Acta Universitatis Agriculturae Sueciae

Doctoral Thesis No. 2022:24
Faculty of Natural Resources and Agricultural Sciences

Travel demand and environmental policy

Jonathan Stråle

Travel demand and environmental policy

Jonathan Stråle
Faculty of Natural Resources and Agricultural Sciences
Department of Economics
Uppsala

SWEDISH UNIVERSITY
OF AGRICULTURAL
SCIENCES

DOCTORAL THESIS
Uppsala 2022

Acta Universitatis Agriculturae Sueciae
2022:24

ISSN 1652-6880
ISBN (print version) 978-91-7760-923-0
ISBN (electronic version) 978-91-7760-924-7

Swedish University of Agricultural Sciences, Department of Economics, Uppsala, Sweden

Print: SLU Grafisk Service, Uppsala 2022

Travel demand and environmental policy

Abstract

In a simple theoretical set-up, the "regulator" is only interested in the social cost of carbon, but in a second best world when carbon pricing may be problematic in some sectors (such as international travel) the effects of alternative instruments will depend on the income and price elasticities of the demand for the good, tax effects, potential behavioral effects, and other determinants of demand. Understanding how these factors affect travel demand is therefore of great interest for policy. This thesis consists of three papers that estimate and evaluate the effects of income, taxes, prices and leisure time on the demand for international travel, as well as discuss the policy implications of the estimated results. In Paper I, heterogeneous household level income elasticities of international travel from Sweden are estimated. It is shown that increases in income have a large effect on the demand for international travel, and that this is particularly driven by the households who consume relatively little of the good. In Paper II, the effects of the recent Swedish aviation tax on the demand and price of international air travel from Sweden are estimated. The effects of the tax on the demand for international air travel are large, but no significant price effects can be found at a price index level. Using web-scraped route level price data, a price elasticity is also estimated, and it is shown that the demand effects from the tax are much larger than can be explained by pure price effects from the tax, even when it is assumed that the tax has a full pass-over on the prices of air travel. This indicates behavioral effects of the tax. In Paper III, the effects of increases in leisure time on the demand for leisure travel, and the importance of starting levels of leisure time, are analyzed both theoretically and empirically. It is shown that increases in leisure time have a positive effect on travel demand when the starting amount of leisure that the individual has is low, but that the effects decrease as the starting amount of leisure time increases.

Keywords: travel demand, air travel, income elasticity, price elasticity, tax effects, behavioral effects, leisure time, environmental policy.

Dedication

To my mother, Marie Stråle, for giving me the curiosity and tenacity needed for academic pursuits.

Contents

List of publications

This thesis is based on the work contained in the following papers, referred to by Roman numerals in the text:

I. Stråle, J. (2021). Household level heterogeneity in the income elasticities of demand for international leisure travel. Tourism Economics. (published online, forthcoming in print).

II. Stråle, J. (2022). The effects of the Swedish aviation tax on the demand and price of international air travel. (manuscript).

III. Stråle, J. (2022). Constrained leisure: the effects on travel demand when leisure time increases. (manuscript).

Paper I is reproduced with the permission of the publishers.

1. Introduction

Battling the emissions of greenhouse gases is one of the main global challenges that our generation are faced with. This thesis focuses on the demand side of a particularly emission intensive good: international travel. The main culprit in terms of carbon emissions from international travel is that it is made predominantly by air. As a sector, air travel still accounts for a relatively small share of greenhouse gas emissions. The share of total emissions from the sector, including the added effects of high altitude emissions, is estimated to be “only” 4-5 percent of global emissions. At an individual level however, air travel increases the individual emissions a lot. Kamb and Larsson (2019) show that one trip from Sweden to Phuket results in an individual emission of 3 tonnes of carbon dioxide equivalents. Considering that they estimate that the average Swede emits 10 tonnes of carbon dioxide equivalents, international air travel quickly results in a large share of individuals’ carbon foot prints. This together with the pre-pandemic trends are unsettling: it is clear that people love to travel and all else equal international travel, and its carbon emissions, are likely to continue to increase over the coming decades.

Despite the evident failure to halt the emissions of greenhouse gases so far, it is not a new issue in the economic literature. More than a 100 years ago, Pigou (1920) introduced the concept of negative externalities of production, and how to correct the resulting market failures with a “simple” tax. A negative externality is a cost of production that affects other people than the producer or consumer of the good, but that is not paid for by the producer. The social cost from the emission of greenhouse gases due to production is precisely this: the producer pays for the inputs that results in the emissions, but does not pay for the cost that the emissions have on other people, through e.g. global warming, i.e. the negative externality. The social marginal cost of the production is therefore larger than the marginal cost that the producer is faced with, since the cost of the emissions from the production is not paid for by the producer, and herein lies the market failure. Due to the fact that the cost of emissions is not included, the producer can sell the good at a lower price than it could have if it was. This leads to a higher demand for the good, and thereby a higher production, than is socially optimal. Pigou's solution is to tax the producer with the marginal cost of the externality, and to thereby correct the market failure by forcing the producer to pay for the full costs of its production, including the social cost that is incurred on external parties.

This so called Pigouvian tax has two desirable effects. In the short run, the price of the good increases, and due to this less of the good is consumed. Since the tax corrects the market failure, the socially optimal level of the good is now consumed and thereby a socially optimal level of emissions from the good also occur. In addition, the producer now has an incentive to emit less, since this will lower its cost of production due to lower taxes (as the tax is based on how much the producer emits) which would give it a competitive advantage in the industry. In the longer run, a Pigouvian tax on carbon emissions therefore also incentivizes the innovation of cleaner technologies. To achieve this latter effect, the tax must however be connected directly to the carbon that the producer emits. A tax on e.g. output in general does not give the producers the same incentives, as they would have to pay the same tax regardless of how clean their production is.

While Pigou's elegant solution has been critiqued by other theorists (see e.g. early critique by Coase, 1960), this type of tax is generally considered to be the gold standard when it comes to environmental policy to battle carbon emissions: a "first best" to strive for. In practice however, this gold standard is hard to reach due to a myriad of reasons. As a start, it is difficult quantify the social cost of emissions (see e.g. Baumol, 1972). Even if we had the political will and ability to implement an international tax on carbon emissions it is not clear what the price of carbon emissions would need to be to solve the issues of global warming. Another key point that needs to be achieved is international cooperation. In the case of air travel, a carbon tax on jet fuel would e.g. get us very close to the first best scenario, *if* it is implemented internationally. If only a few countries implement the tax, airlines could easily avoid it by refueling the planes in countries where the tax is not present and we would observe a "carbon leakage" (see e.g. Babiker, 2005). If this first best cannot be achieved, policy makers must resort to second best alternatives (see e.g. Cremer and Gahvari, 2001, and Cremer et al., 1998). One way to achieve this is to try to decrease the demand for air travel through other types of policy. How effective such policies are will however depend on how sensitive the demand for air travel is to changes in income, prices and taxes. In addition, other factors that might affect the demand of air travel must also be considered. One such factor could e.g. be the amount of leisure time that individuals have at their disposal.

This thesis consists of three papers that estimate and evaluate the effects of these factors on the demand for international travel as well as discusses the policy implications of the estimated results. In Paper I, the income elasticity of international travel from Sweden is estimated. Using detailed, household level expenditure data heterogeneous income elasticities are estimated for consumers with different levels of relative demand. In Paper II, the Swedish aviation tax that was introduced in 2018 is evaluated. The effect on the demand and price of international air travel from Sweden is estimated. Using web-scraped route level price data a price elasticity is in addition estimated, and it is shown that the demand effects from the tax are much larger than can be explained by pure price effects from the tax. In Paper III, the effects of increases in leisure time on the demand for leisure travel are estimated. In particular, the importance of the starting amount of leisure time is considered, both theoretically and empirically, and it is shown that increases in leisure time has a positive effect on the demand for leisure travel if the initial level of leisure time is low.

In the next section, the relevant literature on the effects of income, prices and taxes on the demand for travel, as well as the relevant literature on time in economics, is briefly reviewed. In section 3, the three appended papers of this thesis are summarized.

2. Relevant literature

2.1 Income

Income has been crowned as the most important determinant for travel demand (see e.g. Peng et al., 2015). In the empirical economic literature on the income effects on travel demand, the main focus is to estimate the income elasticity of demand, i.e. how much the demand changes, in percent, if income increases with one percent. How the elasticities are estimated in the literature is heavily shaped by what type of data that is available to the researchers.

The total number of passengers in the market of interest has typically been used as the dependent variable and some form of aggregate or per capita income variable is used as the income variable, especially in the earliest literature. Estimations are typically made using basic linear regression. Examples include Mutti and Murai (1977) who use regional aggregate real income as their income variable, Straszheim (1978), Kopsch (2012) and Boonekamp et al. (2018) who use GDP, Battersby and Oczkowski (2001) who use industrial production, Alperovich and Machnes (1994) who use real wage per employee, Jorge-Calderón (1997), Dargay and Hanly (2001) and Chi and Baek (2012) who use per capita disposable income and Graham (2000) who uses aggregate total expenditure as the income variable. This type of elasticity estimation gives a rough understanding of how important income is for the demand of international travel, in the market that is being studied, and in general the estimated income elasticities are above 1. This indicates that international travel is a so called luxury good: if income increases with one percent, the demand for international travel increases by more than one percent. The range of the estimated income elasticities in these studies are however huge: from negative elasticities in Anderson and Kraus (1981) to elasticities above 4 in Mutti and Murai (1977).

In later years, a strand of literature where focus is put on the reasons for this heterogeneity in the estimated income elasticities have been formed. Income elasticities have been shown to vary depending on what type of destination that is considered (Peng et al., 2015), the time period that is being studied (Gunter and Smeral, 2016) and the relative income level in the source country (Waqas-Awan et al., 2020). Given that heterogeneity is observed at an aggregate level, it is reasonable to assume that there are differences in income elasticities also at an individual, or household, level. To explore this one does however need individual or household level data, something that is not as common in the literature. Most examples of estimations with this type of data is also made at a destination level, i.e. based on surveys made at certain destinations (see e.g. Marrocu et al., 2015). Due to the self-selection that happens when individuals choose where to go on vacation, these types of estimates are however likely not representative in a broader perspective, and as shown by Brida and Scuderi (2013) the income variables in many of these papers are also highly restricted as income categories usually are used for privacy reasons.

There are however a few examples where income elasticities of travel demand are estimated using representative household data, which also allows for a heterogeneity analysis at a household level. The main source of heterogeneity that has been considered in the literature is based on differences in income. The income elasticity of the probability to participate, i.e. how the probability that an individual decides to travel changes when the income increases with one percent, seems to be decreasing as income levels increase. Alegre and Pou (2004) estimate the income elasticity of probability of tourism participation to be around 0.9 for the poorest households, decreasing to 0.6 for the richest households. Alegre and Pou (2016) find similar results for the US, where income elasticities start at 1.2 for the poorest households and decrease to 0.3 for the richest households. In both cases, all types of leisure travel are however considered, not international travel specifically. Eugenio-Martin and Campos-Soria (2010) estimate income elasticities for international travel using a household survey for the EU-15 countries and find that the income elasticity for the probability of participation in international travel increases from 0 to around 1 for the first income deciles, after which it decreases back to around 0 for the highest income deciles. When it comes to the income elasticity of travel expenditure, rather than probability of participation, Alegre et al. (2013) estimate heterogeneous elasticities, once again with Spanish household data, and find that the income elasticity increases with income from around 1.3 to 1.9 over the income distribution. Heterogeneity is also considered along the expenditure dimension, i.e. differences in income elasticities depending on the relative demand level, in one previous paper. Hung et al. (2012) use a household survey in Taiwan (once again, domestic travel is included in the dependent variable) and find negative income elasticities for the lower percentiles and positive elasticities for the higher percentiles. In addition, the effects of the financial crisis on the income elasticities of travel demand have also been given some attention in the literature, but only two papers have evaluated this effect using household level data: namely Alegre et al. (2013) and Alegre and Pou (2016). They both find very small effects on the income elasticities from the crisis.

Overall it is clear that there is a huge variability in the estimated income elasticities in the literature. There are also very few papers in the literature that use representative household data to estimate the elasticities, and when they are used international travel is rarely considered specifically (in general since this information is not included in the data sets they are using). This makes a huge difference since the income elasticity of international travel in general is higher than the income elasticity on domestic travel (see e.g. Peng et al., 2015). Given the differences depending on source country it is also important for policy makers to know the income elasticities in the country of interest. In my first paper of the thesis, I make a contribution to this literature by estimating heterogeneous income elasticities of international leisure travel at a household level using the Swedish Household Budget Survey, while also estimating the effect of the financial crisis on the estimated distribution of income elasticities.

2.2 Price and taxes

How changes in prices affect the demand for international travel, and air travel specifically, is of great interest to policy makers. One of the intentions when environmental taxes are used is to increase the price, and thereby decrease the demand, of the good in question. In the basic case, the full effect of a tax on the demand can be estimated through the use of price elasticity.

Recent literature has however found that environmental taxes in several cases have a larger effect than what can be explained by only a price increase due to the tax, and hence price elasticities might not tell the full story when it comes to the effect of environmental policy. Here we first consider the literature on price elasticities, followed by the very sparse literature on the effects of aviation taxes. Finally, a few examples of the aforementioned cases where environmental taxes have had larger effects than expected is briefly presented.

Just as for the income elasticities of travel demand, price elasticities have also been shown to vary a lot between e.g. source markets, destinations, type of travelers (e.g. business and leisure travelers) and the type of data as well as type of methodology that is used in the estimation (see e.g. Brons et al., 2002, and Peng et al., 2015). While there is some consensus in the level of average price elasticities (in almost all cases the elasticity is negative, i.e. a price increase leads to a reduction in demand, as expected), the width of the estimates is large, ranging from small positive elasticities in some cases to being well below a negative unit elasticity in other cases (see e.g. Brons et al., 2002, who show that elasticities vary between 0.21 and -3.2 in their meta study). When looking at the European market for international air travel however, the average elasticities are in most cases close to a negative unit elasticity.

Most papers in the field, especially the older papers, also assume that price changes are exogenous, which given the pricing strategies of airlines is now known not to be the case. Prices of a certain flight are changed depending on the demand, which in itself depends on the price, and so forth. This leads to biased estimates of the price elasticity if ordinary regression techniques are used. The dominating strategy to avoid this endogeneity bias in the literature is to use a so called instrumental variable approach. The key here is to find a variable that correlates with the prices of air travel, but not with the choice to travel by the passengers. If such a variable is found, the variation in prices that affects the demand can be isolated from the variation in demand that affects the prices, and an unbiased price elasticity can be estimated. A recent example of this is Mumbower et al. (2014) who use web-scraped price and seating data to estimate price elasticities in the US market, and how it varies depending on a number of factors, while also addressing the aforementioned endogeneity problem using the air-lines prices in all other markets than the market that they study, as well as the number of daily nonstop flights that the competitor has, as instruments for the price. They find an average price elasticity that varies between -1.32 and -1.97 depending on the price, but that the elasticity also varies greatly on a number of other factors such as the departure day of the week and time of day that the ticket is booked. Hsiao and Hansen (2011) is another example and they use the distance of the route times the price of jet fuel as an instrument, finding elasticities between -1.05 and -2.97 depending on route and market. Given this variety in estimates, it is important to estimate a trustworthy elasticity for the market that is being considered. For Sweden, the available literature is scarce. To the best of my knowledge, only one published paper exists, namely Kopsch (2012) who use aggregate price index data in their estimations and find price elasticities between -0.67 and -0.85.

The literature on the effect of aviation taxes on the demand for air travel is a research field that is very small, but growing as more and more countries are introducing passenger based aviation taxes. The literature in this field can be divided into two categories depending on the type of analysis that is made. The first is ex ante analyses based on model simulations where the demand effect is estimated using assumptions on price elasticities and tax pass-over (i.e. how much the price actually increases as a result of the tax). Examples of papers that use this type of analysis are Mayor and Tol (2007) and Forsyth et al. (2014) who evaluate the effects of the British air passenger duty and Australian aviation tax respectively. The more relevant category in the literature is however empirical ex post analyses, where only a few papers can be found. The results in the existing papers are also somewhat conflicting. Borbely (2019) is one recent example. He uses the synthetic control group method at an airport level and find that the tax, which is of a very similar size as the Swedish tax, reduces the total number of passengers from Germany by 2 percent. He further finds that this effect can mostly be explained by the effect at airports that are dominated by budget air lines as well as a “leakage” of passengers to airports close to the German border, i.e. that passengers are deliberately avoiding the tax by flying from a neighboring country (which naturally defeats the purpose of the tax). Falk and Hagsten (2019) evaluate the same tax, but for Germany as well as Austria (where the tax was also introduced) and find much larger effects. They find a reduction in international passengers by 9 percent the first year and 5 percent the second year after the introduction of the tax. Contrary to Borbely (2019) they find no evidence of “leakage”, but they do also find that the main driver of the effect is found at low cost-carrier airports. A third example is Seetaram et al. (2014) who estimate income, price and tax elasticities for route level international travelers from the UK, and find modest tax elasticities for most destinations, indicating a low effect of the tax on the number of passengers.

A very interesting recent development in the literature on environmental taxation is that CO_2 and gasoline taxes have been shown to result in much larger effects than what is to be expected given the price effects of the taxes. Li et al. (2014) finds that the effect of gasoline taxes in the US is larger than the expected price effects, and shows that salience through media coverage of the tax is a plausible explanation for this. Similarly, Rivers and Schaufele (2015) find that the effect of the carbon tax in British Columbia, Canada, on the demand for gasoline is 4.1 times larger than an equivalent change in a tax-exclusive price. Finally, Andersson (2019) shows that the tax elasticity of the Swedish CO2-tax, implemented in 1991, is three times higher than the price elasticity. If this is shown to be a general phenomenon it is naturally great news for environmental policy makers.

My second paper in the thesis contributes to all three areas in the literature. It estimates the effects that the Swedish aviation tax has on the demand and price of international air travel. In addition, it estimates a price elasticity using web-scraped data and it is shown that the tax effects are much larger than expected from price effects of the tax alone.

2.3 Leisure time

The final determinant of travel demand that is considered in this thesis is the importance of the amount of leisure time that individuals have at their disposal. In my third and final paper I specifically consider the importance of the starting level of leisure time when leisure time is increased exogenously, either through retirement or through an increase in vacation days, from both a theoretical and empirical perspective. The literature on this is however extremely limited. One example is Aguiar et al. (2013), who descriptively analyze how individuals who lost their job due to the Great Recession in 2008 use their newly found extra leisure time. They find that the most common increase is in time spent on sleeping and daily leisure activities such as watching TV. This is however purely a descriptive paper, and even this paper does not focus on travel demand specifically.

There are however adjacent fields that my research in the third paper relates too. One of these fields is the incorporation of time in economic modeling. One of the first attempts to incorporate time into households' utility maximization is done by Becker (1965) who develops a theory of the allocation of time between different activities. Becker departs from the standard economic consumption theory, where households maximize their utility by consuming different goods based on the monetary constraint that comes from the prices of the goods and the income that the households' earn, by introducing non-work time in the maximization problem. The time constraint is the total time available to the household less of the time the household spends at the work place and Becker further assumes that time can be converted into goods by spending more time at work and lowering the time spent at consumption. This reduces the budget constraint into one, namely the "full income" that can be achieved if all time is spent on working (which greatly simplifies the mathematical solution of the model). This does however also mean that Becker assumes that each individual can freely decide exactly how much to work, and in such a world leisure time can never increase exogenously. This has also been the prevalent assumption in most theoretical work where time is considered, both when demand for goods are in focus (as in e.g. DeSerpa, 1971) and when labor supply is modeled (as in e.g. Heckman, 1974).

This type of flexibility in work time is however far from the realities of the labor market. In most cases the work time is fixed when you are employed. The norm in most developed countries is something close to a 40-hour work week, and the amount of vacation time that is offered is also fixed (and often very limited). Due to this, a sub-field in the literature has emerged where the labor supply decision by individuals are modeled when individuals can only choose to accept the working hours that are offered, or not work at all. Examples of this type of literature are Moffitt (1982), Dickens and Lundberg (1985), Tummers and Woittiez (1991), and Feather and Shaw (2000) who all show theoretically, in slightly different ways, that the individual chooses to work the offered work time if the utility of doing so is larger than not working at all, even if it is far from the work time the individual would freely choose. They also find empirical evidence that many, if not most, individuals would choose a different work time than they have if they would be free to do so. Given this type of constraints in the labor market, an exogenous shift in leisure time is thereby also possible.

To the best of my knowledge however, no paper theoretically models the effect on the demand for time intensive goods, such as leisure travel, if the amount of work time (and thereby leisure time) is exogenously changed. As already mentioned, the empirical literature on the effect of changes in leisure time is also extremely limited. In part, this is likely from the assumption that exogenous changes in leisure time are not possible (and it is for sure debatable, especially when one considers the whole lifetime of an individual). Another reason is likely that even if exogenous changes in leisure time can happen, it rarely does. The laws regarding work time and vacation time very rarely changes. One example of a massive increase in leisure time is however retirement, which is also an event that I use in my third paper. The effects of retirement on consumption is also relatively well researched. The most common focus in this literature is on the retirement-consumption puzzle, i.e. that total consumption drops at retirement, something that is in violation of the so called permanent income hypothesis. The main focus in this literature is however on expenditures on food, and that the retirement-consumption puzzle can be explained by an increased home production (i.e. that households cook more when they are retired instead of eating out). Two prominent examples are Aguiar and Hurst (2005) and Luengo-Prado and Sevilla (2013), but there are several papers with the same focus. A few of these papers have also analyzed the effects of retirement on leisure travel expenditures. Miniaci et al. (2010) include holiday spending in their analysis, but find no effect from retirement in Italy between 1985-1996, and Redmond and McGuinness (2020), who find negative effects for retired males in Ireland, but it is not common and leisure travel is not in focus in these papers, especially not in relation to leisure time.

The effects of increased leisure, as well as retirement, on the demand for leisure travel is thereby heavily under-researched and my third paper makes a valuable contribution to this, in some aspects almost nonexistent, literature.

3. Summary of appended papers

3.1 Paper I – Household level heterogeneity in the income elasticities of demand for international leisure travel

In the first appended paper of the thesis I investigate household level heterogeneity in the income elasticities of demand for international leisure travel from Sweden. In particular, I estimate different household level income elasticities for each percentile of the distribution of expenditure on international leisure travel, conditional on the household level characteristics. Different income elasticities are thereby estimated for households that have a relatively low and a relatively high demand for international travel, given their characteristics (such as their age, what type of city they live in, how big the household is, etc.). These results are also analyzed in light of the theoretical framework by Matsuyama (2002) and Morley (1998) where this type of heterogeneity is predicted. In addition, the distributional effects of the 2008 financial crisis are also estimated. Given how sparse the literature on income elasticities that use representative household data is, this paper is a valuable addition. Especially since it is one of the very few papers that considers heterogeneity at a household level, and since it is the only paper (to the best of my knowledge) that analyzes the distributional effects of the financial crisis on the income elasticities. In the Swedish context, the results in this paper are also valuable since it is the first paper (to the best of my knowledge) that estimate the Swedish income elasticities of international travel using household level data. Given how much income elasticities can vary depending on source country, this is valuable for policy makers in Sweden.

The elasticities of interest are estimated using the Swedish Household Budget Survey (Hushållens utgifter - HUT - in Swedish), for the years 2003-2009 and 2012, together with a method that is called censored quantile regression. The Swedish Household Budget Survey is made by Statistics Sweden and includes detailed yearly expenditure data on the household level as well as general background information of both the household and its individuals. Each year, new households are sampled and the total sample size for all years is almost 18.000 households.

The main empirical issue when it comes to estimating income elasticities of leisure travel using household level data is that a large share of the population does not travel internationally in a given year. In Sweden, roughly half of the population travels abroad in the years that are studied. The households who do not travel therefore have a zero expenditure on international travel and the dependent variable is therefore "censored". Due to this, traditional econometric methods yield biased estimates. The method that I use in this paper, censored quantile regression, is a method developed by Powell (1984) and Powell (1986) as an extension to quantile regression framework introduced by Koenker and Bassett Jr. (1978) to account for the issues of censoring in the dependent variable at the same time as the kind of distributional analysis that I am interested in can be made.

Using the CQR framework, the income elasticity is estimated for each quantile (which is the same as percentile) of the conditional distribution of international leisure travel expenditure. As roughly half of the sample has no expenditure on international travel, the lowest percentile that can be estimated is the 51:st quantile. As the reader who have survived this far in the text probably have noticed, the terminology surrounding this method is a mouthful to say the least. The part that makes the interpretation extra complicated is the "conditional" part. The income elasticity for a high conditional quantile should be interpreted as the income elasticity for those households who have a high expenditure on international leisure travel given their observable household characteristics that have been controlled for. The estimated income elasticities, for each percentile, are therefore an average income elasticity for all of the households who, given their household characteristics, consume in the same percentile. The high consumers are thereby those who consume the most relative to households that are similar to them, and the low consumers are those who consume the least compared to similar households. In addition to the CQR method, the average income elasticity for Sweden is also estimated using the so called two-part model.

The main effects in this paper can be neatly summarized in one graph. As can be seen in Figure 1, the income elasticities are the highest for those who consume relatively little of international travel. The income elasticity at this level is also very large: if these households get one percent more income they increase their demand for international leisure travel with more than five percent. For these households, international travel is a strong luxury good: they desperately want to travel more and as soon as they get more income they react strongly. As the relative expenditure on international travel increases, the income elasticity decreases, ending up at around 1 for those who consume the most of the good, given their household characteristics. These households are closer to consuming international air travel to satiety, as they "only" adjust their demand with the same percentage as the income increases. The average income elasticity is also high as it is very close to 3.

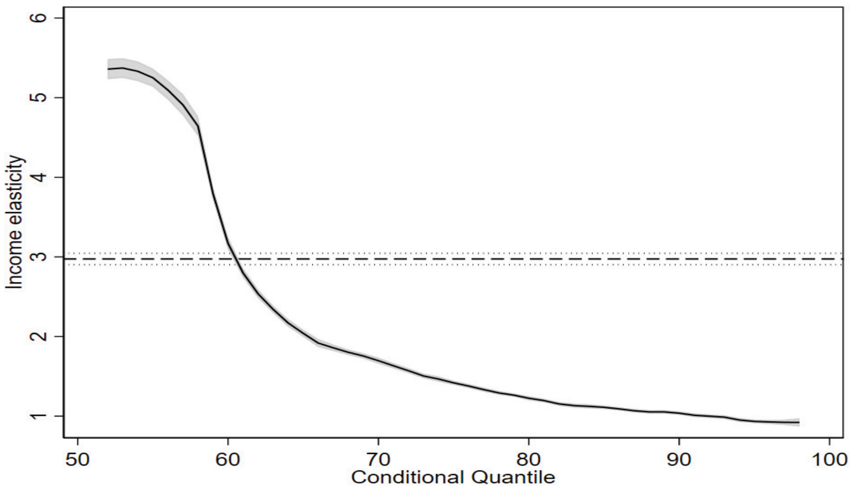


Figure 1. Estimated income elasticities

Using the same method, the distributional effects from the financial crisis on the income elasticities are also estimated. This is done by comparing the estimated elasticity curve in 2007 with the same for 2009 and it is found that the income elasticities are slightly larger in the year after the crisis than in the year before, but the difference is very small. This indicates that households' sensitivity to income changes is robust to an economic crisis.

These results are important for policy for several reasons. First of all, it can give an indication for how the demand for international travel will develop. Since the income elasticities are generally high, continued increases in income (which all else equal is to be expected, at least in the long run) will result in continued increases in demand for international travel. This will particularly be driven by the households who at the moment consume relatively little of the good. At the same time, the results together with the theoretical model of Matsuyama (2002) do also give insight in the "maturity" of the international travel market in Sweden, and indicate that average income elasticities are likely to decrease over time. Policies that aim to decrease the demand for international air travel by increasing the price of air travel will also be less effective as the price effects will be dwarfed by continued increases in income. On the flip side, income taxation could be an effective way to hamper the demand.

3.2 Paper II – The effects of the Swedish aviation tax on the demand and price of international air travel

In the second paper of the thesis I estimate the effects of the Swedish aviation on the demand and price of international air travel. The tax was introduced in April of 2018, and the size of the tax depends on how far away the destination is from Arlanda, starting at 60 SEK for countries completely within Europe and ending at 400 SEK for countries that are further away from Arlanda than 6000 km. What is interesting with this tax is that it was introduced as an environmental tax, and it received a lot of media attention when it was introduced. Understanding the demand effects of this tax, and whether this effect comes from a pure price effect or from behavioral effects connected to the "signal" that the tax sends, is thereby of utmost interest for environmental policy.

Estimating the causal effect of a tax is however no easy endeavor. The main issue, as with all attempts of causal estimations, is that we do not know the so called counterfactual: how many people that would have traveled by air if the tax was not introduced, nor what the price would have been if the tax was not introduced. The main issue is that there are a lot of factors that affect air travel, especially at the aggregate level, and simply comparing the levels of passenger or prices before and after the tax was introduced is not enough. We therefore need a trustworthy estimate of the counterfactual outcomes, i.e. an estimate of what would have happened in Sweden if the tax was not introduced.

To achieve this, I construct a "synthetic" Sweden using the synthetic control group method developed by Abadie et al. (2010) and Abadie et al. (2015). This is a method that creates a control country by choosing a weighted average of similar countries that minimizes the differences between the country of interest (in this case Sweden) and the synthetic control country, before the intervention of interest (in this case: the tax) takes place. If successful, the method thereby creates a "replica" of Sweden that mimics the development of international air travel and prices (as well as other important variables) before the tax is introduced. Given that this replication before the tax is successful, and under a few other assumptions, the method thereby also produces estimates of the counterfactual of interest: i.e. how many that would have traveled by air from Sweden, and what the price of air travel would have been, if the tax had never been introduced. The estimated effect of the tax on these variables are therefore the difference between Sweden and the synthetic Sweden for the post-tax period.

To create the synthetic Sweden, and estimate the causal effects of the Swedish aviation tax, I use other European countries that are not too dissimilar to Sweden, and that has not been exposed to a similar tax as Sweden under the period that is studied. When it comes to the passenger estimation, I use the share of the population that travels internationally by air as the main outcome variable. This choice is made as the passenger share is more representative for the demand level in a country than the total number of passengers, and thereby more comparable between countries. For the price effect estimation, I use a price index of international air travel, which is weighted by popularity of destinations to show a representative price level for all international air travel. Since there is a lot of seasonal variation in both the passenger shares and price index data, I deseasonalize the data before the synthetic control group is constructed. The data for these variables, just as other variables of interest, are retrieved from Eurostat and is at a quarterly level between 2011 and the end of 2019.

The estimated effects of the tax on the demand for international air travel are large. The effect starts at a decrease in passengers, when compared to the synthetic control group, with almost 6 percent in the first quarter after the tax. The effect becomes stronger over time, ending at a decrease of almost 13 percent in the last quarter of 2019. No significant effects are however found on the price index of air travel. Given the size of the tax, and the fact that a price index is used in the price estimation, this is however not surprising.

While these estimated effects are interesting on their own, it is still important to get an estimate on how much of the demand effect that can be explained by a (potential) price effect from the tax, and how much that can be explained by behavioral effects from the tax. To achieve this, we need detailed price data and a reliable estimate of the price elasticity of air travel from Sweden. For the price data, I therefore "web-scraped" Expedia.com during 2018 (i.e. built a program that automatically downloads prices of air travel tickets to specific destinations on a daily basis). This data is used together with route level passenger data, from Eurostat, to estimate a price elasticity. The estimated price elasticity, which is estimated at -0.76, is then used together with the route level price data to estimate how large the demand effect ought to be if it only had a price effect on the demand, under the assumption that the prices did in fact increase with the same amount as the tax is (i.e. 60-400 SEK depending on the destination).

It is shown that the demand effects ought to be between minus 1-2 percent if price effects are the only effects of the tax. Since the actual demand effects are much larger, this provides evidence for that the tax in addition to price effects has a large behavioral effect, likely coming from the media attention surrounding the tax. In addition, other behavioral effects are briefly considered. In particular, a potential "Greta Thunberg"-effect is descriptively analyzed and discussed. While the trends in popularity of Greta Thunberg seems to be very similar in Sweden and in the countries that constitute the synthetic control group, which speaks against a potential "Greta"-effect, it cannot be ruled out that the increased passenger effect the second year of the tax in part is due to a larger increase in environmental awareness in Sweden than in the synthetic control group.

