Figure 15 Predicted probability of choosing rail across ΔPrice

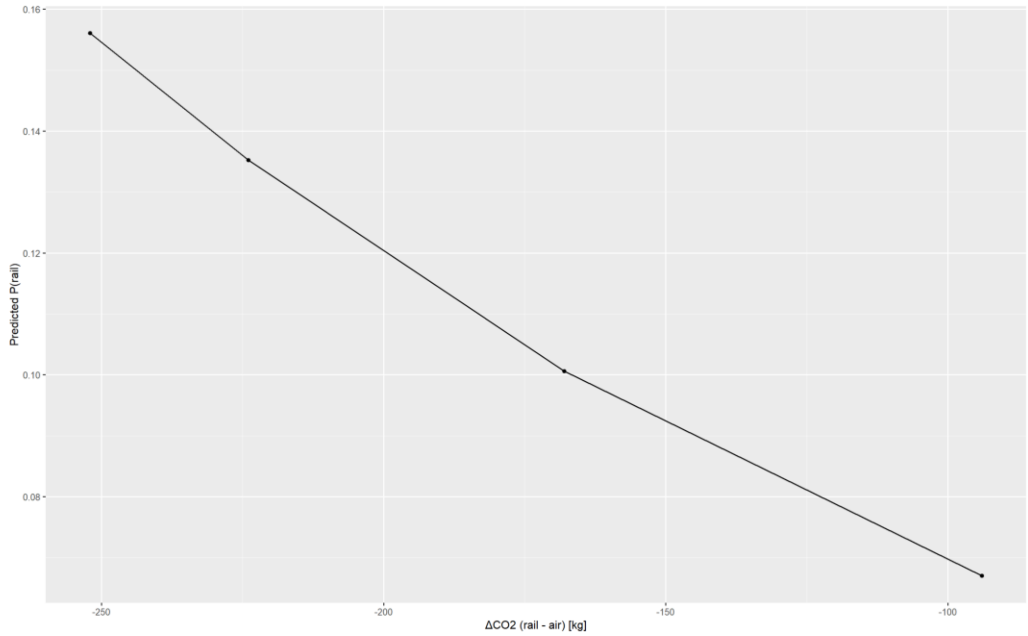

Figure 16 Predicted probability of choosing rail across Δ CO_2

Pooled logistic regression models (clustered SE at respondent level)

	Dependent variable:						
	Rail choice (1 = rail, 0 = flight)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ΔTime (rail - air) [h] (centered)	-0.656***	-0.742***	-0.750***	-0.718***	-0.772***	-0.755***	-0.767***
	(0.071)	(0.079)	(0.082)	(0.079)	(0.082)	(0.084)	(0.086)
ΔTime² (quadratic; centered)				-0.106***		-0.112***	-0.115***
				(0.035)		(0.037)	(0.038)
ΔPrice (rail - air) [EUR]	-0.022***	-0.025***	-0.032***	-0.025***	-0.026***	-0.034***	-0.035***
	(0.002)	(0.002)	(0.005)	(0.003)	(0.003)	(0.005)	(0.005)
Income (ordinal)		0.249	0.326**	0.250	0.203	0.286*	0.276*
		(0.160)	(0.163)	(0.162)	(0.153)	(0.157)	(0.158)
ΔPrice × Income			0.003**			0.003**	0.003**
			(0.001)			(0.002)	(0.002)
ΔCO2 (rail - air) [kg]	-0.005***	-0.006***	-0.006***	-0.005***	-0.006***	-0.005***	-0.005***
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)
Moral norm index (MN; q34 only)					0.527***	0.536***	0.295*
					(0.125)	(0.127)	(0.154)
Preference/attitude index (q35)							0.435***
							(0.159)
Controls included	No	Yes	Yes	Yes	Yes	Yes	Yes
SE clustered by respondent	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	931	882	882	882	882	882	882
Log Likelihood	-502.239	-426.349	-424.404	-422.728	-411.755	-405.685	-399.825
Akaike Inf. Crit.	1,012.478	892.697	890.807	887.456	865.510	857.370	847.651

Note: *p<0.1; **p<0.05; ***p<0.01
Cluster-robust standard errors (HC1) at respondent level.

Figure 17 Pooled logistic regression model

Hypothesis summary (clustered SE p-values; LR tests vs baseline where applicable)

Hypothesis	Parameter	Expected_sign	Estimate	p_value	LR_test_p
H1 (attributes)	ΔTime	Negative	-0.742	0	
H1 (attributes)	ΔPrice	Negative	-0.025	0	
H1 (attributes)	ΔCO2	Negative	-0.006	0.0001	
H2 (income moderates price)	ΔPrice × Income	Positive	0.003	0.045	0.049
H3 (non-linear time)	ΔTime²	Negative (concave)	-0.106	0.003	0.007
H4 (moral norm)	MN	Positive	0.527	0.00003	0.00000

Figure 18 Hypothesis summary