This paper thereby makes several valuable contributions to the literature. First of all, it adds to the sparse literature on the effects of aviation taxes. In particular, it is, to best of my knowledge, the only paper that evaluates the Swedish tax. Secondly, it makes a valuable contribution to the relatively new literature on behavioral effects of environmental taxes. Just as for carbon taxes and gasoline taxes, the Swedish aviation tax also seems to have a much larger effect than can only be explained by price effects of the tax. This is of great value for policy makers that wish to reduce emissions from air travel. Finally, the paper also makes a small contribution to the literature on price elasticities.

3.3 Paper III – Constrained leisure: the effects on travel demand when leisure time increases

In the third and final paper of the thesis I turn my focus to a completely different demand driver, namely the amount of leisure time individuals has at their disposal. In this paper, the effects that an increase in leisure time has on the demand for leisure travel is considered, both from a theoretical and empirical perspective. In particular, special focus is given to the baseline level of leisure time that individuals have when the leisure time is exogenously increased, i.e. how much leisure time the individual has before an increase in leisure time happens, and how this affects the demand for leisure travel when income is held constant. Two countries are used to evaluate this: Sweden and the US. These are chosen since they differ in the amount of time that the average citizen spends at work. In particular Americans work a lot more than Swedes on average, partially because Swedes have access to a lot more vacation time than Americans. In the comparison, the event of retirement is used as the exogenous increase in leisure time. In addition, the effects of getting extra vacation time in Sweden is considered by using the event of turning 40 as a proxy variable, since a large share of the workforce get between 4 and 6 more vacation days at this age.

A theoretical model is derived where, in addition to monetary prices and income levels, a budget constraint on time is considered (in similarity with e.g. Becker, 1965, and DeSerpa, 1971). The individual maximizes its utility by spending money on two goods, and by relaxing (i.e. spending time but not money). One of the goods requires only money to consume. The other good requires money as well as time to consume. This time intensive good is a representation of leisure travel: in order to go on a vacation, we need to spend money as well as time. The individual can further not decide how much he or she works. Work time is exogenously decided in the model and this is made to represent the 40-hours work week norm as well as the fixed amount of vacation most employees have. This also allows us to analyze what happens to the demand for the time intensive good when leisure time is exogenously increased due to retirement, when the starting level of work-time is different. Using the average annual work hours per employee in Sweden and the US, it is shown that the demand for the time intensive good increases more in the theoretical “US” than in the theoretical “Sweden”. That is, when the starting level of leisure time is lower the effects on the demand for the time intensive goods is higher when the individual retires.

To test the effect of retirement in these countries empirically, the Swedish Household Budget Survey and the US Expenditure Survey is used for the years 2003-2009 and 2012. Using a restricted sample of 58-68 year olds, the effects of retirement is estimated on both the probability to travel and on the expenditure level given that you are a traveler. The effect on the probability to travel is estimated using probit, and the effect on the level of demand is estimated using ordinary least squares (OLS) on the sub-sample that has a positive expenditure on different types of leisure travel. In Sweden, domestic and international travel is considered as well as total leisure travel, i.e. the aggregate of the two. In the US, total leisure travel expenditure is considered as well as expenditure on air travel specifically. In Sweden, similar estimations are made for the effect of turning 40, where a sub-sample of 35-44 year olds are used in the estimation.

The estimated effects are also in line with the theoretical predictions. Retirement has a large effect on both the expenditure on total leisure and air travel in the US, as expenditures on total travel increases with slightly more than a thousand dollars per year due to retirement, but no such effects are found in Sweden. In addition, retirement has a positive effect on the probability to travel in the US in general but no effect is found on the probability to travel specifically by air. In Sweden, retirement has a positive effect on the probability to travel domestically but a negative effect on the probability to travel internationally. The aggregate effect is also negative. In addition, no effect on either the probability or expenditure level is found from individuals that are turning 40, when many get between 4-6 more vacation days.

The results therefore suggest that increased leisure time does indeed have an effect on the demand for leisure travel, given that the initial amount of leisure time is small enough. As the starting amount of leisure time increases, the effects are smaller. In addition, the estimated effects suggest that there is a point where extra leisure time have no effect on the demand for leisure travel. This is however not captured in the simple demand model that is derived. These results are important for environmental policy as it is likely that leisure time can increase due to increased automation. Understanding how this extra leisure time affects the demand for emission intensive goods, such as leisure travel, is therefore important to predict future changes in emissions as well as for considering potential environmental effects of changes in working time. In addition, one suggestion to reduce emissions is to “down-shift” the economy, where the argument is that if everyone works and earns less they will consume less goods, which will reduce emissions. If increased leisure time results in a shift towards more emission intensive goods, a rebound effect would occur and the result on emission reductions would be smaller than intended. The results in this paper do however suggest that any potential rebound effects would be small, given that the initial leisure time is large enough.

References

Abadie, A., A. Diamond, and J. Hainmueller (2010, 6). Synthetic control methods for comparative case studies: Estimating the effect of California's Tobacco control program. *Journal of the American Statistical Association.* 105 (490), 493–505.

Abadie, A., A. Diamond, and J. Hainmueller (2015, 2). Comparative Politics and the Synthetic Control Method. *American Journal of Political Science.* 59 (2), 495–510.

Aguiar, M. and E. Hurst (2005, 10). Consumption versus expenditure. *Journal of Political Economy.* 113 (5), 919–948.

Aguiar, M., E. Hurst, and L. Karabarbounis (2013). Time use during the great recession. *American Economic Review* 103 (5), 1664–1696.

Alegre, J., S. Mateo, and L. Pou (2013, 12). Tourism participation and expenditure by Spanish households: The effects of the economic crisis and unemployment. *Tourism Management* 39, 37–49.

Alegre, J. and L. Pou (2004). Micro-economic determinants of the probability of tourism consumption. *Tourism Economics.* 10 (2), 125–144.

Alegre, J. and L. Pou (2016, 6). US household tourism expenditure and the Great Recession. *Tourism Economics*. 22 (3), 608–620.

Alperovich, G. and Y. Machnes (1994). The Role of Wealth in the Demand for International Air Travel. *Journal of Transport Economics and Policy*. 28, 163–173.

Anderson, J. E. and M. Kraus (1981, 11). Quality of Service and the Demand for Air Travel. *The Review of Economics and Statistics*. 63 (4), 533–540.

Andersson, J. J. (2019, 11). Carbon Taxes and CO2 Emissions: Sweden as a Case Study. *American Economic Journal: Economic Policy*. 11 (4), 1–30.

Babiker, M. H. (2005, 3). Climate change policy, market structure, and carbon leakage. *Journal of International Economics.* 65 (2), 421–445.

Battersby, B. and E. Oczkowski (2001). An econometric analysis of the demand for domestic air travel in Australia. *International Journal of Transport Economics*. 28 (2), 193–204.

Baumol, W. J. (1972, 6). On Taxation and the Control of Externalities. *The American Economic Review*. 62 (3), 307–322.

Becker, G. S. (1965, 9). A Theory of the Allocation of Time. *The Economic Journal*. 75 (299), 493–517.

Boonekamp, T., J. Zuidberg, and G. Burghouwt (2018, 6). Determinants of air travel demand: The role of low-cost carriers, ethnic links and aviation-dependent employment. *Transportation Research Part A: Policy and Practice*. 112, 18–28.

Borbely, D. (2019, 8). A case study on Germany's aviation tax using the synthetic control approach. *Transportation Research Part A: Policy and Practice*. 126, 377–395.

Brida, J. G. and R. Scuderi (2013, 4). Determinants of tourist expenditure: A review of microeconometric models. *Tourism Management Perspectives*. 6, 28–40.

Brons, M., E. Pels, P. Nijkamp, and P. Rietveld (2002, 5). Price elasticities of demand for passenger air travel: a meta-analysis. *Journal of Air Transport Management*. 8 (3), 165–175.

Chi, J. and J. Baek (2012, 7). A dynamic demand analysis of the United States air-passenger service. *Transportation Research Part E: Logistics and Transportation Review*. 48 (4), 755–761.

Coase, R. H. (1960). The Problem of Social Cost. *The Journal of Law & Economics* Vol. 3 (Oct., 1960), pp. 1-44

Cremer, H. and F. Gahvari (2001, 5). Second-best taxation of emissions and polluting goods. *Journal of Public Economics*. 80 (2), 169–197.

Cremer, H., F. Gahvari, and N. Ladoux (1998, 12). Externalities and optimal taxation. *Journal of Public Economics.* 70 (3), 343–364.

Dargay, J. and M. Hanly (2001). The determinants of the demand for international air travel to and from the UK. *In 9th World Conference on Transport Research*, Edinburgh, Scotland.

DeSerpa, A. C. (1971, 12). A Theory of the Economics of Time. *The Economic Journal*. 81 (324), 828–846.

Dickens, W. T. and S. J. Lundberg (1985). Hours Restrictions and Labor Supply. *NBER Working paper series* (No.1638).

Eugenio-Martin, J. L. and J. A. Campos-Soria (2010, 8). Income and the substitution pattern between domestic and international tourism demand. *Applied economics*. 43 (20), 2519-2531.

Falk, M. and E. Hagsten (2019, 1). Short-run impact of the flight departure tax on air travel. *International Journal of Tourism Research*. 21 (1), 37–44.

Feather, P. and W. Shaw (2000, 10). The demand for leisure time in the presence of constrained work hours. *Economic Inquiry.* 38 (4), 651–661.

Forsyth, P., L. Dwyer, R. Spurr, and T. Pham (2014, 2). The impacts of Australia's departure tax: Tourism versus the economy? *Tourism Management*. 40, 126–136.

Graham, A. (2000). Demand for Leisure Air Travel and Limits to Growth. *Journal of Air Transport Management.* 6, 109–118.

Gunter, U. and E. Smeral (2016). The decline of tourism income elasticities in a global context. *Tourism Economics.* 22 (3), 466–483.

Heckman, J. (1974, 7). Shadow Prices, Market Wages, and Labor Supply. *Econometrica*. 42 (4), 679–694.

Hsiao, C. Y. and M. Hansen (2011, 11). A passenger demand model for air transportation in a hub-and-spoke network. *Transportation Research Part E: Logistics and Transportation Review*. 47 (6), 1112–1125.

Hung, W.-T., J.-K. Shang, and F.-C. Wang (2012, 1). Another Look at the Determinants of Tourism Expenditure. *Annals of Tourism Research.* 39 (1), 495–498.

Jorge-Calderón, J. (1997, 1). A demand model for scheduled airline services on international European routes. *Journal of Air Transport Management.* 3 (1), 23–35.

Kamb, A. and J. Larsson (2019). Climate footprint from Swedish residents' air travel. Technical report, Chalmers.

Koenker, R. and G. Bassett Jr. (1978, 1). Regression Quantiles. *Econometrica.* 46 (1), 33–50.

Kopsch, F. (2012, 5). A demand model for domestic air travel in Sweden. *Journal of Air Transport Management.* 20, 46–48.

Li, S., J. Linn, and E. Muehlegger (2014). Gasoline Taxes and Consumer Behavior. *American Economic Journal: Economic Policy:* 6 (4), 302–42.

Luengo-Prado, M. J. and A. Sevilla (2013, 6). Time to Cook: Expenditure at Retirement in Spain. *The Economic Journal.* 123 (569), 764–789.

Marrocu, E., R. Paci, and A. Zara (2015, 10). Micro-economic determinants of tourist expenditure: A quantile regression approach. *Tourism Management*. 50, 13–30.

Matsuyama, K. (2002, 10). The Rise of Mass Consumption Societies. *Journal of Political Economy*. 110 (5), 1035–1070.

Mayor, K. and R. S. Tol (2007, 11). The impact of the UK aviation tax on carbon dioxide emissions and visitor numbers. *Transport Policy*. 14 (6), 507–513.

Miniaci, R., C. Monfardini, and G. Weber (2010, 3). How does consumption change upon retirement? *Empirical Economics*. 2009 38:2 38 (2), 257–280.

Moffitt, R. (1982). The Tobit Model, Hours of Work and Institutional Constraints. *The Review of Economics and Statistics*. 64 (3), 510–515.

Morley, C. L. (1998, 1). A dynamic international demand model. *Annals of Tourism Research*. 25 (1), 70–84.

Mumbower, S., L. A. Garrow, and M. J. Higgins (2014, 8). Estimating flight-level price elasticities using online airline data: A first step toward integrating pricing, demand, and revenue optimization. *Transportation Research Part A: Policy and Practice*. 66 (1), 196–212.

Mutti, J. and Y. Murai (1977). Airline Travel on the North Atlantic: Is Profitability Possible? *Journal of Transport Economics and Policy*. 11, 45–53.

Peng, B., H. Song, G. I. Crouch, and S. F. Witt (2015, 9). A Meta-Analysis of International Tourism Demand Elasticities. *Journal of Travel Research*. 54 (5), 611–633.

Pigou, A. 1920. *The Economics of Welfare*, 1st ed. London: Macmillan.

Powell, J. L. (1984, 7). Least absolute deviations estimation for the censored regression model. *Journal of Econometrics*. 25 (3), 303–325.

Powell, J. L. (1986, 6). Censored regression quantiles. *Journal of Econometrics*. 32 (1), 143–155.

Redmond, P. and S. McGuinness (2020, 10). Consumption in Retirement: Heterogeneous Effects by Household Type and Gender. *Journal of Population Ageing*. 2020 , 1–19.

Rivers, N. and B. Schaufele (2015, 11). Salience of carbon taxes in the gasoline market. *Journal of Environmental Economics and Management*. 74, 23–36.

Seetaram, N., H. Song, and S. J. Page (2014, 7). Air Passenger Duty and Outbound Tourism Demand from the United Kingdom. *Journal of Travel Research*. 53 (4), 476–487.

Straszheim, M. R. (1978). Airline Demand Functions in the North Atlantic and Their Pricing Implications. *Journal of Transport Economics and Policy.* 12, 179–195.

Tummers, M. P. and I. Woittiez (1991). A Simultaneous Wage and Labor Supply Model with Hours Restrictions. *The Journal of Human Resources*. 26 (3), 393–423.

Waqas-Awan, A., Rosselló-Nadal, J., & Santana-Gallego, M. (2021). New insights into the role of personal income on international tourism. *Journal of Travel Research*, *60*(4), 799-809.

Acknowledgements

This has been a long and strenuous journey, and I would not have been able to do it on my own. First of all, I would like to thank my main supervisor, Rob Hart. He has given me plenty of support in how to write papers, developing research ideas, helping me prioritize and of course, in the form of feedback on my work. I am also very thankful for his trust in the efficiency of my "just-in-time" academic delivery system, as he so eloquently puts it. I have also been blessed with an excellent team of assistant supervisors. Claes Ek's input, on my second paper in particular, have been extremely valuable. Daniel Wikström and Tingmingke Lu have also provided valuable help on the empirical aspects of my research. Efthymia Kyriakopoulou have not only supported me in my thesis research but has also helped me look ahead for future research opportunities; a special thanks to Efi for believing in my potential and including me in her applications for funding.

I also owe thanks to several other colleagues for providing valuable comments on my research. Corrado di Maria, Yves Surry and Giannis Karagiannis gave me excellent feedback on my first paper. Daniel Spiro gave me food for thought on my last paper, but in the very beginning of my journey. I've also received good comments from Tabaré Capitán on my second paper. I've received plenty of feedback on both my first and my second paper through conferences and workshops (NAERE Copenhagen, EAERE Manchester, UPhD Breakfast Club, Uppsala, SUDSWEC Uppsala to name a few). In particular, I received a valuable comment by Torben Mideksa, who suggested that I should use the synthetic control group method in my second paper when I presented at SUDSWEC.

I am also very thankful for my wonderful colleagues. The department of economics at SLU is a really great work environment, primarily due to the people who work here. Julian has been my closest office mate during these years, and we've had many interesting and deep talks about everything and nothing. George showed me the ropes when I started, gave me many laughs and an even stronger positive attitude in life. Chrysa has been a wonderful friend, providing advice and emotional support as well as a key sense of humor. Gaëlle has been a Duracell battery of energy and an excellent sangria compadre. Jacob definitely gets comedy and Georgios is always positive. Overall the PhD students here are surprisingly fun to spend time with. I am also thankful for how open the more senior staff is to helping junior students. I've had very good talks with Helena, Shon, Dick, Johan, Ruben, Torbjörn, Jens, Sarah and of course Hans, who I shared friends with even before starting my PhD journey. I'm also very thankful for the encouraging chats with Luca Di Corato, when I was a master student. Thanks also for excellent support and patience from the admin group, as well as for help with the technicalities of the PhD studies I received from Gordana.

I owe my success during the first year to my fantastically brilliant colleagues at Uppsala University with whom I had the luck to start at the same time with. Davide, Anna, André, Sebastian, Lillit, Sofia and Daniel: thank you for the best possible first year of PhD studies and for lots of fun times outside of academia. Also thanks to Arnaldur, definitely one of the top five Icelandic guys in Uppsala.

I'm also blessed with having amazing friends outside of work. Philip, Maja, Jean-Alexander, Erika, Désirée, Axel-Charles, Nicci, Erik: you guys have done for me more than you can ever imagine. Giving me massive support through personal difficulties and always bringing me joy when we hang out. A special thanks to Philip: our almost daily contact during the last year and a half have helped me immensely. Thanks also to Emanuel and Katrina, for much needed getaways to Karlstad and for showing me how not to be a färsking. From my masters' cohort I'm also thankful for encouraging words, both before and during my PhD studies, from Helena Robling, Johannes, Felix, Fabian, Erik, Louise, Markus, Alessio, and Tom, to name a few.

Finally, but definitely not least, I'm immensely thankful for the support my mother, Marie, and my sister, Jennifer (as well as her partner Matte), have given me over the years. My farfar, Eiler, and my farmor, Ingegärd, have also always cheered me on over the years. May you rest in peace farmor. All in all, in times like these you realize that you have so many wonderful people around you. I wish I had the time and space to include all of you here.

I

Empirical Article

TOURISM ECONOMICS
The Business and Finance of Tourism and Recreation

Tourism Economics
2021, Vol. 0(0) 1–22

Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/13548166211033406
journals.sagepub.com/home/teu
SAGE

Household level heterogeneity in the income elasticities of demand for international leisure travel

Jonathan Stråle
Department of Economics, Swedish University of Agricultural Sciences, Sweden

Abstract

This article deepens the understanding of household level heterogeneity of income elasticities of demand for international leisure travel. This is done through the use of Swedish household level expenditure data which together with censored quantile regression allows for estimation of income elasticities based on relative consumption levels. In addition, an analysis of how the distribution of income elasticities was affected by the 2008 financial crisis is made. Results show a great heterogeneity in the estimated income elasticities, with income elasticities being the largest for the households who consume relatively little of the good, and a small positive effect of the financial crisis on the estimated distribution of income elasticities. These results can be used by policy makers, as well as managers in the tourism industry, to predict and influence the demand of international tourism at a more detailed level. The results also go in line with theoretical predictions and give further insight in market penetration as well as an ongoing structural change in the demand for international tourism.

Keywords

censored quantile regression, heterogeneous elasticities, income elasticity, international leisure travel, international tourism

Introduction

Income has been shown to be one of the most important determinants of international tourism demand in a multitude of papers. While there exists a general consensus in the literature that international tourism is a luxury good with an income elasticity above one, meta-studies such as Crouch (1996) and Peng et al. (2015) show that there is a large variation in the estimates between papers, some even showing negative income elasticities. One explanation for this observed range in estimates is that different approaches are used to estimate the income elasticity. A clear difference

Corresponding author:
Jonathan Stråle, Department of Economics, Swedish University of Agricultural Sciences, Box 7013, Uppsala 750 07, Sweden.
Email: jonathan.strale@slu.se

that can be observed in the literature is which type of data that is used in the estimation. Historically, most papers have used aggregate data on a country or route level, where some version of GDP is the most common income variable and the number of passengers is the most common measure for tourism demand (see, for example, Crouch, 1996). While these types of income elasticity estimates are useful for many applications, such as forecasting of international passenger flows, the use of micro-econometric models have several advantages as it more closely reflects the behavior of the tourists. Papers using aggregate data are still the most common approach in the literature, but the use of micro-data has become a lot more common in the past decades (Wang and Davidsson, 2010). Most of these papers use data that are collected on location however, and while this is helpful for the local tourism industry, the external validity of the estimates is lower due to self-selection by tourists to the destination that is being considered. In addition, the bias that comes from the fact that not everyone in a given country travels abroad in a given time period cannot be addressed. As is pointed out by, for example, Brida and Scuderi (2013), the analysis is usually also severely hampered by the fact that these types of on-location surveys rarely have detailed income data as this variable is usually collected as a categorical rather than a continuous variable due to anonymity reasons, and the knowledge on the income elasticities that they provide are thereby a bit limited.

One way to solve these issues is to use micro-econometric methods when analyzing a representative country level sample, which combines the advantages of using micro-data with the generalizability to a country level that estimations using aggregate data provide. In particular, the use of this type of data enables the researcher to address heterogeneity at a household level that can be analyzed for the entire population, as issues due to self-selection and censoring can be addressed. Despite these advantages, there are so far relatively few papers that analyze income elasticities using representative household data, Alegre and Pou (2004), Hung et al. (2012) and Alegre and Pou (2016) being three examples, and it is clear that further research using this type of data is useful to deepen the understanding of income elasticities for the demand of international tourism at a household level.

Heterogeneity is also a key explanation for the variability in estimated income elasticities that is observed in the meta-studies. Historically, the income elasticity has been assumed to be constant in tourism modeling but newer empirical evidence suggests that the income elasticity varies due to a number of factors such as the relative income level in the source country (Waqas-Awan et al., 2020), type of destination that is considered (Peng et al., 2015) or the time period that is being studied (Gunter and Smeral, 2016). Despite the fact that an understanding of this variability is important in, for example, forecasting performance, as shown by, for example, Smeral (2017), little attention has so far been shown to the heterogeneity in income elasticities at a household level. In addition to the previously mentioned advantages of household level estimation, an understanding of household level heterogeneity can help improve managerial decisions in the tourism industry as well as policy measures considered since aggregate income elasticity phenomena, such as differences between countries or decreasing elasticities over time, can be better understood.

This article tries to fill this research gap in two ways. First, we estimate heterogeneous income elasticities for households that have different levels of demand for outbound international leisure travel using Swedish household level expenditure data and censored quantile regression (CQR). Different income elasticities are estimated for each percentile of the conditional distribution of tourism expenditure so that the effect of a change in household income for relative top, mid and low spenders is analyzed separately. This addresses both household level heterogeneity at the same time as the advantages of using a representative country level sample are utilized. The resulting heterogeneity and its implications are analyzed using intuition from the theoretical contributions of Matsuyama (2002) and Morley (1998), who both predict varying income elasticities based on income and expenditure levels. Second, we use the financial crisis of 2008 to estimate how the distribution of income elasticities changes at a household level in response to an economic crisis.

The main purpose of investigating household heterogeneity along the expenditure distribution is threefold. First of all, heterogeneous income elasticities at a household level give a better insight into how economic policy will affect household demand for international tourism. This insight can be used from a governmental perspective, when wanting to increase or decrease demand for international tourism, as well as managers in the tourism industry. The latter is especially true as customers' expenditure levels, in comparison to, for example, customers' income, is observable by travel agencies, hotels and other actors in the tourism industry. Second, this type of heterogeneity analysis can be used to determine the level of market penetration and saturation for outbound international tourism in the country that is being studied, in this case Sweden. In general, aggregate income elasticities are used to determine the level of market maturity, a lower income elasticity signifying a higher level of maturity (see, for example, Graham, 2000). Getting an understanding of household heterogeneity in income elasticities gives a more nuanced picture of how far households have reached in consuming international tourism to satiety, at the same time as it provides further insight in structural change in demand for tourism and its effect on long term income elasticities. Third, a distributional understanding of how a financial crisis affects household level income elasticities improves the understanding of how resilient households' income elasticities are to economic crisis. This is important to be able to predict how fast the demand for international tourism will recover after an economic crisis, and to understand which type of households that will be the main driver of this recovery.

The main contribution of this article is therefore that heterogeneity based on household level demand for international tourism is considered, a metric that in comparison to household income is directly observable by actors in the tourism industry. While a few papers studying heterogeneity along the income distribution are already available (such as Alegre and Pou, 2004, and Alegre et al., 2013), only one other paper that use a representative household sample looks at heterogeneity along the tourism expenditure distribution (Hung et al., 2012). As already explained, this is valuable for both the tourism industry directly as well as policy makers. The second contribution is that the distributional effect of the 2008 financial crisis is estimated, something that to the best of our knowledge has not been previously considered in the literature. This is especially useful since we are currently in the midst of an economic crisis due to the COVID-19 pandemic, and while the current crisis in the tourism market is a lot different from the dip in demand because of the 2008 financial crisis, households' responsivity to increasing incomes will likely still be an important factor in the recovery of international tourism demand. In addition, due to the rich Swedish data that are used, a few other minor contributions can be made. Estimations are made for only international tourism expenditure, not all types of tourism as is usually the case in the household level literature. This distinction is relevant as domestic and international tourism differs in terms of income elasticities. In addition, separate estimations for expenditures made to booking agencies before departure and expenditures that are made on location are carried out. Differences in income elasticities when current income or total expenditure is used as the income variable are also considered, a choice that is often discussed in the literature (see, for example, Alegre and Pou, 2016).

The rest of the article is structured as follows. In the next section, the relevant literature on household heterogeneity in income elasticities as well as a brief empirical background on international travel from Sweden is presented. In the Data section, the data that are used and how the key variables are constructed are presented. In the Econometric Strategy section, the econometric strategy with the CQR estimator is presented. In the Main Results section, the results are presented and discussed together with robustness checks of the estimates. The Conclusion section concludes.

Literature review and empirical background

The empirical literature on household heterogeneity of the income elasticity of demand is still rather sparse, but it is clear that there exists heterogeneity along several dimensions. The main source of heterogeneity that is considered is differences in income elasticities depending on the level of household income. The pattern of heterogeneity along the income distribution appears to be different depending on whether the income elasticity of tourism participation or tourism expenditure is considered. For the probability of tourism participation, Alegre and Pou (2004) and Alegre and Pou (2016) find decreasing income elasticities for Spanish Households as income increases. Alegre and Pou (2004) estimate the income elasticity of probability of tourism participation to be around 0.9 for the poorest households, decreasing to 0.6 for the richest households. Higher education also leads to a lower income elasticity for all percentiles of the income distribution. Alegre and Pou (2016) find different elasticity levels depending on what type of income measure they use, current income or total expenditure, with the former generating elasticity estimates between 0.3 and 0.17 and the latter estimates between 1.2 and 0.3. Eugenio-Martin and Campos-Soria (2011) also estimate heterogeneous income elasticities of the probability of participation in tourism using a household survey for EU-15 countries. They find that the income elasticity of probability of participation in domestic travel decreases from around zero for the lowest income decile, to negative 5 for the highest income decile, while the income elasticity for the probability of participation in international travel increases from 0 to around 1 for the first income deciles, after which it decreases back to around 0 for the highest income deciles. The income elasticity of tourism participation therefore seems to be in general decreasing in income. When it comes to the income elasticity of tourism expenditure, rather than probability of participation, Alegre et al. (2013) estimates heterogeneous elasticities, once again with Spanish household data, and find that the income elasticity increases with income from around 1.3 to 1.9 over the income distribution.

When it comes to household heterogeneity based on the size of tourist expenditure, most studies that address this are made with data that are collected on location. Marrocu et al. (2015) is one example who analyzes heterogeneity of micro-determinants of tourism expenditure in Sardinia using quantile regression. As their income variable is categorical, they do not estimate income elasticities directly, but they show that high income households spend more than low income households and that this difference increases over the expenditure distribution. Peréz-Rodriguez and Ledesma-Rodriguez (2019) is another example that look at heterogeneity in tourism expenditure on the Canary Islands. They also use three levels of income in their analysis and find similar results for the effect of income along the expenditure distribution as Marrocu et al. (2015). An example of paper that uses visitor survey data with detailed income information is Chen and Chang (2012). They focus on the effect of travel-agents on travel expenditure, but use quantile regression to estimate the effects of interest at five different quantiles. They find a quite low heterogeneity in income effects as the income estimates are stable over most quantiles, but the top quantile (90th) shows an income effect that is roughly four times higher than the other considered quantiles. The only paper that does a heterogeneous analysis of tourism expenditure using a representative household sample is, to the best of our knowledge, Hung et al. (2012) who use the Survey of Family Income and Expenditure in Taiwan. Their dependent variable is percentage of household income spent on tourism, and using quantile regression they find negative income effects for lower quantiles (10th and 25th) and positive effects for the 50th quantile and above

The effects of economic crises on the income elasticity of tourism demand are also under-researched, especially at a household level. As shown by, for example, Smeral (2014), this is also a very important aspect to consider to improve forecasting performance, especially when forecasting is made in the midst of economic turbulence. Interestingly, differences in income elasticities before and after an economic crisis are found in the papers that do estimations based on aggregate data, and the direction of the effect can also go both ways depending on which origin country is being studied, but the same effects are not found in the two papers that use household data in their estimations. Smeral (2014), for example, find that Australia and Japan have higher income elasticities in slow growth, post-crisis, periods than fast growth periods (4.91 vs. 2.95 for Australia and 3.97 vs. 2.17 for Japan) while the EU-15 countries and USA have higher income elasticities in fast growth periods than slow growth (2.43 vs. 1.28 for EU-15 and 2.37 vs. 1.17 for USA). Gunter and Smeral (2017) similarly find that income elasticity of outbound tourism in the period after the financial crisis (year 2008–2014) is significantly higher (1.64) than in the fast growth period preceding the crisis (0.65). At a household level, only two papers have been written where the effect of the financial crisis on the income elasticity of tourism is tested. The first one is Alegre et al. (2013) that use Spanish Household data for the period 2006–2010. They find very small effects on the income elasticity of both the probability of participation and on tourism expenditure conditional on participation, but in different directions. The income elasticity for participation decreases slightly (from 0.57 to 0.51) while the elasticity for expenditure conditional on participation increases slightly (0.61–0.77) and even though the differences are significant, the change due to the crisis is far from those estimated using aggregate data. Alegre and Pou (2016) use the US Household Expenditure Survey to estimate the effect of the crisis, and find no significant effect on the income elasticity when the periods 2005–2008 and 2009–2012 are compared. These contradicting results are by themselves interesting, and motivate further research in the area, especially at a household level as the present article considers. In addition, none of the papers that considers the effect of the crisis on a household level estimates distributional effects of the crisis. While they consider heterogeneity for the full sample, as previously explained, they do not estimate separate effects of the crisis for different types of households. This is potentially important, especially if the crisis has heterogeneous effects on the income elasticity. In theory, the average income elasticity could be unchanged while the distribution is affected, increases for some households being canceled by decreases for others, which would affect both forecasts and policy recommendations.

From a theoretical point of view, household heterogeneity of income elasticities is expected for a luxury good such as international tourism. According to Engel's law (Engel, 1857), households that get richer reduce their expenditure share on necessities such as food in favor of more luxurious goods. However, what is considered a necessity and a luxury changes as a society keeps getting richer; something that was considered the highest of luxury 100 years ago, such as car ownership, is now considered to be a necessity by many households. Matsuyama (2002) builds on this premise and constructs a model with a spectrum of goods that are introduced to and consumed by agents in sequence: each new good is consumed up to a certain level after which more income is used to consume the next affordable item on the agents' shopping list of preferred goods. As households differ in income, each good starts off as a luxury good that only the richest households can afford. As income levels rise, each new good goes from being a luxury to a necessity that everyone consumes. Increased demand for the good also increases the efficiency of its production which leads to a decrease in price of the good. This price reduction in turn leads to the richest households having money left over to consume the next good, and the cycle continues. If this theory is relevant to international tourism, we expect different households to have different income elasticities for the good at the same time: the richest households who consume the good to satiety will have the lowest income elasticity, the good is now a necessity for these households, and the poorest households, for which the good is the highest luxury, who can only consume little of the good will have the highest income elasticity. While income is the main driver behind this heterogeneity, it is also implied that income elasticities falls as the level of consumption of the good increases. In addition to heterogeneity between households at a cross-section, this theoretical set-up also provides intuition for how income elasticities can change at an aggregate level for luxury goods: as the good becomes more and more affordable, the income elasticity will decline as more and more households perceive the good as a necessity rather than a luxury good.

Differences in income elasticities for international tourism based on differences in income levels is also hypothesized by Morley (1998), who develops a dynamic model that allows demand elasticities to vary over time. He hypothesizes a U-shape curve of income elasticities: the richest and poorest countries are expected to have the lowest income elasticity while the mid-income countries are expected to be the most responsive to an increase in income. The poor having a low response as they still only barely can afford to travel internationally, and an increase in income must be allocated toward other more important goods first, and the rich countries having a low elasticity as they already consume international tourism until satiety (that is the good is no longer a luxury good in these countries). The middle income countries can afford to travel internationally but are not consuming the good to satiety, and an increase in income will be allocated to this good to a large degree. While Morley (1998) constructed this hypothesis with a country comparison in mind, it is reasonable that a similar pattern is present also at a household level within a country. This has already been investigated along the income distribution to some extent, as already described, but a similar pattern can be expected also along the expenditure distribution, with the exception that those who consume nothing of the good has a zero income elasticity.

Turning now to a descriptive empirical background of the international travel from Sweden, the main dependent variable in this article is expenditure on international leisure travel. This expenditure category mainly consists of expenditure on international air travel and hotel payments. It is therefore useful to examine key background information on the development of the consumption and prices for these goods, as well as the development of income levels in Sweden.

International air travel, the main mode of transportation for Swedish travelers going abroad, has been continuously increasing in Sweden over recent decades, both in absolute terms and in relation to other means of transportation. Figure 1(a) shows how the number of international and domestic flights per person has developed between 1990 and 2015, when only traveling by Swedes is considered (connecting flights by internationals are, for example, excluded). As can be seen, there is a clear upward trend and the number of international flights per person per year has increased from around 0.5 to 1 during this time period. Looking at this graph, it is also important to keep in mind that far from everyone flies abroad in a given year, so the development among those who fly is even greater. Domestic flights per person is also included in the graph as a reference, and it is clear that this type of air travel follows a completely different pattern as it has been very stable over the same time period and even reduced a bit. As international air travel and hotel stays abroad are strong complements, it is not surprising that that the share of total expenditure that is spent on international travel (which includes both air travel expenditure and hotel expenditure) also has increased over the time period studied, as can be seen in Figure 1(b). Figure 1(c) shows how international travel by air has developed in relation to travel by train and boat by plotting the share of total number of trips from Sweden to another country that is made by air, including all types of travel and not just leisure travel. As can be seen, the share of international trips that is made by air is also increasing during the time period.

Figure 2 presents a graph of total expenditure, the measure of income that is used in this article (as discussed further in the Econometric Strategy section), as well as a graph of the price index for charter air travel. As is expected, income has been steadily increasing except for a few declines connected to the Swedish financial crisis of the early 1990s, the burst of the dot-com bubble in 2000

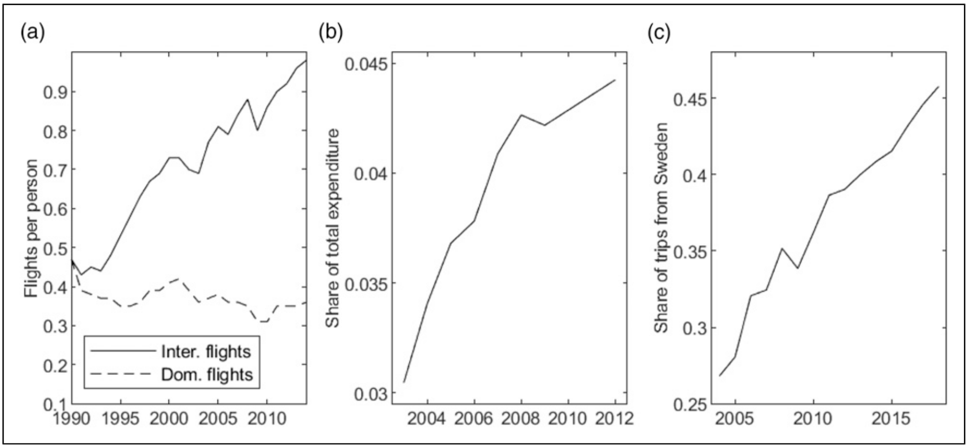


Figure 1. Development of international travel: (a) International and domestic flights per person in Sweden, when only Swedish travelers are considered (b) Swedish international leisure travel expenditure share of total expenditure. (c) Share of total number of trips from Sweden to another country that is made by air, when all travel from Sweden by air, boat and train are considered. Flights data in (a) from Kamb and Larsson (2018), expenditure shares in (b) are the author's own calculation from the Swedish Household Budget Survey for the years 2003–2012, micro-data from Statistics Sweden, and the shares in (c) are the author's own calculations based on data from the following databases at Eurostat: "International transport of passengers from the reporting country to the country of disembarkation," "Passengers embarked and disembarked in all ports by direction - annual data," "International intra-EU air passenger transport by reporting country and EU partner country," and "International extra-EU air passenger transport by reporting country and partner world regions and countries."

and the Great Recession in 2008. The development of the price index for charter air travel does however not show any clear trends.

Data

The data that are used in this article is the Household Budget Survey (HBS) for the years 2003–2009, and 2012 (the years 2010 and 2011 are not included as the survey was not conducted these years). The HBS is made by Statistics Sweden and includes detailed yearly expenditure data on the household level for all consumption categories in the COICOP classification system as well as general background information of both the household and its individuals. The yearly sample size is between 1972 and 2871 households and the total sample size for all years is 17,924 households. Each year a new sample of households is randomly selected, hence the full data set is repeated cross-section data and not panel data. The households are interviewed continuously throughout the year, and for infrequent purchases, such as leisure travel, the households report their purchases during the previous 12 months. Households who are interviewed at the beginning of a year will therefore mainly be answering for the previous year. Only households with a member younger than 79 are included in the survey. The main expenditure category of interest in this article is expenditure on international leisure travel. This expenditure category includes all types expenditures on leisure travel outside of Sweden and three variables are available: the total household expenditure on international leisure travel and two sub-categories that captures the expenditure that is made in Sweden (to a booking agency, airline or hotel, for example) and those expenditures that are made

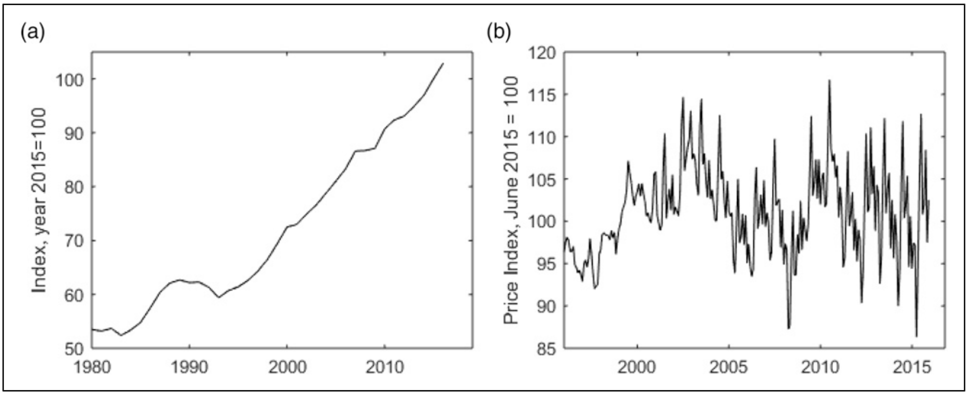


Figure 2. Development of income and price of international air travel: (a) Total expenditure (b) Price index for package holidays. Total expenditure data from the database "Household consumption expenditure (ESA2010) by purpose COICOP. Year 1980–2017" from Statistics Sweden and price index data from the database "Harmonized Index of Consumer Prices (HICP), monthly data" from Eurostat.

once at the destination (such as food, local transportation but also hotels if the payment is made on arrival or during the trip), respectively. The dependent variable of choice in this article is total expenditure on leisure travel, but the other two available categories, expenditure and leisure travel made in Sweden and expenditure made on location, will however be used as dependent variables in a sensitivity analysis. Given the focus of this article, the main explanatory variable of interest is household income. To capture and correct for the fact that households smooth their consumption by saving and borrowing, in accordance with the permanent income hypothesis, total household expenditure is used as the main income variable in this article. If, for example, disposable income would be used as income variable instead the resulting estimates would likely be biased downward as the sensitivity in leisure air travel expenditure due to changes in disposable income, which is a measure of the current income, should be lower than the sensitivity to changes in permanent—or life—income. This is especially the case when a full representative sample of the population is used that includes households that use loans (such as students) or savings (such as retired individuals) for their consumption, which is the case for the sample that is used in this article. This choice is however not made completely without controversy as, for example, Alegre and Pou (2016) show that income elasticities estimated with disposable income (or current income), rather than the total expenditure, are significantly lower. Due to this, disposable income is used in a robustness check.

To control for potential endogeneity, a set of control variables is used. These are indicator variables to control for what type of city the household lives in (the three biggest cities in Sweden, medium sized cities, or if the household lives in a municipality smaller than 50,000 inhabitants, which is the baseline), what type of employment the main respondent in the household has (employed being the baseline), whether the main respondent in the household has a college education or not, and what year the household was interviewed in (i.e., yearly fixed effects variables). In addition, a variable that captures the size of the household and a variable for the age of the main respondent are also included as control variables. The control variables are all included to account for the possibility of omitted variable bias as it is likely that they are correlated with both the total expenditure of the household and the expenditure on international leisure travel. In addition to the included control variables, other sources of endogeneity might be present. This is discussed further in the Possible endogeneity issues section.

To give a quick overview of some of the variables that have been described, descriptive statistics are presented in Table 1. There are a few aspects about the variables that are worth noting. International travel expenditure that is made in Sweden, such as air travel tickets and prebooked accommodation, is on average slightly larger than the expenditure that is made once the household has left Sweden. For the 75th (unconditional) expenditure quantile, the difference is larger, which is probably a result from larger prebooking fees for trips that are longer and further away. As expected, total expenditure exhibits a much lower dispersion compared to disposable income. As disposable income is income net from taxes a few households had negative disposable incomes, probably due to large infrequent tax payments in the year they were interviewed, at the same time as a few households had very large incomes (that possibly also is temporary). Total expenditure is much less dispersed, which is to be expected if households smooth their consumption. The age of household members and the household size both exhibit expected descriptive statistics.

Something that also becomes clear in Table 1 is that slightly more than half of the sample has zero expenditure on international leisure travel in the year of the sampling. This has implications for the econometric method used to estimate the income elasticities of interest, which is discussed in the next section.

Econometric strategy

To estimate the elasticities of interest, the following model is used

$$\ln(T_i + 1) = \alpha + \beta(\tau)\ln I_i + \gamma(\tau)\mathbf{X}_i + \epsilon_i \quad (1)$$

where T_i = household i's expenditure on international leisure travel, I_i = household i's total expenditure, the chosen income variable, and $\mathbf{X}_i$ is a vector of control variables such as location dummies, household size, employment dummies, and yearly fixed effects, as described in more detail in the previous section. Worth noting is that control variables that concern personal, rather than household, attributes are only included for the reference person in the household as the inclusion of the same variables for other household members has little to no effect on the main coefficients of interest. The coefficients of interest are $\beta(\tau)$, which can be interpreted as the income

Table 1. Descriptive statistics.

Variable	Mean	Std. dev.	Min.	Max.	p.25	p.50	p.75	N
Travel exp. total	13,783	24,029	0	561,477	0	0	20,766	17,924
Travel exp. Swe.	7759	14,648	0	281,810	0	0	10,760	17,924
Travel exp. abroad	6021	12,799	0	334,570	0	0	7524	17,924
Total exp.	355,083	204,306	7731	3,168,246	215,239	317,573	449,182	17,911
Disp. income	427,251	293,881	−455,596	1.15×10^7	261,501	398,706	528,858	17,924
Age 1st person	39.95	21.78	0	79	21	41	59	17,924
Age 2nd person	45.69	16.19	0	93	36	45	57	14,609
Age 3rd person	23.56	16.14	0	93	10	18	38	8804
Age 4th person	12.91	11.75	0	90	5	11	16	5941
Household size	2.79	1.37	1	11	2	2	4	17,924

elasticity of the τth conditional quantile of the distribution of international leisure travel expenditure. The income elasticity will therefore be allowed to be different for different conditional quantiles of the expenditure on leisure air travel. Different income elasticities are in other words estimated for those households who, given their household characteristics, are, for example, low or high spenders of international leisure travel.

Since more than half of the sample has zero expenditures on international leisure travel, and since the log of zero is undefined, the dependent variable is transformed by adding a one to all observations. This is a common way to address the issue, but it also introduces the risk of bias, as shown by, for example, Bellemare and Wichman (2020). To avoid this risk, the inverse hyperbolic sine (IHS) transformation can be used instead. This transformation is also considered in this article, but as these estimates are very similar to the estimates when the $\ln(T_i + 1)$ stransformation is used (see the sensitivity analysis in the Robustness checks section), the $\ln(T_i + 1)$ transformation is kept for the main analysis. The fact that less than half of the sample has a positive expenditure on leisure travel, while the rest of the sample has zero expenditure during the year of the sampling also means that the dependent variable is censored at zero. This introduces attenuation bias by construction if standard, ordinary least squared (OLS) based-based methods are used to estimate the elasticities of interest. Traditionally, different types of Tobit-based estimators have been used to address the issue of censoring. This includes the original Tobit estimator introduced by Tobin (1958) as well as different types of hurdle estimators (see, for example, Amemiya, 1984, for an overview). However, these estimators only produce consistent estimates if two rather strong parametric assumptions hold, namely, that the error terms are both homoscedastic and normally distributed, something that often is not the case. Two alternatives that can be estimated without these parametric assumptions are a basic two-part model, where probit or logit estimation is used for the participation decision and OLS regression for the quantity decision, and the sample selection model suggested by Heckman (1979), often denoted the Heckit model. However, both of these rely instead on assumptions of how the zeroes are generated, specifically if the zeroes are zeroes by choice (the two-part model) or due to some unobservable sample selection (the Heckit model). In addition to this, neither Tobit-based estimators nor the two-part or Heckit models allow for heterogeneous estimates of the coefficient of interest, which is needed to estimate the income elasticities of interest in equation (1). In part due to these limitations, censored quantile regression (CQR) is instead used as the main method of estimation in this article. Censored quantile regression is a semi-parametric method developed by Powell (1984, 1986) as an extension of the quantile regression framework introduced by Koenker and Basset (1978). Contrary to Tobit estimators, CQR is invariant to both the distribution of the error terms and to potential heteroscedasticity. The method also produces consistent estimates regardless of the reason for the zeroes to exist in the sample as no assumptions regarding the data generating process is needed. Hence, the exact reason for some of the households to choose a zero expenditure on international leisure travel does not need to be known in order to estimate the income elasticities for the different conditional quantiles for those households who have a positive expenditure on this good. In addition to this, censored quantile regression gives insight into how the whole conditional distribution of the dependent variable is affected by changes in the variables of interest as estimates at different conditional quantiles of the dependent variable can be estimated. CQR thus enables the estimation of the type of heterogeneous income elasticities that is of interest in this article. While CQR is the main method of estimation in this article, standard Tobit and two-part estimates are also included for comparison. Even though Tobit estimates are likely biased, as discussed above, it is still interesting to include this estimate since Tobit is still a popular method that many can relate to. In addition, two-part estimates are included to provide an estimate of the average income elasticity. The two-part model is chosen instead of the Heckit model since it is better suited when the zeroes in the dependent variable are “true” zeroes, that is, when the zeroes are a result of the household decision and not due to sampling selection, which is likely the case for the consumption of international leisure travel. The two-part model is estimated using the “twopm” package, written by Belotti et al. (2015) and average marginal effects, the elasticity in the case of income, are calculated using the built in Stata package “margins.” In the following subsections, the CQR model, how it is estimated, how the estimated coefficients are to be interpreted and possible endogeneity issues are described and discussed in more detail.

Censored quantile regression

For a model linear in the coefficients, such as the general linear model

$$y_i = x_i'\beta_\tau + u_\tau \tag{2}$$

the conditional regression quantile $Q_{y_i|x_i}(\tau)$ is given by

$$Q_{y_i|x_i}(\tau) = x_i'\beta(\tau) \tag{3}$$

where the coefficients $\beta(\tau)$ are (or at least are allowed to be) different for each quantile. The τth sample quantile is found by solving the minimization problem

$$\min_\beta \sum_{i=1}^{n} \rho_\tau(y_i - x_i\beta) \tag{4}$$

where $\rho_\tau(\cdot)$ is a check-function such that $\rho_\tau(\lambda) = (\tau - 1(\lambda < 0))\lambda$. Hence

$$\rho_\tau(y_i - x_i\beta) = \begin{cases} y_i - x_i'(\beta) & \text{if} \quad y > x_i'\beta \\ (\tau - 1)\left(y_i - x_i'\beta\right) & \text{if} \quad y \le x_i'\beta \end{cases} \tag{5}$$

The estimation of the coefficients $\beta(\tau)$ is thus a minimization of asymmetrically weighted absolute residuals, which can be compared with classical regression methods that instead are based on a minimization of squared residuals.

In the case of left-censoring at C, y is only observed if $y^* > C$ and C is observed if $y^* \le C$, and the conditional regression quantile is now instead given by

$$Q_{y_i|x_i}(\tau) = \max\left[C, x_i'\beta(\tau)\right] \tag{6}$$

The standard estimator for this censored quantile regression model is the Powell (1986) estimator

$$\min_\beta \sum_{i=1}^{n} \rho_\tau(y_i - \max[C, x_i\beta]) \tag{7}$$

where $\rho_\tau(\cdot)$ is the same check-function as before. Given that the estimation of this estimator is successful, it provides consistent $\beta(\tau)$ estimates, as shown by Powell (1986). In practice however, estimation of this partially linear minimization problem, which needs to be estimated using numerical methods, often has issues with convergence. Several attempts to facilitate the estimation have been made, see, for example, Buchinsky (1994), Buchinsky and Hahn (1998) and Khan and Powell (2001), and the method that will be used in this article is the three-step procedure developed by Chernozhukov and Hong (2002), described below.

The three-step censored quantile regression estimator

The first step in this method is to estimate a probability model where the probability of a non-censored observation is predicted

$$\delta_i = p\left(\dot{X}_i'\gamma\right) + \epsilon_i \tag{8}$$

where δ_i takes the value 1 if the observation i is not censored and 0 otherwise, $p(\cdot)$ is a probability function modeled by probit in this article, and $\dot{X}'$ indicates the desired transforms of (X_i, C_i). Using this estimation, the sub-sample $J_0 = \{i : p(\dot{X}_i'\widehat{\gamma}) > 1 - \tau + c\}$ is constructed, where c is a trimming constant strictly between 0 and τ used to reduce the risk of projecting observations that are not truly non-censored due to a misspecified probability model. The second step is to run a standard quantile regression estimation on the projected sub-set J_0 from the previous step. Hence, $\beta_0(\tau)$ is estimated through the minimization problem given in equation (4) using the sub-set J_0. This initial estimator is consistent but inefficient. To increase the efficiency, a new sub-set J_1 is constructed using the estimated $\beta_0(\tau)$ coefficients such that $J_1 = \{i : X_i'\widehat{\beta}_0(\tau) > C_i + \upsilon_n\}$ where υ_n is a small positive number such that $\sqrt{n} \times \upsilon_n \rightarrow \infty$ and $\upsilon_n \rightarrow 0$. The third step is to once again run a standard quantile regression estimation but using the new sub-set J_1, resulting in an estimator that is both consistent and efficient. To estimate this, the CQIV Stata module written by Chernozhukov et al. (2012) is used with the exogenous option that allows for estimation of the three-step CQR estimator. The trimming constant c in the first step described above is allowed to be the default, which is 0.03. Hence three percent of the sample is trimmed to reduce the risk of a misspecified probability model. Standard errors for the estimated coefficients are obtained through a non-parametric bootstrap procedure where the number of repetitions is also the default in the CQIV module, which is one hundred, and the used seed number is 1477. A higher repetition has also been considered, which only results marginally smaller standard errors but do not affect the results.

Interpretation of estimated coefficients

The interpretation of the estimated coefficients is the same as for standard quantile regression estimates. The estimated coefficients are the partial derivatives of the conditional quantile of y with respect to the regressor of interest. For regressor j, this is given by $\partial Q_{y_i|x_i}(\tau)/\partial x_{ij} = \beta_j(\tau)$. As described by, for example, Buchinsky (1998), this derivative is to be interpreted as the marginal change in the τth conditional quantile due to the marginal change in the jth regressor. As both the expenditure on international leisure travel and total expenditure are log-transformed, $\beta(\tau)$ in equation (1) can be interpreted as the income elasticity for the τth conditional quantile of the expenditure on international leisure travel directly. That is, how much (in percent) the expenditure of international leisure travel increases when total expenditure increases by one percent, for the conditional quantile of interest. As the CQR estimator is a conditional estimator, it is important to keep in mind that the estimated coefficients should be interpreted with respect to the covariates that are included in the model. Hence, the interpretation is slightly different from OLS-based methods where the law of iterated expectations allows estimates for the conditional expected value to also be interpreted for the unconditional expected value. The income elasticity for a high conditional quantile should therefore be interpreted as the income elasticity for those households who have a high expenditure on international leisure travel given their observable household characteristics that have been controlled for. Another, perhaps more intuitive, way to interpret the estimates is provided by Kowalski (2016) who explains the conditional quantile treatment effect by comparing two groups of people with the same observable characteristics but who differ in the main variable of interest, income in our case. The estimated income elasticity in this article is then the percentage difference in expenditure on international leisure travel between two groups that have the same covariates but where one of the groups has one percent higher total expenditure than the other group.

Possible endogeneity issues

While the censored quantile regression framework successfully deals with the bias that comes from the censoring mechanism, potential issues with endogeneity still remain. One such concern is the possible issue of self-selection, especially that those who wish to travel internationally self-select into higher total expenditure brackets because of this wish. For this to be an issue however, increased expenditure on international leisure travel must be specifically targeted by the households. If the households self-select into higher income brackets just to consume more in general, no such issue exists. While there might be a few occurrences of these travel fanatics, we argue that most households strive for higher income brackets to increase their overall consumption and that if this bias is present, it is limited. Another concern is that there might be omitted variables that affect both total expenditure and the expenditure on leisure travel. Apart from the variables that are already controlled for, it is however not clear what omitted variables could be an issue. While it is important to show some caution when interpreting the estimated income elasticities, we argue that issues with endogeneity, if present, should be small as there are no obvious issues that are not addressed.

Main results

The main estimates of interest are the estimated income elasticities, the coefficients before $\ln I$ in equation (1), for different conditional quantiles. For the main analysis, this is estimated for all the years included in the data set (i.e., 2003–2009 and 2012). For the analysis of the distributional effect of the financial crisis in 2008, two separate estimations are made: one for the year 2007 and another for the year 2009. The estimated quantile effects are then compared.

In Table 2, the estimates for the main analysis are presented for every 10th quantile between 55 and 95 when the three-step CQR estimation method is used (due to the censoring, the first quantile with positive expenditure is the 51st quantile). Tobit and two-part model estimates are also included for comparison. For brevity, only the income elasticity coefficient estimates are included in Table 2, but in all estimations, the full set of covariates has been included. Full estimation tables where all the covariates are included are provided in the Online Appendix A1. The income elasticity estimates are also plotted in Figure 3, for quantiles larger than 50, where the two-part estimate is included as a straight line for comparison.

As can be seen in both Table 2 and Figure 3, the CQR estimations show overall high income elasticities that start very high for the lower conditional quantiles, those households who spend the least on international leisure travel compared to their compeers, and decrease steadily as spending on international leisure travel increases. As the estimates can be interpreted as income elasticities directly, it can be seen that for the 55th conditional quantile the estimated income elasticity is about 5. This means that when income increases by 1%, expenditure on leisure travel increases by approximately 5% for households that spend relatively little on international leisure travel. For those households who spend the most on international leisure travel compared to households with similar background characteristics, the income elasticity estimates are around 1. For those households who spend the least on international leisure travel compared to their compeers therefore, international leisure travel is a strong luxury good. As households spend more money on international leisure travel, the income elasticity steadily reduces until it reaches levels that are close to unit elasticity for

Table 2. Income elasticity estimates from CQR, Tobit, and two-part estimations.

Variables	Quantile 55	Quantile 65	Quantile 75	Quantile 85	Quantile 95
ln *I*, CQR	5.331***	2.170***	1.466***	1.124***	0.952***
	(0.123)	(0.0488)	(0.0335)	(0.0260)	(0.0257)
ln *I*, Tobit			5.710***		
			(0.147)		
ln *I*, two-part			2.974***		
			(0.0720)		

Standard errors in parentheses. Tobit and two-part estimates are average marginal effects and not estimated for each quantile.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Adjusted R^2 two-part model: 0.0914 (1st step) and 0.1646 (2nd step).
Prob > F two-part model: 0.0000 (in both 1st and 2nd steps).

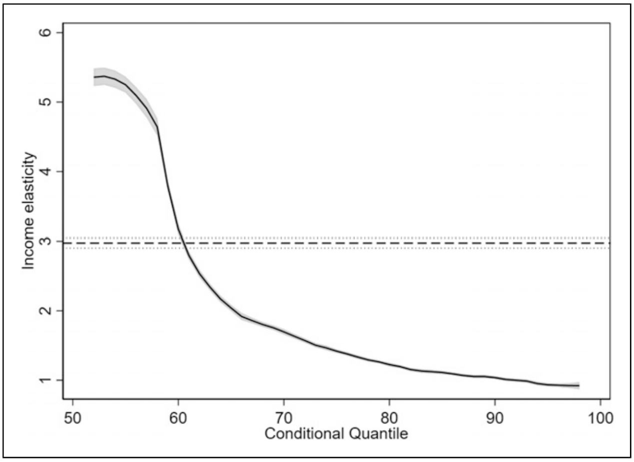


Figure 3. Estimated income elasticities with corresponding confidence intervals. CQR estimates for the quantiles 51 to 99. Two-part estimate included for comparison.

the highest spenders, conditional on the covariates. The average income elasticity, as estimated with the two-part model, is very close to 3, which is slightly higher than the average estimated in the meta-analysis made by Peng et al. (2015). Worth noting is that the elasticity estimated using Tobit is way off in relation to both the CQR and two-part estimation, indicating that caution should be shown when using this method in cases where heterogeneous effects are to be expected.

These results have several practical implications for both policy makers and managers in the tourism industry. For managers in the tourism industry, the observed heterogeneity in income elasticities can be used to improve the efficiency of marketing efforts. Since travel agencies, hotels, and airlines often have customer data on how much households spend on their tourist products (as well as other background characteristics), they can target households who consume relatively little on their product with offers that simulate increased income. One example could be extra bonuses or "miles" for the first dollars that are spent on their product. Also, they can coordinate marketing toward low-expenditure households with policy measures that boost income levels, such as stimulus checks or tax-cuts, as these households are more likely to spend more money on tourism products. From policy makers point of view, fiscal policy to boost the economy through increased disposable income will be very effective to increase the demand for tourism products, and this increased demand will mainly be driven by the households who spend the least on the product. In addition, policy that affects the price of tourism (aviation taxes, for example) is likely to affect the low spenders more than high spenders (since price effects are driven by both substitution and income effects).

The theoretical results in Matsuyama (2002) and Morley (1998) can also be used to understand the distribution of income elasticities that is estimated. The observed pattern is exactly what is expected by Matsuyama's (2002) theory for a luxury product that has reached some market maturity as international tourism is a strong luxury good for those who spend the least on it and then continuously goes toward being a necessity for households who spend the most on the good. The U-shape pattern that is hypothesized by Morley (1998) on a country level also seems to be present on a household level, when expenditure levels rather than income are considered, at least for the part of the curve that can be estimated. As the household equivalent of the relatively poor countries will not afford to travel internationally, their income elasticity cannot be estimated. The curve instead starts at the equivalent of middle income countries, those who can just afford to travel internationally so that half of Morley's U-shape pattern is visible. One theoretical implication of this result is thereby that the estimated pattern of income elasticities can be seen as a snap-shot of the market penetration of outbound international tourism in Sweden. As income levels, and thereby tourism expenditure levels, continue to increase, the market will mature further as more households start to see international tourism as a necessity rather than a luxury, and this "flattening" of the curve will have a downward pressure on the average income elasticity. This also suggests that the annual growth rate of international tourism will, at least at some point, decrease as the international tourism market matures. This does however also depend on whether the shape of the income elasticity curve along the expenditure distribution is the same in other countries. Understanding this type of household heterogeneity can therefore also be useful in forecasting models. Applying the intuition from Morley (1998) on the results also suggests that a larger share of households might participate in international tourism as income levels continue to increase. This is however not necessarily the case, as income constraints is far from the only reasons that households choose not to travel internationally.

Another theoretical prediction in Matsuyama (2002) is also that the price of the good will decrease due to economies of scale as the demand of it increases. This is applicable to some aspects of international tourism, but not as much in others. The long term trend of decreasing prices in the air travel sector could, for example, in part be explained by this type of reasoning: as demand increases, and the good is not seen as the highest of luxury any more, the airlines can use advantages of economies of scale and expand the market by introducing low price carriers. Other parts of international tourism are however more labor intensive, and this type of downward pressure due to economies of scale in the production process will not be present to the same degree. It is therefore far from given that one should expect decreasing price levels in international tourism as a whole, and as we saw in Figure 2(b) in the Literature Review and Empirical Background section the price index for international travel from Sweden has been trendless between 1980 and 2017. Matsuyama's theory together with the presented results also has implications for how the aggregate "good" of international tourism develops over time. As households get richer over time, what is part of their international travel portfolio changes and includes more of the items that previously only the richest households could afford. One clear example is in the choice of transportation. Not long ago, very few households could afford to travel by air and went abroad by train, boat (in the countries where it was possible), or by car. As households became richer, more and more turned to air travel, which in Sweden has resulted in that more than 90% of all international travel currently is made by air. Similar developments can be seen in the choice of destination, which in part is connected to the choice of transportation. Bali was once a destination of a life time for most Swedes, if even that, now it has become a common destination for middle class households. As air travel slowly is going toward becoming a necessity for most tourists, by Matsuyama's theory, it is only a matter of time until the "next" luxury good appears. One can of course only speculate what good this could be, but space tourism could, for example, be one interesting candidate, something that is suggested by, for example, Hart (2018). Regardless of what exactly the "next luxury" will be, the international tourism product is dynamic and constantly changing. Those actors in the industry who can predict what the next luxury will be, or perhaps even influence it themselves through marketing, will also likely get a competitive advantage in the industry. The predicted decrease in the income elasticity for international tourism at the aggregate level will also likely be slowed down if the level of luxury in the good is updated continuously.

Turning next to the distributional effect of the financial crisis, the estimated income elasticities for each conditional quantile in the year before and after the crisis year is presented in Figure 4.

As can be seen, there seems to be a small distributional shift outward with the post-crisis income elasticities being slightly larger than the pre-crisis elasticities, for almost all quantiles. The standard errors are however much larger for these two estimations, which of course is expected since the sample size for each estimation is considerably smaller than in the full estimation, and while the income elasticities are still significant the confidence intervals for the 2 years are overlapping for many quantiles. Hence, a null hypothesis that the income elasticities are the same before and after the crisis cannot be rejected for many quantiles. Even though a clear tendency can be seen when looking at the point estimates for the 2 years, it cannot be definitely concluded that the income elasticities are larger after the 2008 financial crisis, at least for the whole distribution. These results go in line with the results in Alegre and Pou (2016). This means that the Swedish households' sensitivity to income changes remains robust after the financial crisis of 2008, which is good news as this means that the demand for international tourism should recover fast as income levels starts to

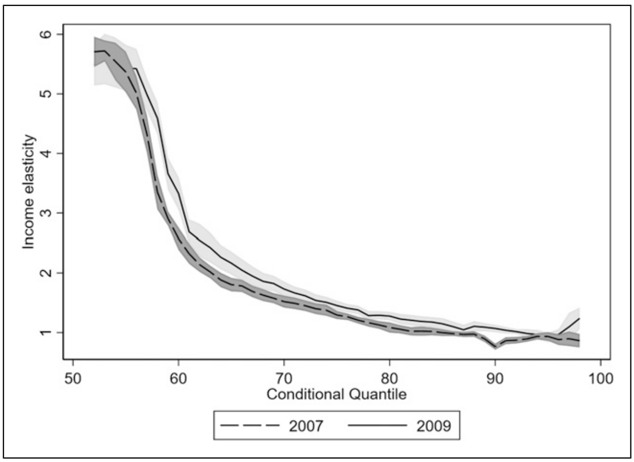


Figure 4. Estimated income elasticities with corresponding confidence intervals for the year before and after the 2008 financial crisis. CQR estimates for the quantiles 51 to 99.

increase again (which is also what happened, as can be seen in Figure 1 in the Data section). In particular, this robustness is more or less the same along the whole expenditure distribution. When applying these results on the current COVID-19 pandemic and the resulting global economic downturn two things can be said. As traveling restrictions become looser, there will still exist a downward pressure on international tourism due to decreases in income levels as a result of the economic downturn around the world. However, when income levels start to increase again the demand is likely to increase fast due to the high income elasticities. Of course, this does not take into account any behavioral effects that the COVID-19 crisis has had on international travelers, which may very well be present in both directions (that people travel internationally more than before to "catch up" missed travel opportunities or that they travel less as the concern for contamination is still present).

Robustness checks

We now turn to robustness checks. First, the covariates that are used are introduced in a step-wise fashion to examine how sensitive the estimates are to new control variables. As can be seen in Table 3, which presents the results for the 55th conditional quantile estimated with CQR, the estimated coefficient for $\ln I$ is stable during this procedure. This gives an implicit indication that omitted variable bias might not be a big issue in the estimation. The estimation for the 55th conditional quantile is also the estimation that is the least stable to the step-wise inclusion of the covariates of all the estimated quantiles. Similar step-wise inclusions for estimations at the other estimated quantiles are even more stable to this procedure.

Second, it could be that the estimates are sensitive to the precise definition of the dependent or main explanatory variable. In the case of the dependent variable, the one that is used in the main specification is the total expenditure on international leisure travel that the household has in a year. Since data on expenditures made in Sweden only, such as expenditure on air travel and pre-paid hotels, as well as data on expenditures made on location are available separately, it is possible to examine how sensitive the estimates are to alternative definitions of the main dependent variable. The main specification is therefore here estimated using the variable that captures the expenditure on international leisure travel that is only paid in Sweden (such as expenditure on air travel and pre-paid hotels), as well as the part that is paid once on location, as the dependent variable separately. As can be seen in Table 4, the estimates when these two variables are used as the dependent variable are however very similar to the corresponding estimations in Table 2. The estimates do therefore not seem to be sensitive to the exact definition of the dependent variable. Similarly, in the case of the main explanatory variable, one could argue that using total expenditure as the income variable instead of disposable income might yield biased estimates. As can be seen in Table 4 however, this is likely not the case as the estimates when the log of disposable income is used as the main explanatory variable instead of the log of total expenditure (keeping the dependent variable the same as in the main specification) are also similar to the estimates when total expenditure is used. The only difference is that the estimates are slightly lower, which is to be expected since consumption of leisure travel most likely is smoothed through savings or credit, something that is not accounted for when disposable income is used as the income variable.

As there could be a potential bias from the fact that a 1 is added to the dependent variable before it is logged, the inverse hyperbolic sine transformation is also considered. According to Bellemare and Wichman (2020), this transformation takes care of the potential source of bias at the same time as the resulting estimates can be interpreted in the same way as when the log-transformation is used, as long as the mean of the variable is large enough (larger than 10 is a suggested limit, which is the case

Table 3. Step-wise inclusion of covariates for the 55th quantile using CQR estimation.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
ln *I*	5.760***	6.728***	5.913***	5.393***	5.319***	5.331***
	(0.141)	(0.169)	(0.131)	(0.138)	(0.129)	(0.123)
Family size		−1.002***	−0.918***	−0.882***	−0.820***	−0.808***
		(0.0650)	(0.0504)	(0.0545)	(0.0556)	(0.0535)
Big city			3.280***	2.556***	2.559***	2.607***
			(0.145)	(0.150)	(0.140)	(0.136)
Medium city			1.927***	1.444***	1.430***	1.429***
			(0.145)	(0.150)	(0.140)	(0.138)
Entrepreneur, 1st member				0.211	0.0838	0.0881
				(0.296)	(0.282)	(0.269)
Student, 1st member				1.166***	1.310***	1.406***
				(0.220)	(0.210)	(0.201)
Unemployed, 1st member				−2.303***	−2.545***	−2.303***
				(0.432)	(0.388)	(0.372)
Retired/stay-at-home, 1st member				−1.469***	−1.779***	−1.636***
				(0.180)	(0.201)	(0.192)
Other employment, 1st member				−1.804***	−1.698***	−1.844***
				(0.561)	(0.529)	(0.523)
Educated, 1st member				1.483***	1.381***	1.369***
				(0.150)	(0.143)	(0.137)
Age first person					0.0115***	0.0123***
					(0.00390)	(0.00373)
Year 2004						0.528**
						(0.225)
Year 2005						0.623***
						(0.231)
Year 2006						0.489**
						(0.237)
Year 2007						0.868***
						(0.224)
Year 2008						0.768***
						(0.228)
Year 2009						0.616***
						(0.230)
Year 2012						0.942***
						(0.215)
Constant	−66.82***	−76.43***	−68.19***	−61.41***	−61.04***	−61.93***
	(1.789)	(2.067)	(1.595)	(1.690)	(1.584)	(1.514)
Observations	17,379	17,377	17,378	17,380	17,378	17,379

in this paper). As can be seen in Table 5, the estimates of the income elasticity for most estimations are very similar to the estimates when the log-transformation is used.

In addition to the ones that have been examined here, a sensitivity analysis has also been done with regard to different censoring points, where slightly higher censoring points are used instead of 0.

Table 4. Income elasticity estimates for alternative travel expenditure and income variables.

Dependent variable	Quantile 55	Quantile 65	Quantile 75	Quantile 85	Quantile 95
ln (T_{abroad} + 1), CQR	4.861***	2.857***	1.615***	1.261***	0.993***
	(0.100)	(0.0665)	(0.0325)	(0.0339)	(0.0320)
ln (T_{Sweden} + 1), CQR	5.044***	2.961***	1.681***	1.193***	0.999***
	(0.133)	(0.0797)	(0.0369)	(0.0272)	(0.0263)
Income variable	**Quantile 55**	**Quantile 65**	**Quantile 75**	**Quantile 85**	**Quantile 95**
ln (I_{disp}), CQR	4.668***	1.878***	1.229***	0.798***	0.674***
	(0.121)	(0.0482)	(0.0357)	(0.0252)	(0.0287)

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

Table 5. Income elasticity estimates when the IHS transformation is used.

Variables	Quantile 55	Quantile 65	Quantile 75	Quantile 85	Quantile 95
IHS (I), CQR	5.682***	2.170***	1.467***	1.124***	0.952***
	(0.130)	(0.0489)	(0.0341)	(0.0260)	(0.0257)
IHS (*I*), Tobit			6.083***		
			(0.157)		
IHS (*I*), two-part			3.160***		
			(0.0771)		

Standard errors in parentheses. IHS: inverse hyperbolic sine. Tobit and two-part estimates are average marginal effects and not estimated for each quantile.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$ adjusted R^2 two-part model: 0.0914 (1st step) and 0.1645 (2nd step).
Prob > F two-part model: 0.0000 (in both 1st and 2nd steps).

The results from this sensitivity check are included in Online Appendix A2, where the estimation is done for the 55th quantile, and show little to no effect on the estimated income elasticities. Overall the estimated income elasticities are therefore robust to the possible sources of bias that can be checked for.

Conclusion

In this paper, we estimate heterogeneous income elasticities of international leisure travel demand for Swedish households based on their relative consumption levels. This is done using the Swedish Household Budget survey for the years 2003–2009 and 2012 where estimation is made with censored quantile regression. The results show that a great heterogeneity in the income elasticities exists, being the highest for the households who consume the least of international tourism relative their peers, with an estimated income elasticity of 5.3, and then steadily decreasing as the relative expenditure on the good increases until it reaches an income elasticity of less than 1 for the relative top spenders of the good. The results further show that the effect of the financial crisis on the distribution of income elasticities is minimal, although a small tendency for an outward shift in the distribution is present, with overall larger income elasticity estimates the year after the crisis than the year before.

The results can be used by managers in the tourism industry and governmental policy makers alike. For the tourism industry, the largest effect on sales can be achieved if households with relatively low travel consumption are targeted in marketing efforts. Marketing that simulates income increases, such as end of year bonuses, will likely be very effective when addressed specifically to these households. Marketing can also be coordinated with stimulus checks or other governmental policy measures that increases households' income. From a governmental policy point of view, it is clear that policy that affects income will also have a large effect on the demand for international tourism, and that this is especially driven by the low spenders. As the distribution of income elasticities remained stable when the 2008 financial crisis hit, it is likely that the economic parts of the decreased tourism demand will recover as the world starts to open up after the COVID-19 pandemic, at least in Sweden. Of course, there are also a lot of other behavioral aspects that can affect the recovery of international tourism that have not been addressed in this paper.

The results together with the theoretical predictions of Matsuyama (2002) and Morley (1998) also increase the understanding of structural change in demand for international tourism, and why global income elasticities seem to decrease over time (as found by, for example, Gunter and Smeral, 2016). The estimated pattern of elasticities becomes a snap-shot of this process, and as more and more households start to view the good as a necessity the average income elasticity decreases, as well as the growth rate of international tourism demand. In addition, the results also provide some theoretical implications for price changes in the tourism industry as well as how the international tourism "good" develops in terms of luxury, specifically when it comes to the mode of transportation and type of destination.

Further research is however needed. Even though this paper is an important contribution, the literature on this type of heterogeneity is still very sparse. Similar analyses should be done for other countries as different countries likely are in different stages of the market maturity. One limitation with this article is also that the data are 10 years old, and research with newer data would therefore be very helpful. Further analysis with regard to the COVID-19 pandemic is also warranted as the current crisis at its heart is not an economic crisis. It is also possible that accounting for this type of heterogeneity can help improve forecasting accuracy, much like Smeral (2017) showed at an aggregate level, which also is an interesting area of future research.

Acknowledgements

Thanks to the Swedish EPA (project Economic instruments and consumption) for financial support. Thanks also to Rob Hart, Corrado Di Maria, Yves Surry, Claes Ek and Daniel Wikström for valuable discussions and comments. Thanks also to the two anonymous referees who contributed with valuable comments that improved the paper.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by Naturvårdsverket (grant no. 37758-1).

ORCID iD

Jonathan Strale https://orcid.org/0000-0002-4591-2164

Supplemental material

Supplemental material for this article is available online.

References

Alegre J, Mateo S and Pou L (2013) Tourism participation and expenditure by Spanish households: the effects of the economic crisis and unemployment. *Tourism Management* 39: 37–49.

Alegre J and Pou L (2004) Micro-economic determinants of the probability of tourism consumption. *Tourism Economics* 10(2): 125–144.

Alegre J and Pou L (2016) US household tourism expenditure and the great recession. *Tourism Economics* 22(3): 608–620.

Amemiya T (1984) Tobit models: a survey. *Journal of Econometrics* 24(1–2): 3–61.

Bellemare MF and Wichman CJ (2020) Elasticities and the inverse hyperbolic sine transformation. *Oxford Bulletin of Economics and Statistics* 82(1): 50–61.

Belotti F, Deb P, Manning WG, et al. (2015) Twopm: Two-part models. *The Stata Journal: Promoting Communications on Statistics and Stata* 15(1): 3–20.

Brida JG and Scuderi R (2013) Determinants of tourist expenditure: a review of microeconometric models. *Tourism Management Perspectives* 6: 28–40.

Buchinsky M (1994) Changes in the U.S. Wage Structure 1963-1987: application of quantile regression. *Econometrica* 62(2): 405–458.

Buchinsky M (1998) Recent advances in quantile regression models: a practical guideline for empirical research. *The Journal of Human Resources* 33(1): 88–126.

Buchinsky M and Hahn J (1998) An alternative estimator for the censored quantile regression model. *Econometrica* 66(3): 653–671.

Chen C-M and Chang K-L (2012) The influence of travel agents on travel expenditures. *Annals of Tourism Research* 39(2): 1258–1263.

Chernozhukov V, Fernandez-Val I, Han S, et al. (2012) CQIV: stata module to perform censored quantile instrumental variables regression. *Statistical Software Components* S457478.

Chernozhukov V and Hong H (2002) Three-step censored quantile regression and extramarital affairs. *Journal of the American Statistical Association* 97(459): 872–882.

Crouch GI (1996) Demand elasticities in international marketing. *Journal of Business Research* 36(2): 117–136.

Engel E (1857) Die produktions-und konsumptionsverhhältnisse des königreichs sachsen. *Zeitschrift des Statistischen Bureaus des Königlich Sächsischen Ministeriums des Innern* 8: 1–54.

Eugenio-Martin JL and Campos-Soria JA (2011) Income and the substitution pattern between domestic and international tourism demand. *Applied Economics* 43(20): 2519–2531.

Graham A (2000) Demand for leisure air travel and limits to growth. *Journal of Air Transport Management* 6(2): 109–118.

Gunter U and Smeral E (2016) The decline of tourism income elasticities in a global context. *Tourism Economics* 22(3): 466–483.

Gunter U and Smeral E (2017) European outbound tourism in times of economic stagnation. *International Journal of Tourism Research* 19(3): 269–277.

Hart R (2018) Rebound, directed technological change, and aggregate demand for energy. *Journal of Environmental Economics and Management* 89: 218–234.

Heckman JJ (1979) Sample selection bias as a specification error. *Econometrica* 47(1): 153–161.

Hung W-T, Shang J-K and Wang F-C (2012) Another look at the determinants of tourism expenditure. *Annals of Tourism Research* 39(1): 495–498.

Kamb A and Larsson J (2018) *Klimatpåverkan Från Svenska Befolkningens Flygresor 1990-2017*. Technical report. Göteborg: Chalmers.

Khan S and Powell JL (2001) Two-step estimation of semiparametric censored regression models. *Journal of Econometrics* 103(1–2): 73–110.

Koenker R and Bassett G Jr (1978) Regression quantiles. *Econometrica* 46(1): 33–50.

Kowalski A (2016) Censored quantile instrumental variable estimates of the price elasticity of expenditure on medical care. *Journal of Business & Economic Statistics* 34(1): 107–117.

Marrocu E, Paci R and Zara A (2015) Micro-economic determinants of tourist expenditure: a quantile regression approach. *Tourism Management* 50: 13–30.

Matsuyama K (2002) The rise of mass consumption societies. *Journal of Political Economy* 110(5): 1035–1070.

Morley CL (1998) A dynamic international demand model. *Annals of Tourism Research* 25(1): 70–84.

Peng B, Song H and Crouch GI (2015) A meta-analysis of international tourism demand elasticities. *Journal of Travel Research* 54(5): 611–633.

Pérez-Rodríguez JV and Ledesma-Rodríguez F (2019) Unconditional quantile regression and tourism expenditure: the case of the Canary islands. *Tourism Economics* 27: 626–648. DOI: 10.1177/1354816619891552

Powell JL (1984) Least absolute deviations estimation for the censored regression model. *Journal of Econometrics* 25(3): 303–325.

Powell JL (1986) Censored regression quantiles. *Journal of Econometrics* 32(1): 143–155.

Smeral E (2014) Forecasting international tourism with due regard to asymmetric income effects. *Tourism Economics* 20(1): 61–72.

Smeral E (2017) Tourism forecasting performance considering the instability of demand elasticities. *Journal of Travel Research* 56(7): 913–926.

Tobin J (1958) Estimation of relationships for limited dependent variables. *Econometrica* 26(1): 24–36.

Wang Y and Davidson MC (2010) A review of micro-analyses of tourist expenditure. *Current issues in Tourism* 13(6): 507–524.

Waqas-Awan A, Rosselló-Nadal J and Santana-Gallego M (2020) New insights into the role of personal income on international tourism. *Journal of Travel Research* 60: 799–809. DOI: 10.1177/0047287520907702

Author Biography

Jonathan Stråle is a PhD candidate in Economics at the Swedish University of Agricultural Sciences, Uppsala. His research primarily concerns demand and policy analysis of international leisure travel, with specific focus on air travel, using modern econometric methods.

Appendix

Appendix A.1. Full estimation results tables

Below are the full estimation table for the CQR estimation where the coefficients for the used covariates and their standard errors are included in addition to the estimated income elasticities. Full estimation results for the Tobit and two-part estimations are also provided.

Table A1: Full table for Tobit, two-part and CQR estimates of the income elasticity of international leisure travel

VARIABLES	Tobit	Two-part (marg. effects)	Quantile 55	Quantile 65	Quantile 75	Quantile 85	Quantile 95
ln(I)	5.710***	2.974***	5.331***	2.170***	1.466***	1.124***	0.952***
	(0.147)	(0.0720)	(0.123)	(0.0488)	(0.0335)	(0.0260)	(0.0257)
Family Size	-0.942***	-0.464***	-0.808***	-0.260***	-0.126***	-0.0535***	-0.0128
	(0.0677)	(0.0334)	(0.0535)	(0.0216)	(0.0149)	(0.0118)	(0.0118)
Big city	2.708***	1.377***	2.607***	0.818***	0.473***	0.327***	0.241***
	(0.169)	(0.0830)	(0.136)	(0.0553)	(0.0388)	(0.0303)	(0.0293)
Medium city	1.140***	0.526***	1.429***	0.438***	0.206***	0.114***	0.0957***
	(0.178)	(0.0854)	(0.138)	(0.0563)	(0.0395)	(0.0308)	(0.0296)
Entrepreneur, 1st member	0.222	0.178	0.0881	0.126	0.135*	0.0951	0.144**
	(0.320)	(0.169)	(0.269)	(0.110)	(0.0770)	(0.0606)	(0.0591)
Student, 1st member	1.391***	0.688***	1.406***	0.365***	0.189***	0.109**	0.161***
	(0.246)	(0.127)	(0.201)	(0.0819)	(0.0575)	(0.0454)	(0.0437)
Unemployed, 1st member	-2.372***	-1.048***	-2.303***	-6.659***	-0.648***	-0.306***	-0.0704
	(0.520)	(0.230)	(0.372)	(0.148)	(0.106)	(0.0828)	(0.0764)
Retired/stay-at-home, 1st member	-1.663***	-0.780***	-1.636***	-0.601***	-0.215***	-0.0847**	-0.0162
	(0.245)	(0.118)	(0.192)	(0.0783)	(0.0547)	(0.0428)	(0.0416)
Other employment, 1st member	-1.762***	-0.815***	-1.844***	-0.957***	-0.465***	-0.269**	0.00545
	(0.680)	(0.309)	(0.523)	(0.208)	(0.152)	(0.118)	(0.113)
Educated, 1st member	1.776***	0.957***	1.369***	0.413***	0.253***	0.174***	0.148***
	(0.159)	(0.0854)	(0.137)	(0.0560)	(0.0393)	(0.0306)	(0.0294)
Age first person	0.0113**	0.00636***	0.0123***	0.00399***	0.00255**	0.00245***	0.00320***
	(0.00468)	(0.00231)	(0.00373)	(0.00152)	(0.00106)	(0.000831)	(0.000821)
Year 2004	0.405	0.192	0.528**	0.222**	0.123*	0.0672	0.0612
	(0.283)	(0.138)	(0.225)	(0.0915)	(0.0643)	(0.0505)	(0.0483)
Year 2005	0.667**	0.320**	0.623***	0.352***	0.196***	0.137***	0.147***
	(0.288)	(0.143)	(0.231)	(0.0939)	(0.0660)	(0.0520)	(0.0501)
Year 2006	0.238	0.128	0.489**	0.258***	0.172**	0.163***	0.104**
	(0.294)	(0.144)	(0.237)	(0.0964)	(0.0677)	(0.0530)	(0.0507)
Year 2007	0.892***	0.456***	0.868***	0.412***	0.274***	0.230***	0.249***
	(0.283)	(0.140)	(0.224)	(0.0916)	(0.0643)	(0.0507)	(0.0487)
Year 2008	0.427	0.224	0.768***	0.338***	0.279***	0.256***	0.248***
	(0.289)	(0.143)	(0.228)	(0.0923)	(0.0647)	(0.0509)	(0.0490)
Year 2009	0.524*	0.287**	0.616***	0.384***	0.268***	0.261***	0.200***
	(0.289)	(0.143)	(0.230)	(0.0933)	(0.0656)	(0.0515)	(0.0498)
Year 2012	0.688**	0.390***	0.942***	0.506***	0.346***	0.309***	0.219***
	(0.269)	(0.133)	(0.215)	(0.0873)	(0.0613)	(0.0482)	(0.0462)
Constant	-70.31***		-61.93***	-18.76***	-9.113***	-4.358***	-1.741***
	(1.806)		(1.514)	(0.600)	(0.411)	(0.320)	(0.318)
Observations	17,911	17,911	17379	17377	17380	17378	17378

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix A.2. Additional sensitivity checks

Below are the estimated income elasticities when different censoring points are used. Censoring points between ln 100 and ln 500 are used and censoring at zero, which is used in the main analysis, is also included for comparison.

Table A2: Alternative censoring points for a CQR estimation at the 55th conditional quantile

VARIABLES	C = 0	C = ln100	C = ln200	C = ln300	C = ln400	C = ln500
ln(I)	5.331***	5.195***	5.205***	5.221***	5.229***	5.240***
	(0.123)	(0.127)	(0.124)	(0.121)	(0.120)	(0.117)
Family Size	-0.808***	-0.800***	-0.798***	-0.806***	-0.802***	-0.800***
	(0.0535)	(0.0543)	(0.0531)	(0.0516)	(0.0514)	(0.0502)
Big city	2.607***	2.859***	2.856***	2.849***	2.829***	2.824***
	(0.136)	(0.138)	(0.135)	(0.131)	(0.130)	(0.127)
Medium city	1.429***	1.234***	1.228***	1.212***	1.193***	1.171***
	(0.138)	(0.141)	(0.138)	(0.134)	(0.133)	(0.130)
Entreprenur, 1st member	0.0881	0.0269	0.0358	0.0404	0.0437	0.0424
	(0.269)	(0.273)	(0.267)	(0.260)	(0.258)	(0.253)
Student, 1st member	1.406***	1.490***	1.480***	1.461***	1.446***	1.479***
	(0.201)	(0.205)	(0.201)	(0.195)	(0.194)	(0.190)
Unemployed, 1st member	-2.303***	-1.411***	-1.410***	-1.355***	-1.367***	-1.472***
	(0.372)	(0.369)	(0.361)	(0.351)	(0.350)	(0.342)
Retired/stay-at-home, 1st member	-1.636***	-1.346***	-1.334***	-1.350***	-1.332***	-1.347***
	(0.192)	(0.195)	(0.191)	(0.186)	(0.185)	(0.181)
Other employment, 1st member	-1.844***	-1.283**	-1.324***	-1.342***	-1.333***	-1.328***
	(0.523)	(0.516)	(0.506)	(0.490)	(0.488)	(0.476)
Educated, 1st member	1.369***	1.859***	1.870***	1.866***	1.878***	1.872***
	(0.137)	(0.139)	(0.136)	(0.132)	(0.131)	(0.128)
Age first person	0.0123***	0.0142***	0.0141***	0.0142***	0.0136***	0.0142***
	(0.00373)	(0.00378)	(0.00370)	(0.00360)	(0.00358)	(0.00350)
Year 2004	0.528**	0.491**	0.494**	0.520**	0.482**	0.488**
	(0.225)	(0.229)	(0.225)	(0.218)	(0.217)	(0.213)
Year 2005	0.623***	0.504**	0.518**	0.531**	0.516**	0.520**
	(0.231)	(0.236)	(0.231)	(0.224)	(0.223)	(0.219)
Year 2006	0.489**	0.285	0.293	0.295	0.273	0.293
	(0.237)	(0.242)	(0.237)	(0.230)	(0.229)	(0.224)
Year 2007	0.868***	0.773***	0.759***	0.780***	0.754***	0.767***
	(0.224)	(0.229)	(0.224)	(0.218)	(0.217)	(0.212)
Year 2008	0.768***	0.611***	0.604***	0.622***	0.554**	0.564***
	(0.228)	(0.232)	(0.227)	(0.221)	(0.220)	(0.215)
Year 2009	0.616***	0.618***	0.621***	0.621***	0.616***	0.606***
	(0.230)	(0.234)	(0.230)	(0.223)	(0.222)	(0.217)
Year 2012	0.942***	0.865***	0.872***	0.902***	0.878***	0.886***
	(0.215)	(0.219)	(0.214)	(0.208)	(0.207)	(0.203)
Constant	-61.93***	-61.34***	-61.47***	-61.66***	-61.72***	-61.90***
	(1.514)	(1.557)	(1.524)	(1.484)	(1.476)	(1.444)
Observations	17379	17377	17373	17364	17362	17345

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

II

The effects of the Swedish aviation tax on the demand and price of international air travel

Jonathan Stråle
Department of Economics,
Swedish University of Agricultural Sciences,
Box 7013, Uppsala 750 07, Sweden. e-mail: jonathan.strale@slu.se

Abstract

This paper evaluates the effects of the Swedish aviation tax, which was introduced in April 2018, on the price and demand for international air travel using the synthetic control group method. No significant effect on the price index of international air travel is found, but the effect on the number of international passengers from Sweden is large, significant and robust. The effect starts at a decrease in passengers, when compared to the synthetic control group, of almost 6 percent in the first quarter after the tax. The effect becomes stronger over time, ending at a decrease of almost 13 percent in the last quarter of 2019. Using web-scraped route level price data together with an estimated price elasticity of international air travel, it is shown that the expected passenger effects ought to be a decrease by around 1–2 percent if the demand response is only due to increases in prices from the tax. This suggests that the tax in addition to a potential price effect has a strong signal effect, likely stemming from the media attention surrounding the tax, which adds to the budding literature that shows that environmental taxes can have larger effects than what pure price effects would suggest.

1 Introduction

Emissions from air travel continue to increase globally, mainly due to rising demand. This has also been the case in Sweden, and in an attempt to brake the continued increase in air travel demand the Swedish government introduced an aviation tax in April 2018. The tax is a fixed tax per passenger and the level of the tax is distance based, starting at around 6 Euros (60 SEK) for trips within Europe and ending at 40 Euros (400 SEK) for trips that are longer than 6000 km. This paper estimates the effects of this tax, on international passenger demand as well as price, through the use of the synthetic control group method (SCM), where Sweden is used as the treatment group and other European countries are used as potential donor countries for a synthetic control group. The effects on the share of the population that travels internationally are estimated, as well as the effect the tax has on a price index of international air travel. Using web-scraped price data together with an estimated price elasticity, the expected demand response is further compared with the estimated passenger effect. This is done to evaluate how much of the passenger effect that can be explained by a price effect from the tax and how much that can be attributed to a signal effect of the tax.

While several countries have introduced different types of air travel taxes, the economic literature about their effects is relatively scarce. The estimated effects in the literature are also somewhat conflicting. A few examples include Borbely (2019) and Falk and Hagsten (2019) who analyze the German and Austrian aviation tax. Borbely (2019), who employs the synthetic control group method at an airport level, find that the tax, which is of a very similar size as the Swedish tax, reduces the total number of passengers from Germany by 2 percent, and that this effect can mostly be explained by the effect at low-cost carrier dominated airports as well as a leakage of passengers to airports close to the German border. Falk and Hagsten (2019) use a panel difference-in-difference approach to evaluate the effect of the tax in both Germany and Austria. They find larger effects than Borbely (2019), namely a reduction in international passengers by 9 percent the first year and 5 percent the second year after the introduction of the tax. They find no evidence of passengers choosing airports in neighboring countries to avoid the tax, but they also find that the main driver of the effect is found at low cost-carrier airports. Seetaram et al. (2014) use an auto-regressive distributed lag model to estimate income, price and tax elasticities of route level international travelers from the UK, and find modest tax elasticities for most destinations, indicating a low effect of the tax on the number of passengers. In addition to these ex post evaluations, there are a few papers that use assumptions on price elasticities and price pass-over from the tax to simulate the effects in a modeling environment. Mayor and Tol (2007) and Forsyth et al. (2014) are two examples, where the British air passenger duty and Australian aviation tax are evaluated respectively.

While it is tempting to use price elasticities to make a quick evaluation of how large demand effects will be from a tax that will be introduced, a growing literature does however show that effects of environmental taxes often are larger than what is expected from their price effects. Andersson (2019) shows that the tax elasticity of the Swedish CO_2-tax, implemented in 1991, is three times higher than the price elasticity. Li et al. (2014) finds that the effect of gasoline taxes in the US is larger than the expected price effects, and shows that salience through media coverage of the tax is a plausible explanation for this. Similarily, Rivers and Schaufele (2015) find that the effect of the carbon tax in British Columbia, Canada, on the demand for gasoline is 4.1 times larger than an equivalent change in a tax-exclusive price.

The main findings in this paper are that the tax has a strong negative effect on the demand for international air travel, an effect that seems to be increasing over time. The effect the first quarter after the tax is a decrease in passengers by 5.7 percent, when compared to the synthetic control group. This effect grows steadily stronger for every quarter after the tax, ending at a decrease in passengers of 12.9 percent the last quarter of 2019. These effects are strongly significant and very robust to changes in the specification. No significant effect is however found on the price index of international air travel. Given the size of the tax and the fact that we are using a price index for the estimation this is not surprising. Using the web-scraped data, and the estimated price elasticity of -0.76, it is however shown that the passenger effects are much larger than can be explained by a pure price effect of the tax, even if the tax had a full pass-over to the ticket prices (i.e. that the prices increased by the exact tax amount). Assuming a full pass-over, the expected demand effect from the price increase is a decrease in demand of between 1 and 2 percent. Since the estimated passenger effects are much higher, this suggests that the tax in addition to a (potential) price effect had a strong signal effect that affected the behavior of Swedish travelers.

The fact that the effect of the tax is increasing also suggests that there is a behavioral response in addition to a potential price effect. As air travel is closely linked to the environmental movement, a movement that got extra fuel when the Fridays-for-future movement with Greta Thunberg in the lead started to raise awareness further, it is possible that part of the estimated passenger effect comes from an increase in environmental awareness. This is especially a "risk" during the second year of the tax, as Greta Thunberg started to rise to fame during the last months of 2018. However, using Google Trends search data we show that the popularity of Greta Thunberg in terms of Google searches is very similar in Sweden as in the countries that are part of the synthetic control group. This, together with the timing of the decrease in passengers (which happens exactly when the tax is introduced), suggests that the tax indeed has a strong effect on the demand of international air travel. It can however not be ruled out that the increasing effects over time comes from a relatively higher environmental awareness with respect to air travel in Sweden than in the synthetic control group.

This paper therefore contributes to both the literature on the evaluation of aviation taxes as well as the literature on the salience of environmental taxes. Given that the evidence from the existing literature on the effects of aviation taxes show different effects, sometimes even contradicting effects, this paper makes a valuable addition to the literature on aviation taxes. This is especially the case since, to the best of our knowledge, no paper has been published where the Swedish aviation tax has been evaluated. In addition, this is the first paper that shows that the tax effects from an environmental aviation tax is higher than the expected price effects, just as the literature on salience in environmental taxes has shown can be the case for carbon and gasoline taxes. Understanding how effective aviation taxes are to hamper the demand of air travel is especially important given how emission-intensive air travel is, and as international air travel has been steadily increasing up until the Covid-19 pandemic. The results are therefore useful for policy makers that aim to reduce the emissions from the aviation sector.

The rest of the paper is organized as follows. In the next section, the aviation tax is described. Section 3 presents the econometric strategy that is employed in the paper and section 4 describes the data that is used. Section 5 presents and discusses the results of the paper, section 6 provides a robustness analysis of the results and section 7 concludes.

2 The aviation tax

The tax is a fixed tax per passenger where the level is based on the distance of the final destination from Arlanda Airport. The tax was voted through the parliament in September 2017 and is applied to all commercial flights, where the airplane is registered for carrying 10 passengers or more, taking off from a Swedish airport from April 1^{st} 2018 and onward.

All passengers on the flights are included except infants (children younger than 2 years), transfer passengers from flights from outside of Sweden that are made within 24 hours, and the cabin crew. The responsibility for paying the tax is put on the airline, but the tax is usually communicated to the customers by the airline in the price specification before the booking is made. The tax-levels are, with a few exceptions, implemented as follows.

- Countries completely within Europe: 60 SEK / passenger (tax-zone 1).
- Countries completely or partially within another continent with a distance of at most 6000 km from Arlanda airport: 250 SEK / passenger (tax-zone 2).
- Countries in a different continent than Europe with a distance of at least 6000 km: 400 SEK/passenger (tax-zone 3).

3 Econometric strategy

To estimate the effect of the tax on the number of international passengers and the price of air travel, the synthetic control group method (SCM) developed by Abadie et al. (2010) and Abadie et al. (2015) is used. The main purpose of the

SCM is to estimate a counterfactual outcome using a data driven approach that minimizes differences between the treatment group, in this case Sweden, and a control group that is constructed through a weighted average of countries that are similar to Sweden. By creating a control group that mimics the development of international air passengers, or the price index of air travel, before the tax is introduced in Sweden, counterfactual outcomes of international passengers and price index are estimated that represent the levels in Sweden if no tax had been introduced. The difference between Sweden and the synthetic control group after the tax thereby becomes the estimated effect of interest, under the assumption that the synthetic control group still successfully mimics the counterfactual development in Sweden without the tax.

Formally, following the terminology of Abadie et al. (2010) and Abadie et al. (2015), we have a sample of $J+1$ countries indexed by j, where unit $j=1$ is Sweden (the country of interest) and units $j=2$ to $j=J+1$ is the donor pool of potential control countries. There are $t=1,...,T$ time periods where time periods $t,...,T_0$ are the preintervention periods and $T_0+1,...,T$ are the postintervention periods. A synthetic control is represented by a $(J \times 1)$ vector of weights $W=(w_2+...+w_{J+1})'$, with $0 \leq w_j \leq 1$ for $j=2,...,J$ and $w_2,...,w_{J+1}=1$. The choice of a particular value of W is thereby a choice of a synthetic control and the choice is made such that the characteristics of the synthetic control, X_0, best replicates the treated unit's characteristics, X_1, where X_1 is a $(k \times 1)$ vector of preintervention characteristics for the treated unit and X_0 is a $(k \times J)$ matrix of the same variables for all the countries in the donor pool. The variables that are included in X_0 and X_1 are called predictor variables and often include preintervention values of the outcome variable in question (as is the case in this paper).

The optimal control W^* is formally selected to minimize the difference between the preintervention characteristics of the treated unit and the synthetic control, $\sum_{m=1}^{k} \nu_m (X_{1m} - X_{0m} W)^2$, where m is a certain predictor variable and ν_m is the weight that reflects the relative importance of the predictor variable m when the discrepancy between X_1 and $X_0 W$ is measured. The variables that have the largest predictive power on the outcome variable should be assigned large ν_m weights. To assign the ν_m weights, and thereafter select the optimal control W^*, a cross-validation technique is used. The preintervention sample is first divided into a training and validation period, where the training period is the first half of the preintervention sample. Using the values of the predictor variables in the training period, the weights ν_m are chosen to minimize the root mean square prediction error (RMSPE) over the validation period. Using these weights, the optimal control W^* is then chosen by solving the minimization problem described above, using the values of the predictor variables for the validation period. Once the optimal control is selected, the treatment effect for the postintervention time periods is calculated as: $Y_{1t} - \sum_{j=2}^{J+1} W_j^* Y_{jt}$.

The recommendation by Abadie et al. (2010) and Abadie et al. (2015) is to only include countries in the donor pool where air travel as well as other predictors are not too dissimilar to the unit of interest, i.e. Sweden. Due to this, only other European countries are included in the donor pool. The outcome variable that is considered for the passenger estimation is the share of the population that travels internationally in a given quarter. The passenger share is chosen instead of the actual passenger numbers since this variable is more representative for the demand level in a given country, and thereby more comparable between countries. Germany does e.g. have a lot higher total number of passengers than Sweden, since the country has a much larger population than Sweden, but due to similarities between Sweden and Germany the share of the population that travels internationally in a given time period is quite similar. This type of re-scaling is also recommended by Abadie (2021) in order to correct for differences in size between units. Once the effect on the passenger shares is estimated, the effect on actual passenger numbers is easily retrieved by multiplying the estimated effect with the population number in Sweden.

Even when shares are used, the recommendation is to exclude countries that are too dissimilar in the outcome variable. Due to this, countries where the share of the population that travels internationally is more than twice as big than the share in Sweden are excluded in the main estimation. This results in the exclusion of Iceland, Cyprus, Malta, Ireland and Luxembourg. In addition, countries that have had a similar treatment as Sweden during the time period of consideration need to be excluded, as one of the identifying assumptions in the SCM is that the potential controls have not been exposed to a similar intervention as in the country of interest. While several countries already had aviation taxes in the beginning of the observed time period, only a few had taxes introduced or changed during the time period of study, namely Norway and the UK, which are excluded. Austria and Germany also has a tax that was introduced in 2011, but as this is in the very beginning of the time series considered (as is described in more detail in the next section), and we thereby only observe the post-tax trends, it is left in the donor pool (a robustness test where Austria and Germany are excluded from the donor pool is however also performed).

As international travel is highly seasonal, both the passenger share and price index variable are deasonalized before the SCM is used. This is done by estimating the average quarterly effect using a linear regression where quarterly dummy variables are used to estimate the average seasonal effect for the pre-treatment time. As the raw-data comparisons suggest that there might be an anticipation effect the summer before the tax is introduced, the desasonalization is based on the time period before the second quarter in 2017. The estimated average quarterly effect is then removed for the whole time series. This is done for all countries that are included, Sweden as well as all potential donor countries.

In addition to the bias that can come from the inclusion of countries that experience a similar tax during the time period that is considered, the countries in the synthetic control group should be also be unaffected by the tax in Sweden. This is similar to the SUTVA assumption in difference-in-difference estimations. One risk with the Swedish aviation tax is that individuals who live in Sweden but close to airports in neighboring countries might try to avoid the tax by booking a flight from the airport across the border, which would lead to a leakage effect. This was e.g. shown to happen in Germany by Borbely (2019). From Sweden, the potential leakage countries are Norway, Denmark and Finland. Norway is already excluded due to their own tax, but Denmark and Finland are left in the donor group due to their similarities with Sweden. In a robustness check, the sensitivity of the results when Denmark and Finland are dropped is however considered, and the results are stable. Another important factor for unbiased results is that there is no anticipation effect present, i.e. that the demand for air travel is affected before the tax is introduced due to the knowledge of the coming introduction. As mentioned, there is some indication of a potential (positive) anticipation effect the summer before the tax was introduced. As no significant effects are found when the treatment time is changed to the second quarter in 2017 however (see Table A3 in Appendix A3), the actual introduction of the tax is used as the treatment time in the main estimations.

One drawback with the SCM compared to standard regression methods is that a confidence interval cannot be easily estimated, and thus inference is not as straightforward. To assess how likely it is that the estimated effects are due to a random fluctuation, rather than being a true effect of the tax, placebo estimations are made for the whole donor pool of potential control countries (a so called in-space placebo test). The effect in Sweden is then compared to the "effects" that are estimated for these countries, where we expect the Swedish effect to be the most extreme (as no similar intervention has been made in the donor countries). A p-value is calculated by comparing the "extremeness" of the Swedish effect to these other countries, while at the same time adjusting for how well the pre-fit is made in these placebo estimations (as a poor pre-fit by itself indicates that any observed "effect" after the placebo-intervention time is less believable). This procedure yields what is called a standardized p-value, and should be interpreted as the probability for the observed effect to be a random event, after adjusting for the quality of the pre-fit in the placebo estimations, i.e. in a very similar fashion as the commonly used p-value in standard regression methods. As the calculation of the p-value is, in essence, a comparison of "extremeness" between the effects in Sweden and the placebo-effects in the donor pool, a standardized p-value of 0 is possible. This does however not mean that there is a zero chance for the effect to be a random event, only that Sweden has the most extreme effect in comparison to the donor pool in that specific post-tax time period (when the pre-fit is adjusted for).

4 Data

The main outcome variable of interest is the share of the population that travels internationally from Sweden. The data that is used is quarterly and for the main analysis the aggregate passenger data on international air travel for European countries are used together with data on the population of each country to calculate the shares of interest. In addition to these passenger shares, quarterly data on how the prices of international air travel have developed is used to examine the effect of the tax on the price of air travel. This data consists of country level price indices for international air travel where the most weight is put on the most popular routes, so as to most accurately portray the true average price of international air travel. The predictor variables that are used in the estimations are GDP/capita, a house price index and the employment rate for each country. All of these data sets are publicly available from Eurostat[1].

The data period that is considered in the main specification for the effect on passenger shares is 2011–2019. The start of the period is chosen as most of the idiosyncratic shock in international travel that resulted from the 2008 financial crisis, which affected different countries to a varying degree, has been recovered by 2011. Since quarterly data is used, this also gives plenty of preintervention time periods for the SCM to work well, as well as doing tests of inference (such as in-time placebo treatment checks). The end of the period is chosen to avoid any potential bias from the extreme decline in air travel that inevitably resulted from the covid-19 pandemic, which given varying levels of restrictions likely had different effects in different countries. Different time periods are however also considered in a robustness check. For the effect on the price index, a shorter time period, 2015–2019, is used since the price index data is not available for Sweden (and most other countries as well) before 2015.

In addition to these aggregate variables, route-level price data was web-scraped from Expedia.com on a daily basis between January 2018 and January 2019. In order to get a representative price for the destination at a certain date, prices for the same take-off date were scraped 1 week, 5 weeks and 9 weeks before take-off (except for the first and last weeks of the web-scraping). One-way tickets from Stockholm (Arlanda airport) to the main airports in Barcelona, Paris, Brussels, Luxembourg, Gran Canaria, Funchal, Kap Verde,

[1] The specific data sets that are used are: "Air passenger transport by reporting country (avia_paoc)", "HICP - monthly data (index) (prc_hicp_midx)","Population change - Demographic balance and crude rates at national level (demo_gind)", "House price index (2015 = 100) - quarterly data (prc_hpi_q)", "GDP and main components (output, expenditure and income) (namq_10_gdp)", "Employment rates by sex, age and citizenship (%) (lfsq_ergan)"

Hurghada, New York, Hong-Kong and Phuket were scraped. In addition to price, the number of stops, total time of the flight and the name of the airline were scraped. Due to data quality issues (missing data), only six of these routes could be used, namely Paris, Barcelona, Brussels, Luxembourg, New York and Hong Kong. This data is used for two objectives. Firstly to estimate a price elasticity of the demand for international air travel from Sweden, which is done in Appendix A1. Secondly, to calculate the expected demand responses due to the potential price effect of the tax by using the monthly average prices together with the estimated price elasticity, to analyze how much of the demand response that can be explained by an increase in prices.

5 Main results

Here the main results of the paper are presented. First, the effects on prices and passengers are presented together with an evaluation of the estimated synthetic control groups. Secondly, the results are interpreted together with the estimated price elasticity and the average monthly destination level price data to evaluate how much of the estimated passenger effect that can be explained by price effects.

5.1 Effects on prices and passenger numbers

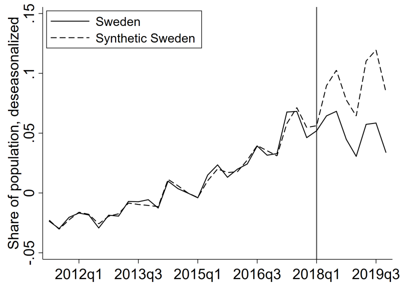
One of the advantages of using the synthetic control group is that it is very easy to get a visual understanding of the estimated effects. In Figure 1 (a) and (b), the development of the deseasonalized share of the Swedish population that travels internationally, and the deseasonalized international price index for air travel from Sweden, is compared with the synthetic counterpart before and after the tax is implemented (the quarter before the introduction of the tax is indicated with a vertical line in the graphs). In Figure 1 (c) and (d), the difference between Sweden and the synthetic control group is shown. Given that a good pre-fit is achieved, this difference should be close to zero before the introduction of the tax. The difference that is present after the introduction of the tax is the estimated effect of the tax. As can be seen, the synthetic control groups do a good job in mimicking both the development of international passenger shares and the price index of air travel before the tax is implemented. For the international passenger shares, there is a clear effect of the tax present and the effect grows larger with time. For the international price index however, the effect is not as clear: there appears to be a positive effect the second and third quarter after the introduction of the tax, but then a negative effect for the remaining post-tax time period.

The estimated effects for each quarter after the introduction of the tax, together with the standardized p-values, are shown in Table 1. In addition to the effects on the passenger shares, the effect is also shown in number of passengers[2]. The effect in percentage terms are also shown, for both the passenger share and price estimation. As can be seen, the effects on the share of the population that travels internationally are not only large and increasing, but also highly significant. In all cases, the standardized p-values are zero. This means that the effect in Sweden is the most extreme effect compared to the estimated placebo effects in the full set of donor countries, after adjusting for how successful the pre-treatment fit is. The graphical representation of these placebo estimations for the passenger shares are also found in Figure 1 (e), where it is clear that Sweden is one of the most "extreme" countries already before the adjustment to the pre-fit is made.

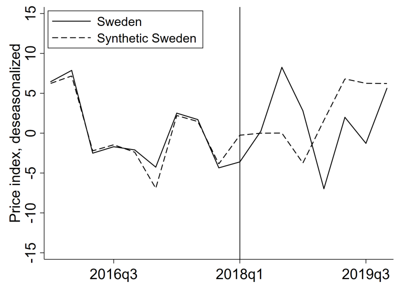
The effect on the price index for international air travel is however not significant in any of the post-tax quarters. Just as we can observe in the graphs, the point estimates are positive the second and third quarter after the tax is introduced, after which the estimates are negative, but the estimates are far from significant. In Figure 1 (f), where the results of the placebo estimations for the donor countries are compared with the effect in Sweden, we can also see that the Swedish estimates does not stand out as much as for the estimation on passenger shares.

Before we turn to interpreting the results, it is of interest to evaluate how reasonable the estimated synthetic control groups are, for both the passenger share and price index estimation. In Table 2, we see which countries that constitute the synthetic control groups, and what weights those countries have in the synthetic control group, for the two main estimations.

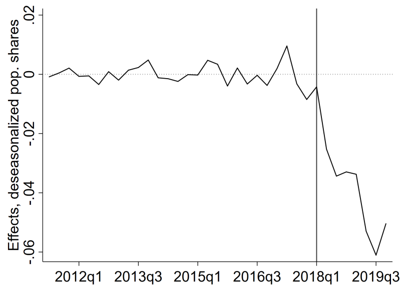
[2]This is simply the estimated effects in passenger shares multiplied by the population of Sweden



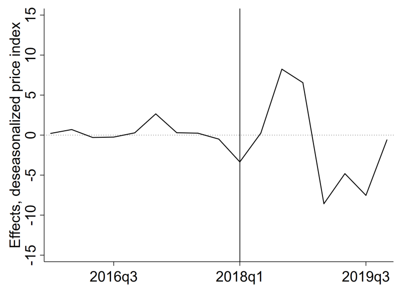
(a) Deseasonalized passenger shares



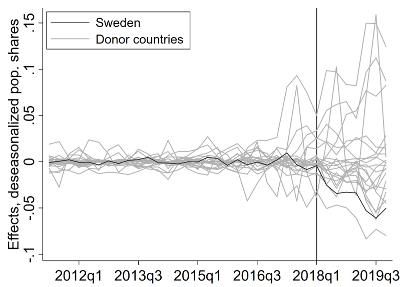
(b) Deseasonalized international price index



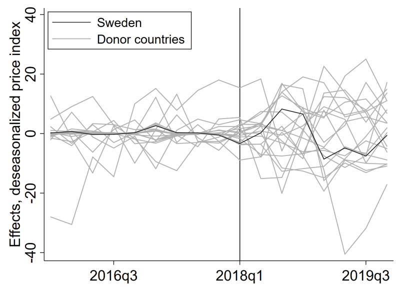
(c) Effect of tax on deseasonalized passenger shares



(d) Effect of tax on deseasonalized price index



(e) In-space placebo test, deseasonalized passenger shares



(f) In-space placebo test, deseasonalized price index

Figure 1: Effects of the Swedish aviation tax on international passenger shares and price index (deseasonalized time series).

Table 1: Quarterly effects of the Swedish aviation tax on the demand and price index of international air travel.

	Int. passengers, share of pop.	Int. passengers (thousands)	Percentage change	Int. price index	Percentage change
2018q2	-0.0253	-257	-5.7 %	0.2533	0.3 %
	(0.000)			(1.000)	
2018q3	-0.0344	-350	-7.1 %	8.2434	7.3 %
	(0.000)			(0.316)	
2018q4	-0.0329	-335	-8.6%	6.5549	7.0 %
	(0.000)			(0.421)	
2019q1	-0.0337	-343	-10.1 %	-8.5754	-10.2 %
	(0.000)			(0.421)	
2019q2	-0.0530	-545	-11.4 %	-4.8140	-4.6 %
	(0.000)			(0.526)	
2019q3	-0.0611	-628	-12.3 %	-7.5296	-6.8 %
	(0.000)			(0.368)	
2019q4	-0.0504	-518	-12.9 %	-0.5948	-0.6 %
	(0.000)			(0.947)	

Standardized p-values within parentheses

For the passenger share estimation, we see that Finland, Denmark, Germany, Slovakia and Croatia are the countries that create the synthetic control group where Finland, Denmark and Germany together constitute almost 80 percent of the synthetic control group. Given how similar Sweden is to these three countries, in many respects, the synthetic control group for the passenger share estimation seems reasonable. For the price index estimation, the synthetic control group is created using a completely different set of countries, namely: Bulgaria, Slovenia, Lithuania and Poland. Intuitively, these countries seem like a worse comparison group to Sweden.

To further investigate how well the synthetic control groups replicate Sweden we can see how balanced the predictor variables are for each estimation in Table 3, where the mean for each predictor variable for the validation period (i.e. the second half of the pre-treatment sample) is presented for Sweden and the synthetic control group, together with the weight that the predictor has in

Table 2: Donor weights in the main estimations.

Country	Passenger	Price	Country	Passenger	Price
Austria	0	0	Hungary	0	0
Belgium	0	0	Italy	0	0
Bulgaria	0	0.348	Lithuania	0	0.262
Czech Republic	0	0	Latvia	0	0
Germany	0.190	0	Netherlands	0	0
Denmark	0.222	0	Poland	0	0.0900
Estonia	0	0	Portugal	0	0
Spain	0	0	Romania	0	.
Finland	0.386	.	Slovenia	0	0.299
France	0	0	Slovakia	0.158	0
Croatia	0.0440	0			

Countries not included in the donor group presented as a dot.

the fitting of the synthetic control group.

As can be seen, there are some differences in the averages of the predictor variables. In both the passenger share and price index estimations, the mean of the outcome variable in question as well as the house price index are well balanced (the price index seems to be different but both are very close to zero, due to the deseasonalization procedure). The employment rate are in both cases also not too different, although Sweden has a higher employment in both cases. The main difference can be found in the GDP/capita predictor. For the passenger share estimation the difference is noticeable and for the price estimation the difference is huge.

While the balance in either case is not ideal, the potential damage that this imbalance can result in also depends on how important these variables are in the construction of the synthetic control groups. This is given by the weights of the predictors. As can be seen, in both the passenger and price estimation, the lagged values of the outcome variable in the training period (the first half of the pre-treatment sample) accounts for more than 99 percent of the predictor weights. This means that the other variables have little effect on the share of the population that travels internationally, as well as on the price index, when compared to previous values of the outcome variable in question. The potential issues from an imbalance in the other predictors should therefore be low, which is also illustrated in a robustness check where each predictor is dropped sequentially (see Appendix A.3, Table A4) and the estimates are stable. Nevertheless, the observed predictor balances give more trust in the passenger than in the price estimation.

Table 3: Predictor balance between Sweden and the synthetic control group (mean of predictor variables in validation period) and predictor variable weights.

	Pop. share estimation			Price estimation		
Predictor	Sweden	Synthetic	Weight	Sweden	Synthetic	Weight
Employment rate	76.19	69.82	0.0018	76.40	67.01	0.0016
GDP/capita	11773	9072	0.0026	11875	3229	0.0007
House price index	108.3	104.6	0.0034	111.2	109.2	0.0026
Outcome variable	0.0330	0.0335	0.992*	1.13e-06	-5.39e-07	0.995*

*aggregated weight of the outcome variables in the training period

5.2 Price effects vs. signal effects

Turning now to the interpretation of the results. The effect of the tax on the number of international passengers is large, especially considering that no significant effects from the tax can be found on the price index. Given the size of the tax and the fact that we are using a price index to estimate potential price effects, the lack of a significant effect on the price index is however not surprising. The price index is supposed to be representative, i.e. weighted by the most popular routes, and given that around 80 percent of international travel from Sweden by air is within Europe during the tax period, the lion's share of the tax for the ticket prices that are captured by the index will be 60 SEK. While not significant, we do also see a small positive price effect in the beginning of the post tax period, which is then followed by a negative effect. This is also a plausible scenario: given how much passengers drop as a result of the tax this will have a sharp downward pressure on prices as pricing of air travel in general is very sensitive to changes in demand.

Even if the tax has a "full" price effect, i.e. that the prices increased with the exact tax amount, it is still seems unlikely that a potential price effect of the tax can fully explain the massive decrease in passenger numbers, especially given how small the tax is. To investigate how much of the decrease in passengers that can be explained by a (potential) price effect from the tax we need two things: average ticket prices to popular destinations and the price elasticity of international travel from Sweden. This way we can get an estimate of how big the percentage increase of the prices due to the tax are, assuming that the pass-over of the tax on the price is 100 percent, and with the price elasticity calculate what the demand response ought to be. To obtain representative air travel ticket prices, Expedia.com was scraped for the daily prices of a few of the most popular international routes from Sweden during 2018 and the beginning of 2019. This price data and route level passenger data are used to estimate the price elasticity for international travel (to the included routes at least) during 2018 using an instrumental variable approach that is suggested in the literature. The particulars of the price elasticity estimation is provided in Appendix A.1, and the estimated price elasticity is -0.76. This is in line with the price elasticities that are available in the literature for the European market, for which the estimated price elasticities usually are around -1 (see e.g. Brons et al. (2002)). Kopsch (2012) estimates that the price elasticity for air travel in Sweden is between -0.67 and -0.85, and it is also reasonable that the price elasticity is slightly lower in Sweden compared to other European countries since it is more difficult to travel internationally by e.g. trains.

We now have what we need to get a rough estimate of what the expected demand response to the tax ought to be, given the estimated price elasticity and assuming a full pass-over of the tax on the price of air travel. In Table 4, the monthly average of the daily minimum price (in USD) for a one-way ticket to the destinations Barcelona, Brussels, Paris, Luxembourg, New York and Hong Kong is presented for the post-tax months that have been web-scraped. The daily minimum price is chosen since this is assumed to be the most representative price: most people that are booking a vacation are likely to try to get as cheap air travel as possible, given that the airport choice is convenient. The departure airport that is used in the web-scraping is also Stockholm-Arlanda and the cheapest tickets to the destination are therefore

Table 4: Average monthly prices, effects of the tax on the prices if a full pass-over is assumed and expected passenger effects given the estimated price elasticity.

	Tax–zone 1				Tax–zone 2	Tax–zone 3
	Barcelona	Brussels	Paris	Luxembourg	New York	Hong Kong
2018m4	241 (3.14%)	239 (3.16%)	339 (2.21%)	377 (1.98%)	466 (6.59%)	996 (5.16%)
2018m5	248 (3.00%)	220 (3.40%)	283 (2.62%)	449 (1.64%)	511 (5.93%)	874 (5.83%)
2018m6	221 (3.35%)	217 (3.41%)	252 (2.92%)	463 (1.57%)	556 (5.39%)	916 (5.50%)
2018m7	221 (3.32%)	136 (5.51%)	226 (3.24%)	446 (1.62%)	667 (4.46%)	881 (5.68%)
2018m8	152 (4.85%)	134 (5.54%)	233 (3.11%)	412 (1.74%)	831 (3.54%)	718 (6.99%)
2018m9	143 (5.14%)	131 (5.64%)	220 (3.28%)	388 (1.84%)	909 (3.22%)	682 (7.34%)
2018m10	134 (5.47%)	143 (5.11%)	189 (3.82%)	368 (1.93%)	608 (4.79%)	1029 (4.72%)
2018m11	145 (5.01%)	178 (4.05%)	204 (3.51%)	288 (2.46%)	863 (3.35%)	1202 (3.99%)
2018m12	190 (3.77%)	137 (5.31%)	180 (3.99%)	233 (3.05%)	803 (3.59%)	1087 (4.42%)
2019m1	197 (3.51%)	145 (4.83%)	205 (3.37%)	184 (3.77%)	1051 (2.65%)	989 (4.71%)
Average	189 (4.06%)	168 (4.60%)	2331 (3.21%)	361 (2.16%)	727 (4.35%)	937 (5.43%)
Pass. effect (expected)	-1.54 %	-1.75%	-1.22%	-0.82%	-1.65%	-2.06%

excluded, as the cheapest airlines do not operate at this airport, at the same time as it is conveniently located. The price effect of the tax, in percent, if a full pass-over of the tax is assumed, is also given next to the monthly price[3].

As can be seen, the average price effect for the routes in question are between 2.2 and 5.4 percent for the outgoing ticket if a full pass-over of the tax on the price is assumed. However, this does not include a return trip. As most people will buy a two-way ticket, the price effect on the full trip will be half as large (assuming that the return ticket costs about as much as the outgoing ticket). Using the estimated price elasticity of -0.76, we can now estimate what the expected demand effect ought to be, due to the price change from the tax. This is done by multiplying the average price effect with the price elasticity, and dividing the result by two to account for the return trip. As can be seen in the same table, the expected passenger effect for these routes are a decrease of between 0.8 and 2 percent, much lower than the estimated passenger effects for the aggregate of international passengers in Table 1.

While this calculation is done on several assumptions, and only a few routes are considered, it gives us some indication of how large a potential price effect

[3]This is calculated as Tax/(Price-Tax), using the average USD/SEK currency rate for the month in question to convert the tax in SEK to US Dollars

of the tax on the passenger numbers is. The assumptions that are made are further very generous in the sense that the potential price effect is inflated rather than deflated: the daily minimum prices are used (which inflates the price effect if not representative) and a full pass-over of the tax is assumed, which is necessarily not the case due to the competition in the market. Despite this, the potential price effect can only explain a small share of the observed effects on passenger numbers. Due to this, something else must be going on. A likely candidate is that the tax, in addition to a small price effect, has a strong signal effect. The media coverage of the tax was high in Sweden, and since it was introduced as an environmental tax this put the environmental consequences of air travel in the spotlight. A signal effect is hard to estimate directly, but it goes in line with the results in papers such as Andersson (2019), Li et al. (2014) and Rivers and Schaufele (2015) where larger tax effects are found from carbon and gasoline taxes than can be explained by only price effects. Li et al. (2014) also show that salience of the tax through media coverage can explain the larger effects.

Another possible explanation is increasing environmental awareness. If an increase in environmental concern, that results in a reduced demand for air travel, happened in Sweden at the same time as the tax was introduced while a similar shift in environmental awareness did not happen in the countries that constitute the synthetic control group, the results will be positively biased (given that this increased awareness did not come from the tax itself). Environmental awareness has also been, and still is, a strong trend in Sweden. In particular the Fridays-for-future movement with Greta Thunberg in the lead started to get a lot of attention towards the end of 2018 and onward. The question is however whether the environmental awareness, in particular connected to the choice to travel by air, was stronger in Sweden than in the synthetic control group. In Figure 2 the Google trends statistics for the search "Greta Thunberg" is presented for Sweden as well as the countries in the synthetic control group. As can be seen there is no evidence for a larger popularity in Sweden, and in particular the trends are changing in a similar fashion in all of the countries that are considered. This together with the timing of the passenger effect, which happens exactly when the tax is introduced, indicates that the tax indeed has a large effect. That an increased environmental awareness

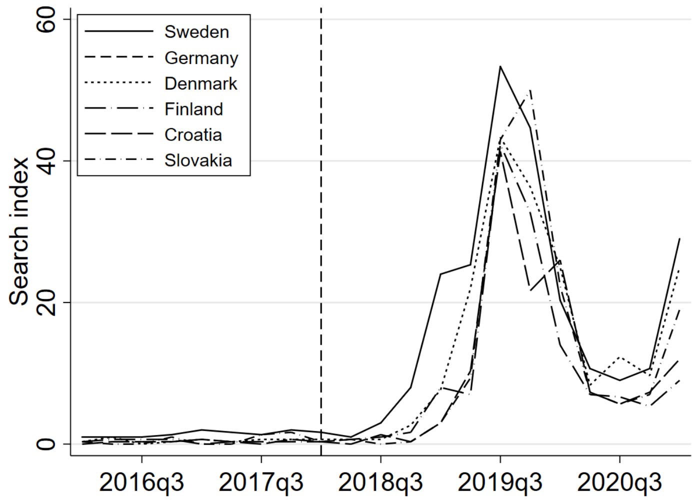


Figure 2: Google search intensity for "Greta Thunberg" in Sweden and the countries that are part of the synthetic control group in the main passenger specification.

is responsible for the increased effects over time can however not be excluded, especially since the media attention of the tax likely accelerated the environmental awareness with respect to air travel through the signal effect discussed earlier.

6 Robustness checks

There are several potential threats to the validity of the estimated effects that need to be considered. This is especially the case for the passenger share estimation. One potential issue is that there could be a leakage effect to neighboring countries, i.e. that people chooses to travel internationally from an airport in a neighboring country instead of an airport in Sweden, as a result of the tax. This would result in a positive bias on the estimated effect. Norway is already excluded due to their own tax, but both Denmark and Finland have large weights in the synthetic control group for the passenger share estimation. In Table 5, the results for the passenger share estimation when Denmark and Finland are dropped are presented. If a leakage effect is present, the effects

Table 5: Examination of potential leakage to Denmark and Finland and potential bias from early taxes in Germany and Austria.

	Main estimation	DK and FI dropped	DE and AT dropped
2018q2	-0.0253	-0.0211	-0.0296
	(0.000)	(0.000)	(0.053)
2018q3	-0.0344	-0.0272	-0.0372
	(0.000)	(0.000)	(0.053)
2018q4	-0.0329	-0.0400	-0.0364
	(0.000)	(0.000)	(0.000)
2019q1	-0.0337	-0.0430	-0.0376
	(0.000)	(0.000)	(0.000)
2019q2	-0.0530	-0.0589	-0.0553
	(0.000)	(0.000)	(0.000)
2019q3	-0.0611	-0.0552	-0.0647
	(0.000)	(0.000)	(0.053)
2019q4	-0.0504	-0.0626	-0.0561
	(0.000)	(0.000)	(0.000)

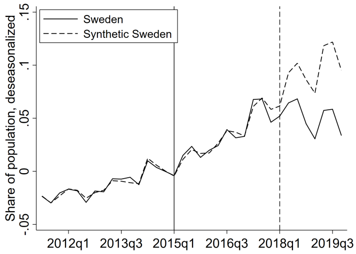
Standardized p-values within parentheses

when Denmark and Finland are excluded should be smaller than when they are included. As can be seen however, the estimated results are very similar to the main estimation, which indicates that a potential leakage effect is small if present at all.

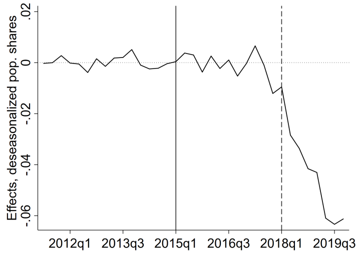
In the same table, the effects when Germany and Austria are dropped from the donor group are presented as well. The reason for this is that these countries got their own aviation tax in the very beginning of the preintervention time period that is used, which potentially could introduce a bias. As can be seen however, the results are very stable when Germany and Austria are dropped as well. Given that the values of the outcome variable in the training period have such large predictor weights in the construction of the synthetic control group, which donor countries that are included could potentially have a large effect on the estimated effects. A sequential drop of donor countries is however considered in Table A6 in Appendix A.3., where the largest and smallest country (with respect to passenger shares) are dropped two at the time, and the results are stable even when the donor group becomes very small.

Another important robustness test is a so called in-time placebo test where the same estimation is made but the treatment time is changed to an earlier date. As no treatment happened at this time, no effect should be visible. In Figure 3, in-time placebo tests are made using the second quarter of 2015 as the placebo treatment time for the passenger share estimation and the second quarter of 2017 as the placebo treatment time for the price index estimation. As the data that is used in the main estimation is deseasonalized using variations up until 2017q2, two different versions of this robustness check is considered for the passenger share estimation. The first one uses the same data as in the original estimation, and only changes the treatment time. This tests the validity of the SCM method on the data that is used in the main estimation. The second one makes a new deseasonalization using the seasonal variation up until the second quarter of 2015 to deseasonalize the whole series. This also evaluates whether the the method of deseasonalization itself introduces any bias in the estimated effects.

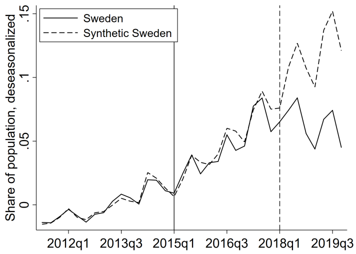
As can be seen, the passenger shares estimation is very robust to the in-time placebo test, especially when the same data is used as in the main estimation. When a new deseasonalization is made, up-until the placebo treatment time, the fit is slightly worse after the the placebo time, but no clear effects are seen until the actual tax happens. For the price estimation, we see a very similar pattern as in the main estimation. The fit between the placebo time and the actual treatment time is slightly worse than in the main estimation, but given that the main estimation for price was not significant this is not surprising. Other placebo treatment times are also considered for the passenger share estimation in Appendix A.3. When the same deseasonalization is used as in the main estimation, the second quarter of 2012, 2013, 2014 and 2016 are considered as placebo treatment times and the results are found in Figure A3. When a new deseasonalization is made, the second quarter of 2013, 2014 and 2016 are considered as alternative placebo treatment times (2012 could not be used as the time pre-treatment time period becomes to short for the deseasonalization to work). The results of these placebo tests are found in



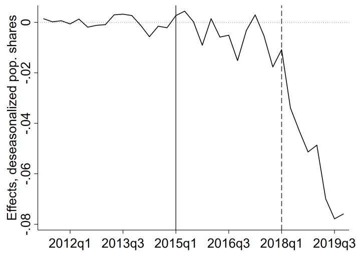
(a) Passenger shares, same deseasonalization



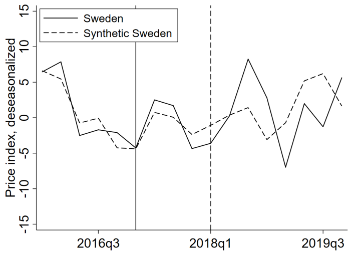
(b) Effects, same deseasonalization



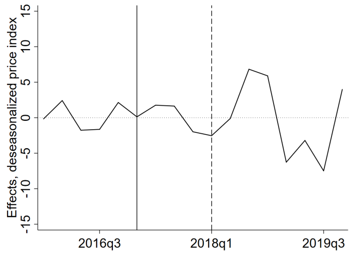
(c) Passenger shares, new deseasonalization



(d) Effects, new deseasonalization



(e) Price index, same deseasonalization



(f) Effects, same deseasonalization (price)

Figure 3: In-time placebo estimations for deseasonalized international passenger shares and price index. For passengers, two different deseasonalization procedures are considered: one being the same as in the main estimation (i.e. deseasonalization based on variation until 2017q2) and one being deseasonalized using the variation until the placebo treatment date.

Figure A4. In all cases the estimations are remarkably stable, even for the lowest placebo times.

In Appendix A.3, other robustness and sensitivity checks have also been considered. To investigate the potential risk of the deseasonalization procedure further, we have considered alternative "deseasonalization periods", i.e. using the variation of different time periods to deseasonalize the whole time series, when the actual treatment time (2018q2) is used. The results of this robustness check is presented in Figure A5, and a high stability is found here as well. The stability to the choice of training periods, in particular how large share of the preintervention sample is used as a training period, is also considered in Figure A6, with stable results. In addition, different starting years for the pretreatment sample have been considered, ranging between 2008 and 2014. The results of this robustness check is presented in Figure A7 and Table A5, once again with remarkably stable results.

Finally, different versions of the outcome variables are considered in Appendix A.2. For passengers, the non-deseasonalized share of the population that travels internationally, the deseasonalized raw number of international passengers and the non-deseasonalized raw number of passengers (i.e. the actual number of international passengers) are considered. The results of these estimations are found in in Figure A1 and Table A2. While the pre-fit is worse for the non-deseasonalized outcome variables, the estimated effects are very similar to the main estimation. The non-deseasonalized international price index is also considered (see Figure A2 and Table A2), with a worse pre-fit and continued non-significant results. Overall therefore, the estimated passenger effects are very robust.

7 Conclusion

In this paper, the effects of the Swedish aviation tax on the demand and price index of international air travel from Sweden are estimated using the synthetic control group method. The tax effect on the number of departing international passengers is large and robust, starting at a decrease of around 6 percent which then gets stronger over time and ends at decrease of around 13 percent in the last quarter of 2019, seven quarters after the introduction of the tax. No significant effect of the tax is found on the price index of international air travel. Given the size of the tax and that a price index is used in the estimation the lack of significant effects is however not surprising, particularly since the price index in all European countries show a high level of variability. The size of the passenger effect is however surprising given the level of the tax. In order to evaluate how much of the effect could be due to a (potential) price effect of the tax, web-scraped price data for six international destinations for the first 10 months after the introduction of the tax is used. Firstly, a price elasticity of the demand for international air travel is estimated at -0.76. Then, using the average monthly prices and the estimated price elasticity the expected demand response due to a price increase is calculated, under the assumption that the tax had a full pass-over on the prices. This analysis shows that the expected effect on demand ought to be a decrease between 1 and 2 percent, if the tax only results in a price effect on the demand. Given that the estimated passenger effect is a lot larger, this is evidence for that the tax in addition to a potential price effect had a strong signal effect. The results in this paper therefore adds to the literature where the effects of environmental taxes have been shown to have larger effects than expected from price effects alone, such as Li et al. (2014), Rivers and Schaufele (2015) and Andersson (2019).

Since the effects of the tax on the passenger demand is increasing over time, this also strengthens the conclusion that there are likely to be behavioral effects in addition to a pure price effect of the tax. It could however also be evidence for a bias from a larger increase in environmental awareness in Sweden when compared to the countries in the synthetic control group, especially since the Fridays-for-future movement, with Greta Thunberg in the lead, started to get international attention the end of 2018 and Greta Thunberg is from Sweden. According to Google Trends data, the popularity of Greta Thunberg in terms of Google searches is however very similar in Sweden and in the countries that constitute the synthetic control group. This is of course a very crude estimate for the potential impact from the Fridays-for-future movement, and it is still possible that increased environmental awareness can explain at least the amplified effects of the tax the second year after its introduction. Given the timing of the relative reduction in international air travel, which coincides perfectly with the introduction of the tax, it is however clear that the tax had a large effect on the demand for air travel, especially as the passenger effects are indeed very robust. The main take away is therefore that in the case of Sweden, an aviation tax was very successful in reducing the number of international passengers. The results from this paper can therefore be used by policy makers both in Sweden, but also in countries that are similar to Sweden.

While this paper makes an important contribution to the relatively sparse literature on the effects of aviation taxes as well as salience of environmental taxes, there are still several areas of interest for future research. Given that there seems to be a behavioral effect in addition to the price effect of the tax, one interesting research topic is to compare the effects of a newly introduced tax with the effects of an increase in already existing taxes. Intuitively the effect should be larger in the initial introduction if a large part of the tax's effect is due to a signal effect of the tax, especially since a newly introduced tax likely gets more media attention than an increase of an already existing tax. In general, stronger evidence on the signal versus price effects of an environmental aviation tax is needed in the literature. In addition, given that the price effect estimations in this paper are far less robust than the passenger effect estimation, further research on the effect on prices is also needed. Ideally, one would have actual price data for at least a year before the introduction of the tax, something that we did not have in this paper as we only had two months of pre-tax destination level price data. Finally, since the effect of aviation taxes seems to differ between countries it is important to also evaluate future aviation taxes to get a broader picture of its effects.

Appendix

A.1 Estimation of price elasticity of air travel in Sweden

A.1.1 Data

The price elasticity is estimated using route level passenger data and the price data that was web-scraped from Expedia.com during 2018, as described in section 4. In addition to the predictor variables that are used in the synthetic control group method, which are used as control variables in the IV-estimation, some other variables are also included in the IV-estimation. The instrumental variable that is used in the price elasticity estimation is monthly jet-fuel price data multiplied by the route distance. The jet-fuel price data is taken from the US Energy Information Agency (EIA) and the route distances is taken from Google maps. Additional control variables are also included. The temperature in Sweden is included as a control variable as this variable possibly can affect both the pricing and demand of air travel, and this data is taken from the European Climate Assessment & Dataset project. In addition, a proxy variable for the break through of Greta Thunberg, whose environmental message grew in popularity towards the end of 2018, is used, which is Google trends data for searches on "Greta Thunberg" in Sweden.

A.1.2 Econometric strategy

To estimate the the price elasticity of international air travel, an instrumental variable estimation is used. This is done in order to correct for the likely bias that stems from the simultaneity in the relationship between air travel ticket pricing and demand of air travel, i.e. that the price affects the demand for air travel at the same time as the demand for air travel also affects how airlines price their tickets. In order for the IV-estimation to solve this issue, the exclusion restriction must hold and the instrument must be relevant. The exclusion restriction requires the instrument to have no correlation with the dependent variable outside the correlation that goes through the explanatory variable of interest, the variable that is instrumented. Ideally, one wishes the instrument to be randomly assigned, but when observational data is used this is rarely the case. Instead one needs to find a variable that likely fulfills the exclusion restriction anyway, and as this is an untestable assumption the feasibility of this assumption must be examined by reason. That the instrument is relevant means that the instrument must have a significant effect on the variable that is instrumented, something which is easily tested in the first stage estimation.

When it comes to possible instruments that can be used for the price of air travel, the literature proposes a few alternatives. Mumbower et al. (2014) provide a comprehensive discussion of the most commonly used instruments, and divide them into four different categories. One category of instruments is cost-shifting variables, a variable that influences the cost per trip for the airline but that does not affect the passengers decision to travel (outside the effect the variable has on the price). This type of variable is most commonly used for estimations using aggregate data, and some examples in the literature are Hsiao and Hansen (2011) who use the jet-fuel price times the route distance as an instrument (which is also used in this paper), Berry and Jia (2010) and Granados et al. (2012) who use a hub-indicator for the destination airports (as flights to hubs can be done at a lower marginal cost due to the use of more fuel efficient air carriers) and Granados et al. (2012) who use distance of the route as an instrument. Another category is referred to as Hausman-type instruments, where the price of the same brand or product in other markets are used as an instrument. An example being Gayle (2004) and Mumbower et al. (2014) who use the average price in all other routes that have a similar length as the route being studied. A third category is Stern-type instruments, where measures of competition and market power are used as an instrument for the price. Berry and Jia (2010) use the number of carriers offering flights in a certain route as an instrument for example and Granados et al. (2012) and Mumbower et al. (2014) use how many daily nonstop flights in the market being studies that are offered by competitors as an instrument. The fourth category presented by Mumbower et al. (2014) is measures of non-price characteristics of other products supplied by firms, the same firm as being studied or others, in the same market. An example being Berry and Jia (2010) who use the percentage of rival routes that offer direct flights, the average distance of rival routes and the number of rival routes as instruments for the price.

The one that is chosen in this paper is a cost shifting instrument that is proposed by Hsiao and Hansen (2011), namely the length of the route times the jet-fuel price in the month that is being considered. As the price of jet-fuel affects the costs for airlines, and the total cost per trip for the airline depends on the distance of the flight, it is likely to be correlated with the price of the ticket for that flight. Given that this is the case, which of course is easily tested, the instrument would be relevant (this is also the case in this paper). In addition, the instrument must fulfill the exclusion restriction, i.e. that it only affects the number of passengers on a flight through the price, and thereby is not correlated with the number of passengers in another way, when other covariates are controlled for. When it comes to the price of jet fuel, this makes sense. It is hard to see how the price of jet fuel would influence individuals decision to travel abroad. Potentially the jet fuel price could be correlated with the economic cycle in general, which of course is correlated with how many people travel abroad, but this can be controlled for through e.g. the employment rate and GDP/capita. When it comes to the distance of the journey, it is not as clear as the length of the journey is strongly correlated with the time it takes to reach the destination, which incurs a time cost on the passenger that acts as a damper of the demand for the trip. On the opposite side, destinations further away are in general considered to be more exclusive and can act as a enhancer of the demand. In any case, the distance is fixed and should therefore not affect the variation in demand for specific routes over the time period that is studied. All in all therefore, it can be argued that this instrument fulfills the exclusion restriction and that the instrument is valid.

The IV-estimation is conducted in two stages. The first stage is given by

$$\hat{Z}_{gt} = \alpha + \gamma I_{gt} + \mathbf{X}\mu + \delta_t + \epsilon \tag{1}$$

where $\hat{Z}_{gt}$ is the log of the ticket price per route g and month t (the monthly average of the daily price data), I_{gt} is the instrumental variable (the jet-fuel price the given month times the distance of the route), and $\mathbf{X}$ is a vector of control variables including house price index, employment rate, GDP/capita, temperature in Sweden, and a Google search index variable for the term "Greta Thunberg". Monthly time fixed effects, δ_t, are also included. The second stage is given by

$$Y_{gt} = \alpha + \beta\hat{Z}_{gt} + \mathbf{X}\mu + \delta_t + u \tag{2}$$

where Y_{gt} is the log of the number of passengers per route and month, $\hat{Z}_{gt}$ is the projected price variable from the first stage and $\mathbf{X}$ is the same vector of control variables that was used in the first stage. As both ticket price and number of passengers are log transformed, β can be directly interpreted as the average price elasticity for international air travel from Sweden, for the routes that are considered, given that the identifying assumptions hold.

A.1.3 Results

The first stage and the estimated price elasticity is presented in Table A1. An OLS-estimation is also included for reference. As can be seen, the estimated price elasticity is -0.76. This means that if the price increase with one percent, the average demand effect is minus -0.76, for the destinations Barcelona, Brussels, Paris, Luxembourg, New York and Hong Kong with departure from Stockholm-Arlanda airport.

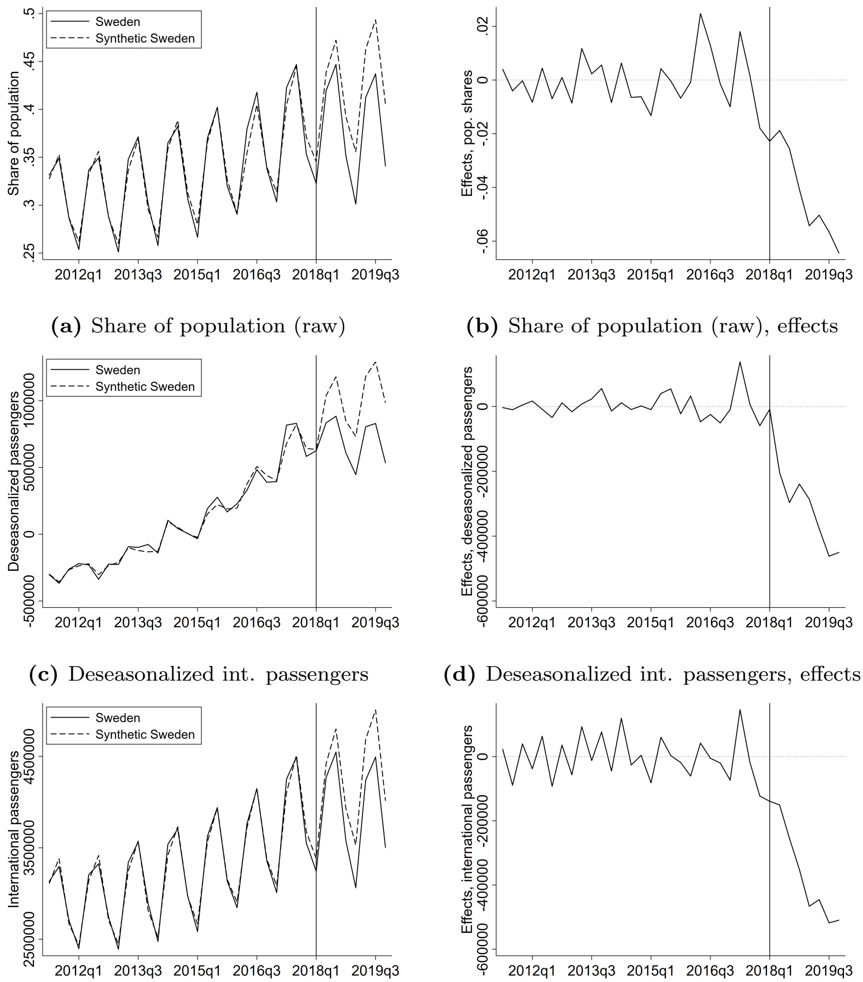
Table A1: The price elasticity of international air travel from Sweden.

VARIABLES	First stage	OLS-estimation	IV-estimation
Ticket price, log-form		-0.620***	-0.758***
		(0.127)	(0.130)
Employment rate	0.871	0.154	0.197
	(0.825)	(0.387)	(0.352)
House price index	-0.153	-0.0414	-0.0651
	(0.117)	(0.206)	(0.186)
Greta effect	0.0371	0.00620	0.0102
	(0.0275)	(0.0639)	(0.0577)
Temperature	-0.00569	-0.000933	-0.00166
	(0.00526)	(0.0115)	(0.0103)
IV	0.785***		
	(0.0360)		
Constant	-49.35	5.678	6.005
	(50.54)	(19.09)	(17.20)
Time FEs	YES	YES	YES
Observations	75	67	67
R-squared	0.872	0.335	0.321

Robust standard errors within parentheses

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

A.2 Alternative outcome variables



(a) Share of population (raw)

(b) Share of population (raw), effects

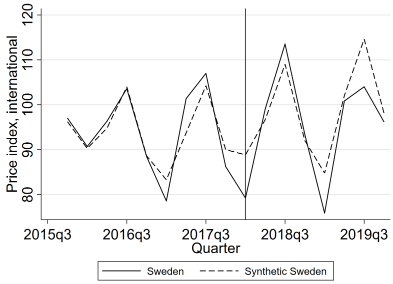
(c) Deseasonalized int. passengers

(d) Deseasonalized int. passengers, effects

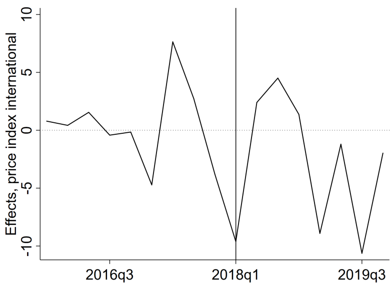
(e) International passengers (raw)

(f) International passengers, effects

Figure A1: Estimation of tax effect with alternative passenger outcome variables: the share of population that travels internationally (without deseasonalization) and international passengers (with and without deseasonalization).



(a) International price index



(b) International price index, effects

Figure A2: Estimation of tax effect with an alternative price outcome variable (price index without deseasonalization).

Table A2: Estimation of tax effect with alternative outcome variables.

	Pop. share, int. passengers	Deseasonalized int. passengers	Int. passengers, raw	Int. price index
2018q2	-.0188	-203672	-150620	2.403
	(0.381)	(0.000)	(0.231)	(0.737)
2018q3	-.0256	-296387	-255114	4.508
	(0.429)	(0.050)	(0.115)	(0.579)
2018q4	-.0407	-239240	-351332	1.369
	(0.048)	(0.050)	(0.000)	(0.947)
2019q1	-.0543	-285746	-466184	-8.913
	(0.000)	(0.050)	(0.000)	(0.421)
2019q2	-.0503	-376671	-445596	-1.203
	(0.190)	(0.050)	(0.000)	(0.947)
2019q3	-.0566	-461758	-517714	-10.632
	(0.238)	(0.000)	(0.038)	(0.526)
2019q4	-.0644	-450275	-509495	-1.973
	(0.048)	(0.050)	(0.000)	(0.842)

Standardized p-values within parentheses

A.3 Extended robustness checks

Table A3: Examination of potential anticipation effects. Treatment time changed to 2017q2.

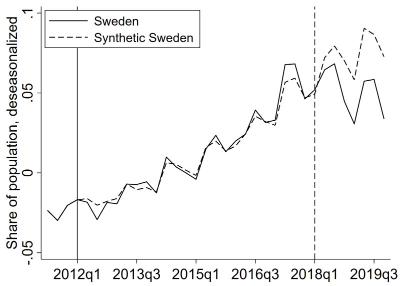
	Int. passengers, share of pop	Int. price index
2017q2	0.0098	1.7648
	(0.143)	(0.158)
2017q3	0.0034	1.6396
	(0.714)	(0.526)
2017q4	-0.0054	-1.9811
	(0.619)	(0.263)
2018q1	-0.0026	-2.5360
	(0.905)	(0.368)
2018q2	-0.0192	-0.1106
	(0.095)	(1.000)
2018q3	-0.0242	6.8296
	(0.000)	(0.263)
2018q4	-0.0315	5.8965
	(0.000)	(0.368)
2019q1	-0.0318	-6.2657
	(0.000)	(0.368)
2019q2	-0.0459	-3.2028
	(0.000)	(0.632)
2019q3	-0.0468	-7.4897
	(0.000)	(0.316)
2019q4	-0.0464	3.9839
	(0.000)	(0.579)

Standardized p-values within parentheses

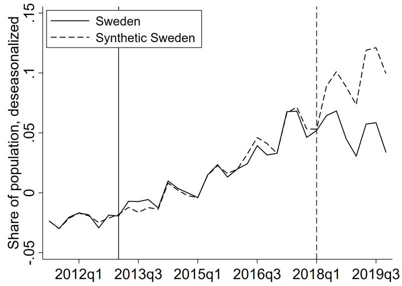
Table A4: Sensitivity to dropping predictor variables in the passenger share estimation. Variables are dropped sequentially, so that the last estimation is fitted only on lagged values of deseasonalized international passenger shares, the outcome variable.

		Variable dropped		
	Main estimation	Employment rate	Houseprice index	GDP/capita
2018q2	-0.0253	-0.0273	-0.0277	-0.0292
	(0.000)	(0.000)	(0.000)	(0.000)
2018q3	-0.0344	-0.0383	-0.0343	-0.0364
	(0.000)	(0.000)	(0.000)	(0.000)
2018q4	-0.0329	-0.0307	-0.0300	-0.0290
	(0.000)	(0.000)	(0.000)	(0.048)
2019q1	-0.0337	-0.0324	-0.0328	-0.0330
	(0.000)	(0.000)	(0.000)	(0.000)
2019q2	-0.0530	-0.0527	-0.0517	-0.0497
	(0.000)	(0.000)	(0.000)	(0.000)
2019q3	-0.0611	-0.0641	-0.0580	-0.0551
	(0.000)	(0.000)	(0.000)	(0.000)
2019q4	-0.0504	-0.0480	-0.0418	-0.0405
	(0.000)	(0.000)	(0.000)	(0.048)

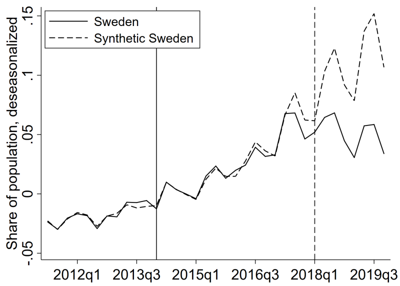
Standardized p-values within parentheses



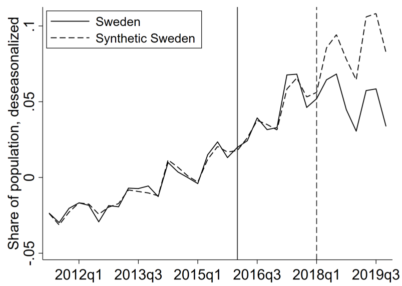
(a) Placebo treatment time: 2012q2



(b) Placebo treatment time: 2013q2

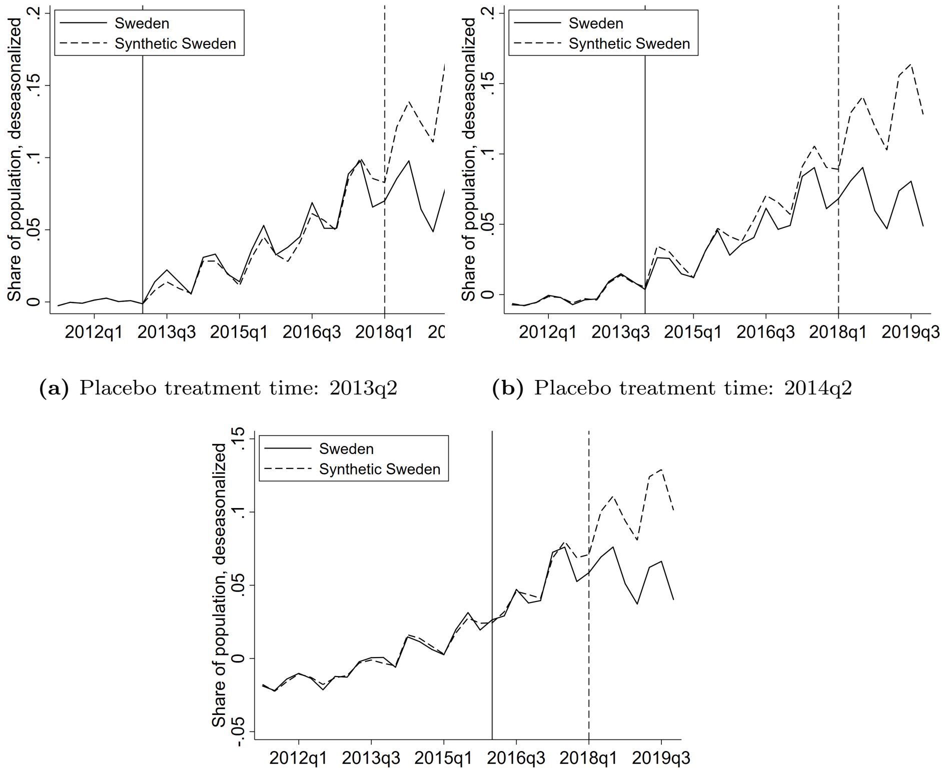


(c) Placebo treatment time: 2014q2



(d) Placebo treatment time: 2016q2

Figure A3: In-time placebo tests for the passenger share estimation with the same deseasonalization as in the main estimation.

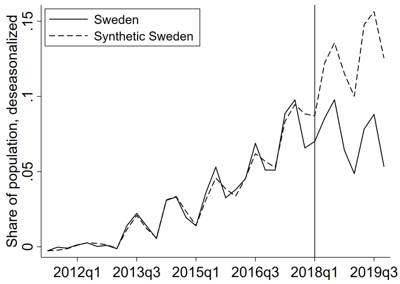


(a) Placebo treatment time: 2013q2

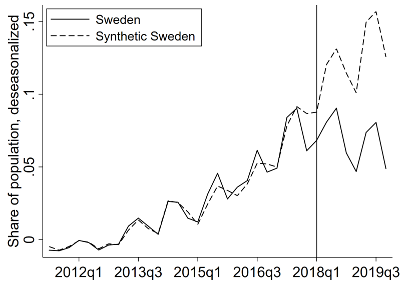
(b) Placebo treatment time: 2014q2

(c) Placebo treatment time: 2016q2

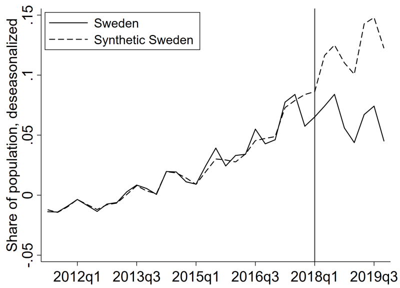
Figure A4: In-time placebo tests for the passenger share estimation with a new deseasonalization based on the placebo pre-treatment time. In all cases the full series are deseasonalized, but the period that the seasonal estimates are based on is changed to the placebo pre-treatment period.



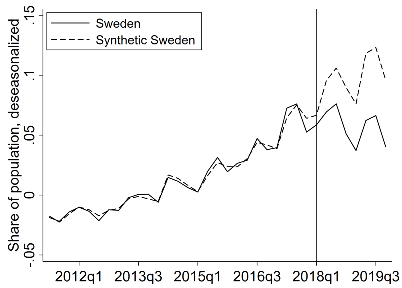
(a) 2011q2-2013q1



(b) 2011q2-2014q1

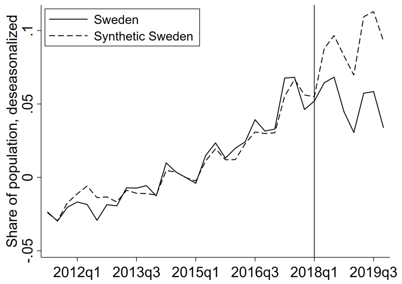


(c) 2011q2-2015q1

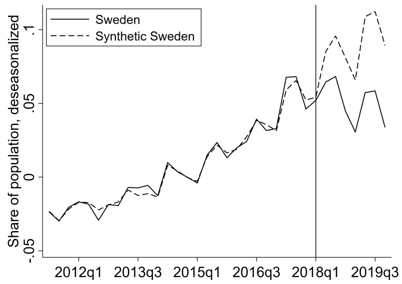


(d) 2011q2-2016q1

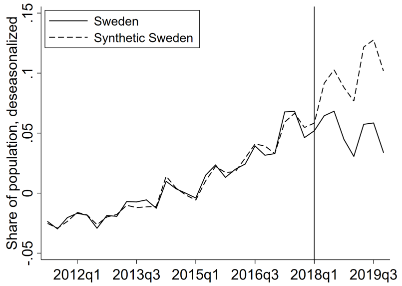
Figure A5: Different time periods used for the deseasonalization in the passenger share estimation. In all cases the whole series is deseasonalized, but the period that the seasonal estimates are based on is changed.



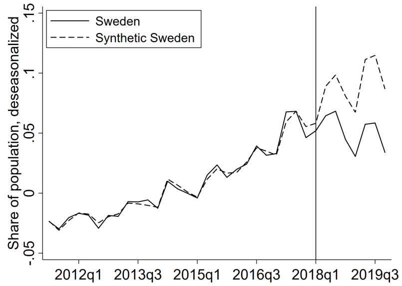
(a) Training period: 10 percent



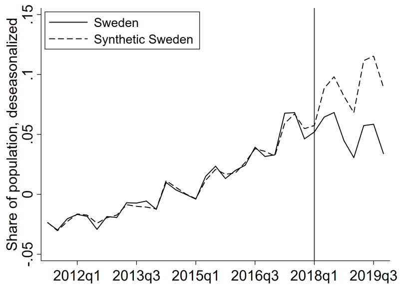
(b) Training period: 20 percent



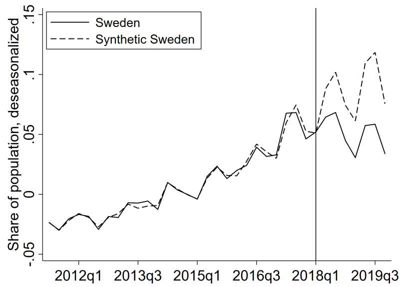
(c) Training period: 30 percent



(d) Training period: 40 percent



(e) Training period: 60 percent



(f) Training period: 70 percent

Figure A6: Different training and validation periods for the passenger share estimation. The baseline, that is used in the main estimation, is that 50 percent of the sample is used as a training period and 50 percent as a validation period.

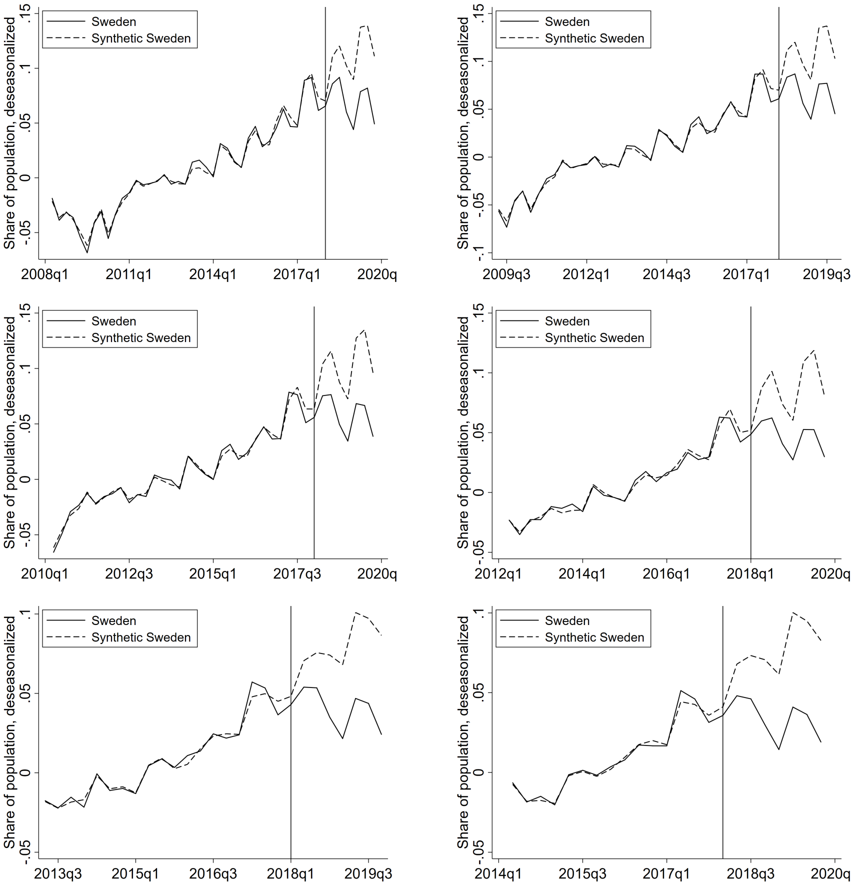


Figure A7: Estimations of the effects on deseasonalized passenger shares using different time periods for the whole sample.

Table A5: Estimations of the effects on deseasonalized passenger shares using different time periods for the whole sample.

	Starting year						
	2008	2009	2010	Main	2012	2013	2014
2018q2	-0.0248	-0.0280	-0.0287	-0.0253	-0.0273	-0.0167	-0.0198
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.286)	(0.000)
2018q3	-0.0287	-0.0332	-0.0394	-0.0344	-0.0391	-0.0222	-0.0271
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.333)	(0.000)
2018q4	-0.0423	-0.0406	-0.0380	-0.0329	-0.0332	-0.0391	-0.0408
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
2019q1	-0.0455	-0.0413	-0.0380	-0.0337	-0.0330	-0.0465	-0.0471
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
2019q2	-0.0589	-0.0586	-0.0591	-0.0530	-0.0564	-0.0541	-0.0592
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
2019q3	-0.0571	-0.0599	-0.0684	-0.0611	-0.0663	-0.0536	-0.0586
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.095)	(0.000)
2019q4	-0.0618	-0.0576	-0.0572	-0.0504	-0.0509	-0.0623	-0.0636
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.143)	(0.048)

Standardized p-values within parentheses

Table A6: Step-wise removal of potential donor countries from most extreme to least, starting from all potential donor countries (28 of them) and then sequentially dropping the countries until there are only 5 left. Which countries that are dropped are given by the country code at the top of the column. Norway and the UK are dropped first due to their own taxes. Passenger shares.

	Full	NO/UK	IS/SK	CY/RO	MT/SI	IE/PL	LU/HU	DK/CZ	PT/LT	NL/FR	ES/IT	HR/DE	FI
2018q2	-0.0138	-0.0233	-0.0225	-0.0215	-0.0204	-0.0280	-0.0249	-0.0348	-0.0138	-0.0272	-0.0257	-0.0284	0.0015
	(0.036)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.417)	(0.000)	(0.000)	(0.000)	(1.000)
2018q3	-0.0197	-0.0286	-0.0280	-0.0270	-0.0249	-0.0368	-0.0300	-0.0381	-0.0148	-0.0318	-0.0287	-0.0305	0.0019
	(0.036)	(0.038)	(0.000)	(0.000)	(0.050)	(0.000)	(0.000)	(0.000)	(0.417)	(0.100)	(0.500)	(0.000)	(0.800)
2018q4	-0.0329	-0.0393	-0.0401	-0.0373	-0.0339	-0.0369	-0.0367	-0.0546	-0.0308	-0.0366	-0.0415	-0.0489	-0.0260
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.083)	(0.100)	(0.125)	(0.000)	(0.600)
2019q1	-0.0371	-0.0410	-0.0418	-0.0383	-0.0347	-0.0375	-0.0364	-0.0605	-0.0368	-0.0416	-0.0453	-0.0571	-0.0380
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.083)	(0.100)	(0.125)	(0.000)	(0.000)
2019q2	-0.0485	-0.0558	-0.0574	-0.0539	-0.0491	-0.0571	-0.0519	-0.0782	-0.0422	-0.0609	-0.0628	-0.0747	-0.0412
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.083)	(0.100)	(0.250)	(0.000)	(0.400)
2019q3	-0.0460	-0.0554	-0.0564	-0.0539	-0.0487	-0.0647	-0.0542	-0.0748	-0.0387	-0.0636	-0.0638	-0.0733	-0.0323
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.250)	(0.100)	(0.250)	(0.000)	(0.600)
2019q4	-0.0544	-0.0592	-0.0598	-0.0549	-0.0503	-0.0569	-0.0542	-0.0818	-0.0482	-0.0596	-0.0650	-0.0773	-0.0583
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.083)	(0.100)	(0.125)	(0.000)	(0.400)

Standardized p-values within parentheses

References

Abadie, A. (2021, 6). Using Synthetic Controls: Feasibility, Data Requirements, and Methodological Aspects. *Journal of Economic Literature 59*(2), 391–425.

Abadie, A., A. Diamond, and J. Hainmueller (2010, 6). Synthetic control methods for comparative case studies: Estimating the effect of California's Tobacco control program. *Journal of the American Statistical Association 105*(490), 493–505.

Abadie, A., A. Diamond, and J. Hainmueller (2015, 2). Comparative Politics and the Synthetic Control Method. *American Journal of Political Science 59*(2), 495–510.

Andersson, J. J. (2019, 11). Carbon Taxes and CO2 Emissions: Sweden as a Case Study. *American Economic Journal: Economic Policy 11*(4), 1–30.

Berry, S. and P. Jia (2010, 8). Tracing the Woes: An Empirical Analysis of the Airline Industry. *American Economic Journal: Microeconomics 2*(3), 1–43.

Borbely, D. (2019, 8). A case study on Germany's aviation tax using the synthetic control approach. *Transportation Research Part A: Policy and Practice 126*, 377–395.

Brons, M., E. Pels, P. Nijkamp, and P. Rietveld (2002, 5). Price elasticities of demand for passenger air travel: a meta-analysis. *Journal of Air Transport Management 8*(3), 165–175.

Falk, M. and E. Hagsten (2019, 1). Short-run impact of the flight departure tax on air travel. *International Journal of Tourism Research 21*(1), 37–44.

Forsyth, P., L. Dwyer, R. Spurr, and T. Pham (2014, 2). The impacts of Australia's departure tax: Tourism versus the economy? *Tourism Management 40*, 126–136.

Gayle, P. G. (2004). Does Price Matter? Price and Non-Price Competition in the Airline Industry. *Econometric Society 2004 North American Summer Meetings, Econometric Society No. 163.*

Granados, N., A. Gupta, and R. J. Kauffman (2012). Online and offline demand and price elasticities: Evidence from the air travel industry. *Information Systems Research 23*(1), 164–181.

Hsiao, C. Y. and M. Hansen (2011, 11). A passenger demand model for air transportation in a hub-and-spoke network. *Transportation Research Part E: Logistics and Transportation Review 47*(6), 1112–1125.

Kopsch, F. (2012, 5). A demand model for domestic air travel in Sweden. *Journal of Air Transport Management 20*, 46–48.

Li, S., J. Linn, and E. Muehlegger (2014). Gasoline Taxes and Consumer Behavior. *American Economic Journal: Economic Policy 6*(4), 302–42.

Mayor, K. and R. S. Tol (2007, 11). The impact of the UK aviation tax on carbon dioxide emissions and visitor numbers. *Transport Policy 14*(6), 507–513.

Mumbower, S., L. A. Garrow, and M. J. Higgins (2014, 8). Estimating flight-level price elasticities using online airline data: A first step toward integrating pricing, demand, and revenue optimization. *Transportation Research Part A: Policy and Practice 66*(1), 196–212.

Rivers, N. and B. Schaufele (2015, 11). Salience of carbon taxes in the gasoline market. *Journal of Environmental Economics and Management 74*, 23–36.

Seetaram, N., H. Song, and S. J. Page (2014, 7). Air Passenger Duty and Outbound Tourism Demand from the United Kingdom. *Journal of Travel Research 53*(4), 476–487.

III

Constrained leisure: the effects on travel demand when leisure time increases

Jonathan Stråle
Department of Economics,
Swedish University of Agricultural Sciences,
Box 7013, Uppsala 750 07, Sweden. e-mail: jonathan.strale@slu.se

Abstract

In this paper the effect of increased leisure time on the demand for leisure travel, a good that is both time and emission intensive, is analyzed both from a theoretical perspective as well as empirically estimated through the use of retirement and an exogenous increase in the number of offered vacation days. In particular, the importance of the initial level of leisure time is investigated through a comparison between Sweden and the US. The theoretical model predicts that the starting point for leisure time is important in how the demand for time intensive goods changes when leisure time increases; the more leisure you have when the increase happens the less the demand is affected. The empirical results also support this as a clear difference between Sweden and US is found: no significant effect of retirement is found on the amount that is spent on leisure travel in Sweden, while the equivalent effect in the US is substantial. No significant effects are further found from the large increase in vacation time that many Swedes get when they turn 40.

1 Introduction

Reducing emissions to reach the climate change goals has never been so urgent, and while other sectors account for larger emissions at an aggregate level the trends in international travel, combined with the emission intensity per trip, are worrying as travel has been steadily increasing over the past decades (at least up until the pandemic). One suggestion by environmentalists to achieve the reduction in emissions is to down-shift the economy instead of chasing everlasting growth. The argument is that if everyone works and earns less, they will consume less, which will lead to lower emissions, while still maintaining a high quality of life due to increased leisure time. Given the income elasticities of leisure travel (see e.g. Stråle (2021)), this is likely to work to some degree. However, a further question is what happens to the demand for goods that are both emission and time intensive, such as leisure travel, if the amount of leisure time is exogenously increased. If the increased leisure time leads to a reallocation of consumption to more emission intensive goods, a rebound effect will occur and emissions will not decrease as much as expected.

This paper investigates what happens to the demand for leisure travel when the leisure time that a household has at their disposal exogenously increases. In particular, we are interested in investigating how important the baseline of current leisure time is when leisure time increases. This is done both by deriving a simple theoretical demand model, where the effect of increased leisure time from different starting points is analyzed, and by empirically estimating the effect of increased leisure time on the demand for leisure travel in two countries that have different levels of baseline leisure time. The latter is done by estimating the effects of retirement in the US and Sweden, two countries that differ in the amount of leisure time employees have access to (especially in terms of access to vacation days), as well as estimating the effect of turning 40 years old in Sweden, an age threshold when a large share of employees gets between 4 and 6 more vacation days.

This paper thereby starts with an assumption, namely that leisure time in fact *can* increase exogenously. Traditional theory on time use and labor supply, such as Becker (1965), DeSerpa (1971) and Heckman (1974), assumes the opposite: the economic agent chooses how much to work based on their utility functions and offered wage rates. Due to this, the only exogenous increases in leisure that are possible are short term shocks such as unemployment or sick leaves. Since the early theoretical works on time in economics, a growing literature has however shown that most individuals are likely to be constrained in their leisure/labor choice due to structural constraints such as the 40 hour work week. This literature argues that most employed individuals are faced with a take it or leave it option: either they work the proverbial 40 hours week, or they do not work at all. Examples of this type of literature are Moffitt (1982), Dickens and Lundberg (1985), Tummers and Woittiez (1991), and Feather and Shaw (2000). While they use different theoretical approaches, the similarity is that the individual chooses to work the offered work time if the utility of doing so is larger than not working at all, even if it is far from the work time the individual would freely choose. They all also find empirical evidence for the constraints on work time in the labor market. Moffitt (1982) find that the people in the sample he uses (working aged men with children) would work 21 hours a week if they could choose freely, and that anyone who wants to work more than 3 hours a week will accept the 39 hour work week that on average was offered. Tummers and Woittiez (1991) finds similar results while Dickens and Lundberg (1985) find the the opposite effect: that the sample would like to work more at the given wage rate if than they were offered, something that likely is explained by the fact that the use a sample low-income men together with an assumption of fixed wage rate independent of work hours. Given this type of constraints in the labor market, an exogenous shift in leisure time is thereby possible.

Papers that focus on exogenous shifts in leisure time are however scarce. One example is Aguiar et al. (2013), who descriptively analyze how individuals who lost their job due to the Great Recession in 2008 use their newly found extra leisure time and find that the most common increase is in sleep time and daily leisure activities such as watching TV. In addition, the effects of retirement have also been analyzed in different settings. The most common focus has been on the retirement-consumption puzzle, i.e. that total consumption drops at retirement, something that is in violation of the the permanent income hypothesis. The main focus in this literature is however on expenditures on food, and that the retirement-consumption puzzle can be explained by an increased home production (i.e. that households cook more when they are retired instead of eating out). Two prominent examples in this literature are Aguiar and Hurst (2005) and Luengo-Prado and Sevilla (2013), but there are several papers with the same focus. A few of these papers have also analyzed the effects of retirement on leisure travel expenditures. Miniaci et al. (2010)

include holiday spending in their analysis, but find no effect from retirement in Italy between 1985–1996, and Redmond and McGuinness (2020), who find negative effects for retired males in Ireland.

In addition, there are also several examples of travel expenditure patterns being analyzed for elderly households in the tourism and travel demand literature (see e.g. Jang and Ham (2009) and Hong et al. (2014)), but no emphasis is in general put on retirement nor the available leisure time. The travel demand literature has also put a lot of effort on estimating the value of travel time, some examples being Cesario (1976), Bockstael et al. (1987) and Feather and Shaw (2000), where the main discussion has been on how to estimate the opportunity cost for leisure time use, but exogenous changes in leisure time are not analyzed in this literature either. While there are several strands of literature that touches upon the aspects that are analyzed in this paper, to the best of my knowledge no other paper explicitly considers the effects from increased leisure time on the demand for time intensive goods. In particular, no paper addresses the importance of the starting level of leisure time, before it increases, as far as I know. This paper therefore makes valuable contributions to the research on constrained work time, retirement consumption as well as the travel demand literature.

The main results in this paper are as follows. In Sweden, retirement only affects the probability of being a traveler. Interestingly, the probability to travel internationally decreases while the probability to travel domestically increases. The aggregate effect on total leisure travel, both domestic and international, is also negative. No effect on the level of expenditure is found. In the US, retirement has a positive effect on both the probability to travel as well as the amount that is spent once traveling. Since income is controlled for, this suggests that the massive increase in leisure time at retirement has a clear effect in the US while a very limited effect in Sweden, where the effect mostly seems to be a reshuffle between international and domestic travel. In addition, no significant effect from turning 40 in Sweden, when the holiday allowance increases, is found. This suggests that there is indeed a rebound effect in terms of allocation towards more energy intensive goods such as leisure travel if leisure time increases, given that the current level of leisure time is low. As shown in the theoretical model, this effect decreases as the starting leisure time increases, and based on the Swedish results increased leisure time seems to have limited effects on the demand for leisure travel already at a starting level of 5-6 weeks of vacation.

These results are important for a number of reasons. First of all, it seems likely that the amount of time that people work can decrease over time. In particular, as automation increases, now with the help of artificial intelligence, it is foreseeable that we will reach a point where very little work-time needs to be allocated. This type of downshift can of course be encouraged further through policy, not the least in an attempt to reduce emissions, in which the effects on the demand for energy intensive goods needs to be taken into account. The evidence from this paper suggests that encouraging people to work less in an attempt to achieve a down-shift could indeed work as the potential rebound effect seems to be limited, at least in the case of leisure travel. In addition, this type of evidence is also an indication of whether employees work the optimal amount based on their own utility functions. As the amount of vacation time (and in most cases also work-time) usually is a take it or leave it offer it is likely that many people work more than they would like if they could choose optimally. These results can therefore also be used by policy makers to adjust work time and vacation laws to get closer to the optimal work time based on an individual utility perspective.

The rest of the paper is structured as follows. In the next section, a background is given on differences in work and vacation time in the US and Sweden. In section 3, the theoretical framework is presented. In section 4, the data that is used in the empirical analysis is presented. The empirical strategy is presented in section 5, the main results are presented in section 6 and robustness checks are performed in section 7. The empirical results are discussed together with the theoretical predictions and potential identification issues in section 8. Section 9 concludes.

2 Background on working time in Sweden and the US

When it comes to working time, there are some notable differences between Sweden and the US. US workers work a lot more than Swedish workers, and according to OECD[1] the total number of working hours per person per year in 2010 was on average 1772 hours in the US while it was only 1484 hours in Sweden. This is the total number of hours worked over the year divided by the number of people in employment.

One of the reasons for the difference in working time is that Swedes on average get a lot more vacation time than Americans. In the US, there is no vacation law that mandates employers to offer vacation to their employees. As a result, 1 in 4 employees in the US receive no vacation at all (Maye, 2019). The lack of mandating laws also results in a large heterogeneity, where the number of vacation days depend on e.g. industry and seniority. The average vacation time is generally estimated to be 10 working days (2 weeks) per year. Older people get a bit more of vacation days on average and people between 55 and 64 years of age get an average of 11.3 offered vacation days per year[2]. By combining the average offered vacation days, and the number of days off due to public holidays, Huberman and Minns (2007) further estimate that the total amount of working days off in the US was on average 20 days in 2000.

In Sweden on the other hand, each worker is entitled by law to 25 working days (5 weeks) of vacation per year. This is the lowest level of vacation for full time workers, and some workers get more than that, usually through negotiation by the unions. In particular, employees in the public sector get more vacation time at certain ages. For individuals who work for the state, the lowest level of vacation days is 28 days and when they turn 30 the number increases to 31. Once a state employee turns 40 the vacation time increases, again, by 4 more days, resulting in 35 days of vacation (or 7 weeks). For employees of municipalities and regional governments, the vacation days increase by 6 days at the age of 40, from 25 to 31 days. Together, this set of employees

[1] OECD, 2022, Average annual hours actually worked per worker, https://stats.oecd.org/Index.aspx?DataSetCode=AVE_HRS (accessed on 2022-03-16)

[2] Zippia, 2022, https://www.zippia.com/advice/pto-statistics/ (accessed on 2022-03-16)

make up about 33 percent of the Swedish labor market[3]. In addition to the employees of the public sector, vacation that is higher than the mandated 25 days is common also in the private sector, where it is common to get more vacation to compensate for potential overtime (usually these agreements results in around a total of 30 days of vacation). This is however not connected to age or seniority, but rather to the type of work the employee has. This difference is also noticeable in the estimated number of days off for Sweden by Huberman and Minns (2007), who estimate that the average number of working-days off in 2000 was 38 days when vacation and public holidays are aggregated, almost double the amount of days off in the US.

3 Theoretical framework

In order for an exogenous shift in leisure time to be possible, we must be in a setting where workers do not choose their working time freely. This is not a completely uncontroversial assumption, especially as the seminal work on time in economics by e.g. Becker (1965), DeSerpa (1971) and Heckman (1974) all considers the leisure/labor choice to be just that: a choice made by the individual as a result of their utility maximizing behavior. Given the structural constraints in the job market however, a completely flexible work time is in most cases far from the truth. This has spawned a small theoretical field where a potential constraint on working time is considered. One example is Feather and Shaw (1999) who expand the labor supply model by Heckman (1974) by introducing a take-it-or-leave it constraint at the labor market: either the individual accepts the working time that is being offered, or they do not work at all. Using this framework they show that the value of leisure time to the individual is different depending on whether the individual is working more, or less, than what is actually preferred.

In the framework by Feather and Shaw (1999), and also Feather and Shaw (2000), the working time (and thereby leisure time) is exogenous, but they do not analyze what happens to the demand for goods when the constraint

[3] Statskontoret, 2022, https://www.statskontoret.se/fokusomraden/fakta-om-statsforvaltningen/de-som-arbetar-i-myndigheterna/ (accessed on 2022-03-16)

changes. To the best of my knowledge, this has further not been considered in any theoretical framework. To address this, we will consider a utility maximization problem where the individual gets utility from consuming goods and from relaxing. For simplicity, we consider a case where an individual can consume two goods, one that is time intensive and one that is not, as well as relaxing (spending time on things that gives utility but that do not cost any money). The time intensive consumption good can be interpreted as leisure travel: a good that requires both money and (quite a lot) of time to consume. The other monetary good can be considered as "all other goods". The individual chooses their optimal allocation of money and time on these three goods by maximizing their utility as:

$$\max U(X_1, X_2, L) = X_1^{\alpha} X_2^{\beta} L^{\gamma} \tag{1}$$

subject to the budget constraints:

$$P_1 X_1 + P_2 X_2 = w\bar{h} + A \tag{2}$$

$$\phi X_1 + L + \bar{h} = 1 \tag{3}$$

where P_1 and P_2 is the monetary prices of goods X_1 and X_2, w is the wage rate, $\bar{h}$ is the working time that is exogenous to the individual and A is non-working income, such as pensions, transfers from the government and income from capital investments. X_1 and X_2 are thus "traditional" consumption goods in the sense that money is needed to consume them, which is constrained by the total income the individual has, but in addition to money, X_1 also requires the individual to spend time in the consumption (for simplicity we assume that X_2 requires no time to consume). This is demonstrated in the second budget constraint, where total available time (standardized to 1) is the sum of working time ($\bar{h}$), time spent on consuming X_1 and time spent on neither working or consuming (L). L can be interpreted as leisure time that is enjoyed without any money consumption tied to it, while ϕX_1 is leisure time spent on X_1. Total leisure time thereby becomes $L + \phi X_1$, as X_1 is considered to be a leisure good, and ϕ can be interpreted as the "time price" of consuming X_1. The total time available should further be seen as discretionary time, time that is net of mandatory "life admin" such as sleeping, cleaning and grocery shopping.

Since we are interested in what happens to the demand for the time intensive good, X_1, when $\bar{h}$ changes we can rearrange the second budget constraint so that:

$$L = 1 - \phi X_1 - \bar{h} \tag{4}$$

and substitute it into the utility function, to simplify the maximization problem:

$$\max U(X_1, X_2, L) = X_1^{\alpha} X_2^{\beta} (1 - \phi X_1 - \bar{h})^{\gamma} \tag{5}$$

$$\text{s.t} \quad P_1 X_1 + P_2 X_2 = w\bar{h} + A \tag{6}$$

which gives us the Lagrangian:

$$\mathcal{L} = X_1^{\alpha} X_2^{\beta} (1 - \phi X_1 - \bar{h})^{\gamma} - \lambda(P_1 X_1 + P_2 X_2 - w\bar{h} - A). \tag{7}$$

Taking the first order conditions w.r.t X_1 and X_2 gives us:

$$\frac{\alpha U(\cdot)}{X_1} - \frac{\phi \alpha U(\cdot)}{1 - \bar{h} - \phi X_1} = \lambda P_1 \tag{8}$$

$$\text{and} \qquad \frac{\beta U(\cdot)}{X_2} = P_2 \tag{9}$$

respectively, where $U(\cdot)$ is the utility function. Dividing equation 8 with equation 9 gives us:

$$\frac{X_2}{\beta}\left[\frac{\alpha}{X_1} - \frac{\gamma\phi}{1 - \bar{h} - \phi X_1}\right] = \frac{P_1}{P_2}. \tag{10}$$

Solving for X_2 gives us:

$$X_2 = \beta \frac{P_1}{P_2}\left[\frac{\alpha}{X_1} - \frac{\gamma\phi}{1 - \bar{h} - \phi X_1}\right]^{-1} \tag{11}$$

which is an expression for the optimal combinations of the two consumption goods X_1 and X_2 given the prices P_1 and P_2, the working time $\bar{h}$, and the parameters α, β, γ and ϕ, all of which are exogenous to the individual. Using this expression we can simulate what happens to the demand for X_1 and X_2 when $\bar{h}$ decreases, so that total leisure time $(L + \phi X_1)$ increases, both when total income is kept constant and when total income decreases due to the decreased working time, given certain values of the parameters in equation 11. A comparison can also be made when the increase in leisure time comes from different initial levels of leisure time, which is what we are interested in. Here we consider what happens when an individual retires, i.e. when $\bar{h}$ approaches zero while the income level is held constant, when the starting levels of leisure time are at the Swedish and US levels respectively.

How the demand for X_1, as well as X_2, changes as $\bar{h}$ changes depends on the parameters, the prices of the good, the initial level of $\bar{h}$ and whether the income level is fixed or not. In the framework of this paper, we consider X_1 to be leisure travel, a good that is time intensive as well as expensive, while X_2 is all other goods. In the simulation of the effect on the demand, we therefore assign ϕ to be 1, and P_1 to be 1.5 while P_2 is 1. This captures that one unit of leisure travel requires one unit of time (a full week of vacation requires all the time of that week e.g.) while the good is more expensive than the general level of all other monetary goods, X_2. Given the choice of a Cobb-Douglas utility function, α roughly represents how much of all expenditure is allocated towards X_1. In the case of leisure travel this is around 0.07, in pure money expenditure terms, given that you have a positive expenditure on leisure travel (based on the data that is used in this paper). For β and γ we allow the parameters to be equal, while having the sum of all parameters to equal to 1, which gives us 0.465 each.

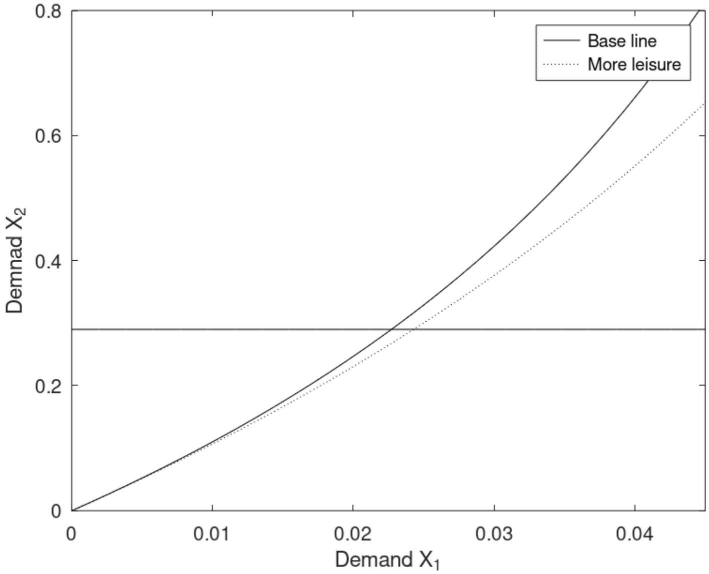
The choice of $\bar{h}$ determines the initial leisure time that the individual has at its disposal. Here, we are interested in comparing what happens when leisure time is increased in Sweden and the US. As $\bar{h}$ is a measure of how much of an individual's discretionary time that is spent at work, we must first consider how much discretionary time that is reasonable to have in a day. While a day consists of 24 hours, each individual must sleep and do a certain amount of other "mandatory" chores that also take up time of the day (cook, clean, grocery shopping and other activities that are not considered to be leisure activities). If we assume that 10 hours of the day goes to these "mandatory" activities the total amount of discretionary time in a day is 14 hours, or $365 \times 14 = 5110$ hours in a year. Comparing this with the estimated total work time per year and employee for Swedes and Americans, 1484 and 1772 hours respectively, as discussed in the previous section, this yields $\bar{h}_{\text{US}} = 1772/5110 = 0.35$ and

$\bar{h}_{\text{SE}} = 1484/1772 = 0.29$.

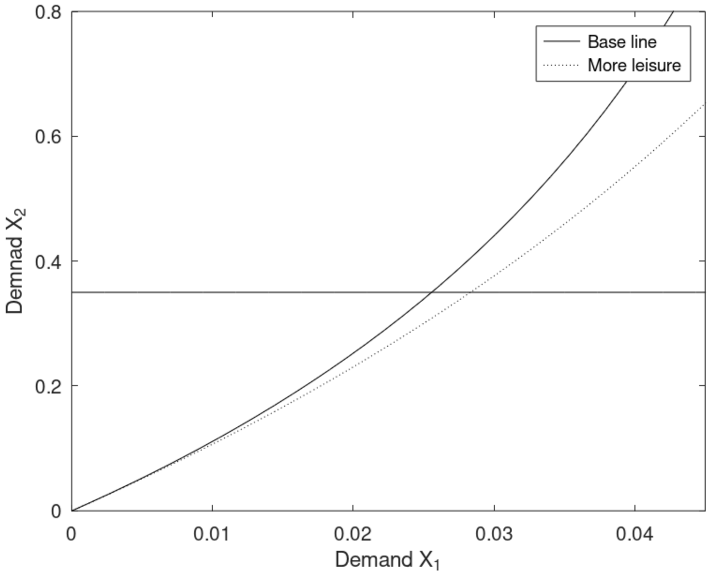
How the allocation between X_2 and X_1 changes as a result of retirement, from the different baseline levels of $\bar{h}$ that reflects the Swedish and US levels respectively, is shown in Figure 1. The curved line in the figures is the allocation line, equation 11, i.e. the allocation between X_1 and X_2 that the individual chooses to consume for different income levels (given the parameters). The close to horizontal lines in the figures is the monetary budget constraint, equation 2.

The intersection between the allocation line and the budget constraint determines how much of X_1 and X_2 that is consumed. When $\bar{h}$ goes to zero, the allocation line shifts outward and the change in consumption of X_1 and X_2 is the difference between the original intersection point and the new. As can be seen in Figure 1 (a), where the baseline leisure time is relatively high, as we use the Swedish level of leisure time, there is a small increase in the demand for X_1 (and decrease in the demand for X_2). When the baseline leisure time is relatively low however, the US case, the increase in the demand for X_1 is clearly higher, as can be seen in Figure 1 (b). The starting level of leisure time does thereby determine how the demand for the time intensive good changes when leisure time increases exogenously. The analysis here does of course depend on the chosen parameters, choices that might be debated, but the model illustrates that how much the demand for time intensive goods increases as leisure time increases depends on the starting level of leisure time: the higher the starting level is, the smaller the change in demand for the time intensive good is.

Figure 1: Effect on demand for good X_1 and X_2 when leisure time increases due to retirement, from different baseline levels of leisure time.



(a) Effect of retirement from a high baseline level of leisure time (baseline $\bar{h} = 0.29$)



(b) Effect of retirement from a low level of baseline leisure time (baseline $\bar{h} = 0.35$)

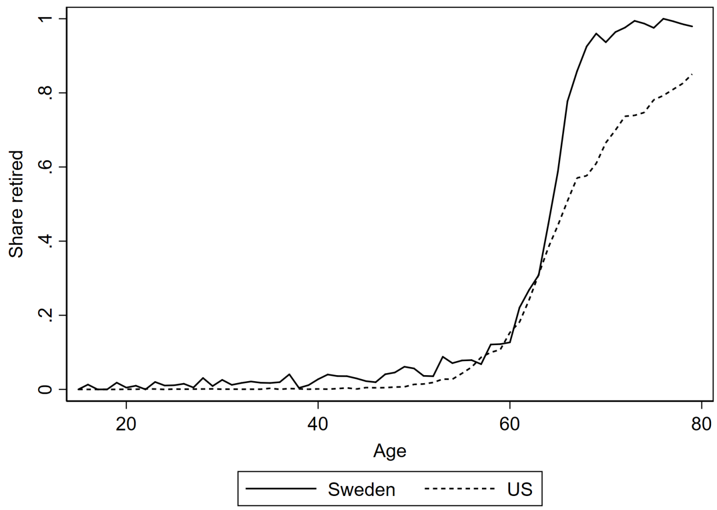
4 Data

This paper uses two consumer expenditure surveys: the Household Budget Survey (HBS, or HUT in Swedish) for Swedish households, collected by Statistics Sweden, and the Consumer Expenditure Survey (CE) for US households, collected by the U.S Bureau of Labor Statistics. Swedish data is a yearly repeated cross-section of randomly selected households between the years 2003-2009 and 2012 (no survey was made for 2010 and 2011). Hence there are new households each year, giving a total sample size of 17,924 households. The US data is quarterly, and follows the same randomly selected households for a full year, but each year there are new households in the sample. The US data is available for all years between 1980 and 2020, but since we in this paper are interested in a comparison between Sweden and the US, we use the same years that are available in the Swedish data in the main analysis. The total sample size in the US data is 88,390 households.

The available travel variables differ slightly between the two surveys. In the Swedish data, expenditure on domestic as well as international leisure travel is available. In the US, expenditure data on total leisure travel as well as expenditure on air travel tickets is available. In all cases it is strictly leisure expenses that are considered, work-related travel is excluded. From an emission standpoint, air travel in the US and international travel from Sweden (since this type of travel is made predominantly by air) are the most interesting variables, but the effect of increased leisure time is interesting for all types of variables.

Retirement is also defined slightly different in the Swedish and US data. In the US it is its own category, and an individual is retired if the main reason for not working the past 12 months is retirement. Due to this definition it is also not possible to see an individual move from being a worker to being retired, even with quarterly data. In Sweden, the retirement variable is combined with not working due to reasons of being a househusband or housewife, but given that the share of retired individuals has a clear spike after the age of 60, as can be seen in Figure 1, together with the culture in Sweden where it is relatively rare to be a stay-at-home husband or wife, a very large proportion of the individuals that are coded as retired should in fact be retired, especially in the age-group that is considered in the analysis. The two retirement variables, the

Figure 2: Average share of retired individuals per year of age. Based on Swedish data from the Swedish Household Budget Survey (collected by Statistics Sweden) and US data from the US Consumer Expenditure Survey (collected by the Bureau of Labor Statistic), for the years 2003-2009 and 2012.



US and Swedish, should therefore be comparable. Other drawbacks with the retirement variables are that no information is given on how long a person has been retired, nor from what they retired from.

When it comes to vacation in Sweden, the Swedish data neither includes information on offered vacation days nor on what type of employer an individual has. Given that only certain types of employees, primarily those working in the public sector, get the exogenous increase in vacation time when they turn 30 and 40, the age can only be considered as a proxy for this increase. Due to this, and since the major increase in vacation days happens when public sector employees turn 40, this will be the age that is analyzed in this paper. Also, as no one gets less vacation time at these ages, any time effects from those that are employed in the public sector should still be visible, especially since about 33 percent of the workforce in Sweden works for the public sector and since the increase in vacation days are large. Nevertheless, this is a clear drawback with the data as any potential effects from the extra vacation that some individuals

Table 1: Mean values of variables of interest in the age group 58–68 for US and Sweden, dependent on retirement status. Expenditure variables are in USD/year for the US and SEK/year for Sweden.

	US		Sweden	
	Workers	Retired	Workers	Retired
Total expenditure	41030	33343	355276	305871
Tot. leisure travel	1429	1406	17003	13554
Tot. leisure travel, positive*	5705	5788	28483	25486
Air travel	370	301	–	–
Air travel, positive*	3929	3639	–	–
Share, leisure travel	0.25	0.24	0.60	0.53
Share, air travel	0.094	0.083	–	–
Medical expenditures	765	671	4674	6750
Expenditure prescriptions	449	520	2598	3366
Age	61.8	64.3	61.3	64.8
Household size	2.06	1.96	1.91	1.79

*mean value conditional on expenditure on the good in question being positive

get when they turn 40 will be diluted by those who do not get this increase in vacation time.

In Table 1 descriptive statistics on some variables of interest are presented for the age group of interest in the retirement analysis. Different averages are presented for the retired and non-retired groups, for US and Sweden respectively. The expenditure levels are presented on a yearly basis for both countries, in SEK for Sweden and in USD for the US. Since the exchange rate between USD and SEK naturally was not fixed during the sample time, comparisons of values will be approximate. The exchange rate was roughly between 7–8 USD/SEK during this period and our income variable of choice (total expenditure) are quite similar in the US and Sweden based on this, although slightly lower in the US than in Sweden for both workers and retired. The average age in the working and retired groups are also very similar in the two countries. An interesting difference is however how many that take part in leisure travel. In Sweden more than 50 percent travels in a year, while the corresponding share of travelers in the US is only around 25 percent. In addition, the average expenditure on travel given that you have a positive expenditure is much larger in the US than it is in Sweden. Finally, we see that expenditure on health variables are larger in the retired group, particularly in Sweden, which indicates that it might be useful to control for this variable.

5 Econometric Strategy

As is evident in Table 1 in the previous section, a large share of the households in both Sweden and the US have zero expenditures on leisure travel in a given year. Traditional methods to handle data with corner solutions like these, or censored data as it sometimes is called, are e.g. the Tobit model by Tobin (1958) or hurdle models (see e.g. Amemiya (1984) for an overview). The aim with these models is to find an average effect, for the whole population, when the effect on both the probability to participate and the level is accounted for. In this paper we are however interested in these effects separately. For the effect of retirement, two different estimations are therefore made for each dependent variable and country of interest. First, the effect on the probability to have a positive expenditure on the leisure travel variable of interest is estimated using probit. Secondly, the effect on the expenditure levels on the different leisure travel variables of interest, for the households that have a positive expenditure on leisure travel, is estimated using ordinary least squares (OLS). This can therefore be seen as a decoupled two-part model, where the effects on the probability to participate in leisure travel and the level of expenditure, given that you are a traveler, are estimated separately.

The equations that are estimated are thereby given by:

$$\Pr(T_i > 0) = \Phi(\gamma_1 + \gamma_2 R_i + \mathbf{X_i}\gamma + \epsilon) \qquad \text{for } 58 \leq age_i \leq 68$$

and

$$T_i = \beta_1 + \beta_2 R_i + \mathbf{X_i}\beta + \epsilon \qquad \text{for } 58 \leq age_i \leq 68$$

where T_i is the household expenditure on the type of leisure travel that is considered (domestic, international or total leisure travel in Sweden and total leisure travel or leisure air travel in the US) and R_i is a dummy variable that indicates whether the household head is retired or not. $\mathbf{X_i}$ is a vector of control variables that includes the household's total expenditure (which is the chosen income variable), the age of the household head, household expenditure on medical services and prescriptions, whether the household head has a high education or not (bachelor's degree and above), number of individuals in the household, whether the household lives in an urban area or not, whether the household owns their home or not, the number of rooms that are in the home and whether the household head is a female or not. In addition, yearly time fixed effects are included in both the Swedish and US estimation and state fixed effects are included in the US estimation. The estimations are further made for households where the household head is between 58 and 68 years of age, to focus on those who are close to the average retirement age. Since the average retirement differ a bit depending on how you define retirement (both for Sweden and the US), different age groups are also considered in a sensitivity check.

Probit is the estimation method used to estimate the effects on the probability to have positive expenditure on leisure travel and $\Phi(\cdot)$ is therefore the cumulative standard normal distribution function. We are interested in the marginal effect of retiring, i.e. how much the probability of having a positive expenditure on the type of leisure travel in question on average changes when an individual retires. This is calculated using the package *margins* in Stata.

Given that the US data is quarterly, each household appears four times in the data set. Since correlation within the households are extremely likely, which deflates the standard errors if not accounted for, standard errors are clustered on a household level in the US estimations. In the Swedish estimations, this is not an issue since the data is yearly and each household only appears once. Robust standard errors are therefore used in the Swedish estimations.

For the effect of turning 40, similar estimations are made, given by the equations

$$\Pr(T_i > 0) = \Phi(\gamma_1 + \gamma_2 A_i + \mathbf{X_i}\gamma + \epsilon) \qquad \text{for } 35 \leq age_i \leq 44$$

and

$$T_i = \beta_1 + \beta_2 A_i + \mathbf{X_i}\beta + \epsilon \qquad \text{for } 35 \leq age_i \leq 44$$

where A_i instead is an indicator variable for whether the household head is 40 years old or above, our proxy variable for whether an individual gets more vacation time or not. The same control variables are used as in the retirement estimations, except for age (since this variable is perfectly correlated with A_i).

These estimations are further only made with the Swedish data, and the sample is restricted to 5 years before and 5 years after the vacation time has increased. This decision is made in order for the sample not to be too small, while at the same time not going too far away from the point where the increased vacation time happens. In a sensitivity analysis shorter time spans are also considered, at the cost of a smaller sample.

In both the retirement and vacation time estimation there are several sources of bias present. Starting with the effect of retirement, one obvious threat to identification is that individuals can self-select to retire. This results in an upward bias if they willingly retire early to be able to travel more, and a potential negative bias if they are forced to retirement for health reasons (as those health reasons likely make traveling more cumbersome). If any of these biases are present, we would however expect to see a variance in estimated coefficients when different age groups are considered. This type of robustness check is therefore considered in section 7. Health issues are also in part controlled for.

Another potential issue is that it can be argued that different "income classes" are compared in the estimation. The income control variable will result in a comparison between households that have the same total expenditure, but differ in retirement status. The advantage with this approach is that we can analyze the effect of retirement, while holding income (or total expenditure in this case) fixed. This is vital to isolate the leisure time effect of retirement from the income effect of retirement. As retired individuals on average consume less than their working counterparts this can however also result in a bias if there are cultural differences in traveling decisions based on the perceived "income class" that the individual is part of, since a retired individual from a higher income class will be compared with a working individual from a lower income class. Since the estimation of the effect on expenditure levels is made on households with a positive expenditure, we do however know that they already are "travelers", i.e. at least have the "habit" of traveling, and it is not unlikely that the total income is much more important in the travel decision than perceived income class. Similarly, if such a cultural effect is present it is likely that it will be present in both Sweden and in the US.

Thirdly, the use of expenditure on leisure travel as the main dependent variable is also a source of concern due to differences in prices of leisure travel over the year. A working individual will in many cases be “forced” to travel at the most popular times of the year, when the cost of travel is the highest, while a retired individual has a much bigger flexibility to choose cheaper travel options on less popular times. The retired individual may therefore be able to travel more with the same travel budget, which results in a negative bias in the estimation on the effect on expenditure. This is however not the case for the probability estimation.

For the effect of turning 40, fewer potential biases are present. The main concern is omitted variable bias, especially as the age span that is considered is quite wide. Since some 35 year olds are compared with 44 year olds, it is not impossible that there are variables that are not controlled for that correlates with both the age and the travel decisions. Such variables could e.g. be job security, family situation (a part from the number of household members, which is controlled for), or simply that the taste for traveling changes with age. This is addressed in part by the sensitivity analysis that restricts the age-span considered, but at the same time this introduces issues with a smaller sample. In addition, the fact that only a share of the sample actually gets more vacation days at these ages is also a concern as the potential effect becomes diluted by the ones that do not get extra vacation days, as discussed in the previous section. The concerns for bias that have been listed, for both the effect of retirement and of extra vacation days, will be addressed further in section 7 and discussed together with the results in section 8.

6 Main results

Here the main results of the paper are presented. These results are discussed together with the theoretical predictions and potential identification issues in section 8.

Starting with retirement, the effect that it has on the probability and expenditure levels of leisure travel in Sweden is presented in Table 2. As can be seen, retirement has no significant effect on the expenditure levels for those households that have a positive expenditure on the different types of leisure travel that are considered. No significant effect can be seen on the expenditure level either for domestic, international or the aggregated total leisure travel. When it comes to the marginal effect on the probability of having a positive expenditure on leisure travel, retirement has a positive effect on the probability to spend money on domestic travel of about 3 percent. This can be interpreted as the probability to travel domestically increases by 3 percent when a person retires. However, the corresponding probability effect on international travel is negative, at about minus 6 percent. There therefore seems to be some substitution effects going on when a person retires: travel abroad is reallocated to travel within Sweden. In addition, the aggregate effect is negative as the effect on the probability to consume all types of leisure travel (the aggregate of domestic and international travel) is negatively affected by retirement, as this effect is negative at about minus 4 percent. Overall therefore, the propensity to travel seems to be lower after retirement than before, at the same time as the expenditure levels are not significantly different.

For the US, the results are quite different, as can be seen in Table 3. The expenditure by those who have a positive expenditure on leisure and air travel respectively both increase due to retirement, and the effects are significant. The expenditure on total travel increases by USD 263 per quarter, while the expenditure on air travel increases by USD 104 per quarter, translating into an increase in leisure travel expenditure of more than 1000 dollars on a yearly basis. In addition, the probability to spend money on leisure travel increases by about 2 percent due to retirement, while the probability to travel by air is unchanged.

The effects on travel demand from turning 40 in Sweden, our proxy variable for increased vacation, are presented in Tables 4. As can be seen, turning 40 has no significant effect on either the probability to travel, nor on the expenditure levels, for any type of leisure travel.

Table 2: Effect of retirement on the probability and expenditure levels of domestic, international and total leisure travel in Sweden. Probit is used to estimate the effect on the probability to travel, OLS to estimate the effect on expenditure for the households that have a positive expenditure on the type of travel in question. Estimations are made for the sub-sample of households that have a household head that is between 58 and 68 years old.

VARIABLES	Domestic, marginal prob. effect	Domestic, SEK/year	International, marginal prob. effect	International, SEK/year	Total, marginal prob. effect	Total, SEK/year
Retired	0.0341**	-587.1	-0.0615***	222.5	-0.0440**	182.8
	(0.0158)	(624.0)	(0.0216)	(1,818)	(0.0217)	(210.2)
Total expenditure	1.43e-07***	0.00550**	5.48e-07***	0.0403***	6.08e-07***	0.00191**
	(3.33e-08)	(0.00241)	(8.29e-08)	(0.00652)	(8.59e-08)	(0.000833)
Age reference person	0.00822***	87.30	0.00271	144.0	0.00571*	77.13**
	(0.00253)	(108.4)	(0.00340)	(300.7)	(0.00338)	(37.11)
Medical services	-4.93e-07	0.0105	-4.92e-07	-0.0603**	-9.31e-07**	-0.00100
	(3.08e-07)	(0.0224)	(3.89e-07)	(0.0287)	(3.79e-07)	(0.00770)
Prescriptions	-1.66e-06*	-0.000796	1.10e-06	0.0485	-1.85e-07	-0.0198
	(1.00e-06)	(0.0431)	(1.34e-06)	(0.101)	(1.33e-06)	(0.0128)
High education	0.0211	819.3	0.101***	4,475***	0.0893***	250.1
	(0.0149)	(579.8)	(0.0206)	(1,543)	(0.0209)	(199.4)
Household size	-0.00342	1,257***	-0.000572	3,126***	-0.00970	330.2*
	(0.0120)	(476.5)	(0.0164)	(1,127)	(0.0165)	(186.3)
Urban	-0.0225	769.8	0.114***	2,974**	0.0924***	-234.7
	(0.0141)	(486.4)	(0.0184)	(1,376)	(0.0183)	(188.8)
Owned living	0.0100	952.0*	0.0576***	3,054**	0.0541**	197.0
	(0.0166)	(503.7)	(0.0213)	(1,543)	(0.0211)	(186.3)
Nr. of rooms	0.00513	-4.010	0.0183***	141.8	0.0168**	-18.12
	(0.00471)	(185.8)	(0.00655)	(494.3)	(0.00663)	(66.31)
Female	-0.0518***	-891.6	-0.0292*	-1,976	-0.0430**	-528.5***
	(0.0132)	(581.0)	(0.0176)	(1,369)	(0.0175)	(189.2)
Time FE's	YES	YES	YES	YES	YES	YES
Constant		-5,018		-11,055		-4,126*
		(6,837)		(19,052)		(2,346)
Observations	2,961	460	2,961	1,533	2,961	1,689
R-squared		0.128		0.149		0.038

Standard errors in parentheses

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

Table 3: Effect of retirement on the probability and expenditure levels of total leisure travel and air travel in the US. Probit is used to estimate the effect on the probability to travel, OLS to estimate the effect on expenditure for the households that have a positive expenditure on the type of travel in question. Estimations are made for the sub-sample of households that have a household head that is between 58 and 68 years old.

VARIABLES	Total travel, marginal prob. effect	Total travel, USD/quarter	Air travel, marginal prob. effect	Air travel, USD/quarter
Retired	0.0211***	262.5***	0.00150	104.2**
	(0.00579)	(57.57)	(0.00391)	(47.90)
Total expenditure	1.02e-05***	0.0797***	4.07e-06***	0.0353***
	(4.25e-07)	(0.00880)	(1.88e-07)	(0.00968)
Age reference person	-0.000644	16.29*	2.71e-05	6.114
	(0.000858)	(9.001)	(0.000568)	(7.577)
Medical services	6.85e-06*	-0.0760*	7.65e-07	-0.0694
	(3.69e-06)	(0.0433)	(2.00e-06)	(0.0429)
Prescriptions	1.20e-05	-0.238**	7.63e-06	-0.299***
	(8.48e-06)	(0.115)	(4.83e-06)	(0.109)
High education	0.0787***	220.3***	0.0474***	153.3***
	(0.00558)	(54.13)	(0.00358)	(47.85)
Household size	-0.0204***	-105.5***	-0.00893***	-3.701
	(0.00254)	(22.74)	(0.00174)	(20.92)
Urban	-0.0142	32.44	0.0261***	-89.48
	(0.0109)	(79.59)	(0.00839)	(87.68)
Owned living	0.0725***	126.4*	0.0264***	35.21
	(0.00768)	(65.19)	(0.00524)	(64.49)
Nr. of rooms	0.00511***	26.59	0.00234***	-9.568
	(0.00134)	(18.45)	(0.000808)	(20.34)
Female	-0.00625	-60.53	0.00846**	-17.46
	(0.00498)	(57.58)	(0.00332)	(59.02)
Time FE's	YES	YES	YES	YES
State FE's	YES	YES	YES	YES
Constant		-1,536***		-23.98
		(581.6)		(499.3)
Observations	26,684	8,921	26,684	3,254
R-squared		0.213		0.183

Standard errors in parentheses

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

Table 4: Effect of turning 40 on the probability and expenditure levels of domestic and international leisure travel in Sweden. Probit is used to estimate the effect on the probability to travel, OLS to estimate the effect on expenditure for the households that have a positive expenditure on the type of travel in question. Estimations are made for the sub-sample of households that have a household head that is between 35 and 44 years old.

VARIABLES	Domestic, marginal prob. effect	Domestic, SEK/year	International, marginal prob. effect	International, SEK/year
Forty	0.0125	-73.84	0.0225	750.7
	(0.0132)	(725.7)	(0.0190)	(1,493)
Total expenditure	1.06e-07***	0.0117***	6.82e-07***	0.0472***
	(3.12e-08)	(0.00227)	(6.75e-08)	(0.00724)
Medical services	6.26e-07	-0.0234	8.99e-08	-0.0674
	(5.70e-07)	(0.0166)	(8.72e-07)	(0.0696)
Prescriptions	-1.37e-06	-0.00728	-2.96e-06*	-0.337***
	(1.41e-06)	(0.0783)	(1.80e-06)	(0.123)
High education	0.0491***	-31.81	0.102***	1,626
	(0.0138)	(747.3)	(0.0205)	(1,502)
Household size	-0.0172***	-658.1**	-0.0491***	339.1
	(0.00571)	(311.5)	(0.00853)	(663.5)
Urban	-0.0179	-810.3	0.0755***	3,859**
	(0.0151)	(782.4)	(0.0220)	(1,661)
Owned living	0.0209	-23.58	0.0338	771.7
	(0.0162)	(761.3)	(0.0229)	(2,165)
No. of roomsAntal rum i bostaden	0.000630	181.4	0.00246	-226.3
	(0.00435)	(245.8)	(0.00651)	(606.2)
Female	0.00327	-1,235*	0.00179	3,086**
	(0.0133)	(708.3)	(0.0192)	(1,449)
Time FE's	YES	YES	YES	YES
Constant		4,931***		-1,269
		(1,457)		(3,410)
Observations	2,505	318	2,505	1,215
R-squared		0.178		0.177

Standard errors in parentheses

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

7 Robustness analysis

Here we consider how robust the estimated coefficients are to changes in the age groups that are considered in the estimations, as well as a step-wise addition of the included control variables. The robustness with respect to age groups can give some indication of whether self-selection issues are present, as well as a general sense of how stable the estimates are. The robustness analysis with respect to the step-wise inclusion of control variables can give some sense of how large a potential omitted variable bias might be, and just as for the age-group analysis stable estimates provide more confidence in the robustness of the main estimates. In addition, robustness of the results to alternative definitions of the retirement variable is considered.

Starting with age groups, Table 5 show the estimated coefficients for the retirement dummy variable for the different specifications when different age groups are used for the estimation. The type of estimation, whether it is probit or OLS on the households with positive expenditure that is used and which the dependent variable is, is given in the first column. In all cases the same set of covariates that are used in the main estimations are included, but for brevity only the coefficient for retirement is presented.

For Sweden, we can see that the coefficients for the expenditure estimations jump around a bit both for domestic, international and total leisure travel. This is expected when the estimates are non-significant and does not provide anything of value, other than that the main effects likely are low or close to zero. For the probability estimates, we see that the probability to travel domestically increases as the age groups become higher. Similarly, the probability to travel internationally is the most negative, and significant, for the lowest age group (55-65 year-olds) and this effect then becomes less negative as the age groups increase in age. For the highest age groups the coefficients are no longer significant. The same pattern is seen for the effect of retirement on the probability to travel at all (total travel). In addition to retirement, the age of the household head therefore seems important in how large the effect of retirement on the probability to travel is in Sweden. While age is controlled for in each estimation, only the effect of age within the sub-sample that is used can be controlled for, and as we see trends in how retirement affects the probability of leisure travel as the age groups changes it is likely that these estimates are biased by the effect of the age of the individuals that are included in the sample. That the probability to travel domestically increases with age, due to a substitution from international travel, is also not surprising as domestic travel is more convenient than international travel. It is however surprising that the biggest negative probability effects on international travel are found in the youngest age group. Overall therefore, the interpretation of the effects from retirement on the probability for Swedes to travel should be treated with some caution.

For the effects of retirement in the US, the stability of the significant estimates are much higher. The effect on the probability to travel is stable, and around 2 percent, for all age groups except for the three highest (63–73, 64–74 and 65–75) where the effect is slightly lower. The effect on expenditure on total leisure travel is also stable, and slightly below 300 dollars per quarter. The lowest age group has the highest effect, 352 dollars, which could be an indication of self-selection bias, but since there is no clear trend over the age group and the variability is low this is likely a random difference. The effect on expenditure on air travel is also moderately stable, and over all around 100 dollars per quarter except for the lowest age group. There is some indication of an increasing trend as the age groups gets higher, but this is also not surprising as flying might be more convenient than e.g. car or train rides and therefore more preferred by older retired individuals than younger. Overall therefore, the US estimates seem robust with respect to the considered age groups.

For the estimations of the effects of turning 40, a different age group robustness check is made. Since in comparison with retirement, the age limit is fixed, the change of age groups that is of interest is the width of the age span around 40. Given that none of the main estimates were significant, this robustness check is of less interest. Nevertheless, they are made and the results are presented in Table A1 in Appendix A.1, where five different age spans are considered around 40. As expected, there is quite a lot of variability in the coefficients (especially for the expenditure estimation) and most of the coefficients are still not significant. A few significant coefficients appeared, but given the general instability in the estimates these are likely to be random events.

Table 5: Probability and expenditure effects of retirement using different age groups between 55 and 75. The type of leisure travel and estimation is given in the far left column.

AGE SPAN:	55-65	56-66	57-67	58-68	59-69	60-70	61-71	62-72	63-73	64-74	65-75
Swedish data											
Dom. travel,	0.0375**	0.0353**	0.0362**	0.0341**	0.0356**	0.0368**	0.0422**	0.0453**	0.0508**	0.0790***	0.0714**
probability	(0.0156)	(0.0153)	(0.0155)	(0.0158)	(0.0167)	(0.0180)	(0.0187)	(0.0201)	(0.0221)	(0.0255)	(0.0304)
Dom. travel,	120.2	-513.8	-684.1	-587.1	-1,282	-787.1	-830.6	-802.2	-470.1	-686.6	-1,198
expenditure	(189.0)	(577.6)	(606.3)	(624.0)	(806.1)	(776.9)	(803.1)	(834.4)	(884.9)	(1,159)	(1,428)
Int. travel,	-0.0822***	-0.0823***	-0.0631***	-0.0615***	-0.0707***	-0.0679***	-0.0510**	-0.0403	-0.0191	-0.0133	-0.00691
probability	(0.0220)	(0.0213)	(0.0213)	(0.0216)	(0.0223)	(0.0228)	(0.0234)	(0.0246)	(0.0264)	(0.0294)	(0.0343)
Int. travel,	-77.34	1,045	246.7	222.5	1,249	-127.9	-774.0	-521.0	-1,384	-1,165	-1,808
expenditure	(1,706)	(1,754)	(1,818)	(1,818)	(2,000)	(2,194)	(2,269)	(2,383)	(2,622)	(3,002)	(3,748)
Total. travel,	-0.0548**	-0.0565***	-0.0426**	-0.0440**	-0.0533**	-0.0509**	-0.0393*	-0.0290	-0.00992	0.0119	0.0134
probability	(0.0219)	(0.0213)	(0.0213)	(0.0217)	(0.0224)	(0.0230)	(0.0236)	(0.0249)	(0.0268)	(0.0299)	(0.0353)
Total. travel,	-1,013	68.19	-313.3	-176.1	502.5	-529.3	-837.4	-567.4	-924.3	-1,032	-1,853
expenditure	(1,578)	(1,637)	(1,709)	(1,717)	(1,884)	(2,041)	(2,123)	(2,241)	(2,464)	(2,864)	(3,518)
US Data											
Tot.travel,	0.0188***	0.0207***	0.0235***	0.0211***	0.0196***	0.0195***	0.0180***	0.0170***	0.0108*	0.0114*	0.0120**
probability	(0.00637)	(0.00609)	(0.00590)	(0.00579)	(0.00570)	(0.00558)	(0.00558)	(0.00558)	(0.00564)	(0.00580)	(0.00593)
Tot.travel,	352.2**	291.3***	227.4***	262.5***	265.1***	246.8***	257.7***	283.4***	299.1***	276.4***	249.7***
expenditure	(145.5)	(63.33)	(59.27)	(57.57)	(57.06)	(55.31)	(55.01)	(57.89)	(58.99)	(60.69)	(62.91)
Air travel,	0.00228	0.00436	0.00268	0.00150	0.000183	-0.000825	-0.000526	-0.00114	-0.00171	-0.00107	-0.000514
probability	(0.00429)	(0.00411)	(0.00398)	(0.00391)	(0.00382)	(0.00371)	(0.00366)	(0.00365)	(0.00368)	(0.00374)	(0.00383)
Air travel,	64.47	103.4**	96.36*	104.2**	116.5**	106.2**	114.9**	180.8***	188.3***	156.1***	137.5***
expenditure	(52.03)	(50.73)	(49.30)	(47.90)	(49.34)	(47.48)	(49.10)	(58.65)	(60.57)	(52.16)	(53.30)

Coefficients for the indicator variable for retirement, all covariates included in the estimations but excluded here. Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Turning now to the step-wise addition of covariates. These are made for all of the considered specifications, but to save space only two of these robustness checks are included here (the others are available in Appendix A.2 for the retirement estimations and Appendix A.3 for the effect of turning 40, for reference). In Table 6, we see how sensitive the estimated effect on the probability to travel domestically in Sweden changes when the included covariates are sequentially added to the estimation. The coefficients are stable overall, but we see that the age of the household head is particularly important as the inclusion of this variable halves the estimated effect of retirement. After the inclusion of age the coefficients are stable around 3 percent. This is interesting given the previous age-group robustness check: age definitely seems to be important for the probability to travel domestically in Sweden. Interestingly, age does not have the same effect on the estimated coefficient of the probability to travel internationally, as can be seen in Table A2 in Appendix A.2.

Table 6: Step-wise addition of covariates for the probability to travel domestically in Sweden

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Retired	0.0538***	0.0610***	0.0308*	0.0328**	0.0356**	0.0356**	0.0350**	0.0355**	0.0322**	0.0341**
	(0.0133)	(0.0133)	(0.0158)	(0.0158)	(0.0158)	(0.0158)	(0.0158)	(0.0158)	(0.0159)	(0.0158)
Total expenditure		1.43e-07***	1.42e-07***	1.55e-07***	1.44e-07***	1.47e-07***	1.52e-07***	1.43e-07***	1.49e-07***	1.43e-07***
		(3.07e-08)	(3.06e-08)	(3.14e-08)	(3.16e-08)	(3.32e-08)	(3.34e-08)	(3.38e-08)	(3.37e-08)	(3.33e-08)
Age			0.00852***	0.00869***	0.00848***	0.00844***	0.00857***	0.00836***	0.00862***	0.00822***
			(0.00254)	(0.00253)	(0.00252)	(0.00253)	(0.00253)	(0.00253)	(0.00254)	(0.00253)
Medical services				-5.30e-07*	-5.16e-07*	-5.18e-07*	-5.29e-07*	-5.19e-07*	-5.34e-07*	-4.93e-07
				(3.14e-07)	(3.12e-07)	(3.11e-07)	(3.08e-07)	(3.07e-07)	(3.10e-07)	(3.08e-07)
Prescriptions				-1.54e-06	-1.46e-06	-1.46e-06	-1.43e-06	-1.39e-06	-1.60e-06	-1.66e-06*
				(1.01e-06)	(1.00e-06)	(1.00e-06)	(1.01e-06)	(1.01e-06)	(1.00e-06)	(1.00e-06)
High education					0.0295**	0.0293**	0.0308**	0.0281*	0.0224	0.0211
					(0.0148)	(0.0148)	(0.0148)	(0.0149)	(0.0150)	(0.0149)
Household size						-0.00289	-0.00399	-0.00908	-0.00483	-0.00342
						(0.0111)	(0.0112)	(0.0119)	(0.0120)	(0.0120)
Urban							-0.0240*	-0.0222	-0.0230	-0.0225
							(0.0141)	(0.0142)	(0.0141)	(0.0141)
Owned living								0.00951	0.00809	0.0100
								(0.0167)	(0.0166)	(0.0166)
No. of rooms								0.00541	0.00539	0.00513
								(0.00470)	(0.00469)	(0.00471)
Female									-0.0519***	-0.0518***
									(0.0132)	(0.0132)
Year FEs										YES
Observations	2,963	2,961	2,961	2,961	2,961	2,961	2,961	2,961	2,961	2,961

Standard errors in parentheses

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

Table 7: Step-wise addition of covariates, expenditure on total leisure travel in the US, OLS estimations on households with a positive expenditure

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Retired	20.97	269.4***	240.9***	253.1***	274.6***	271.7***	267.6***	263.1***	267.3***	262.5***
	(60.09)	(53.80)	(57.05)	(57.20)	(56.81)	(56.72)	(56.93)	(57.55)	(57.28)	(57.57)
Total expenditure		0.0798***	0.0799***	0.0815***	0.0796***	0.0804***	0.0803***	0.0807***	0.0802***	0.0797***
		(0.00756)	(0.00759)	(0.00798)	(0.00810)	(0.00826)	(0.00828)	(0.00867)	(0.00862)	(0.00880)
Age			12.73	14.14	15.99*	13.84	14.34	14.04	15.58*	16.29*
			(8.860)	(9.006)	(8.948)	(8.817)	(8.803)	(8.816)	(8.945)	(9.001)
Medical services				-0.0600	-0.0678	-0.0665	-0.0670	-0.0704	-0.0739*	-0.0760*
				(0.0422)	(0.0424)	(0.0424)	(0.0425)	(0.0432)	(0.0431)	(0.0433)
Prescriptions				-0.297***	-0.283**	-0.274**	-0.272**	-0.286**	-0.285**	-0.238**
				(0.114)	(0.114)	(0.112)	(0.112)	(0.113)	(0.113)	(0.115)
High education					285.4***	273.8***	267.6***	228.7***	216.6***	220.3***
					(53.89)	(55.08)	(54.94)	(52.99)	(52.73)	(54.13)
Household members						-80.74***	-80.55***	-98.13***	-94.67***	-105.5***
						(25.59)	(25.59)	(23.66)	(23.20)	(22.74)
Urban							161.6**	171.4**	128.2*	32.44
							(65.98)	(66.84)	(67.48)	(79.59)
Owned living								127.6**	129.3**	126.4*
								(64.41)	(64.18)	(65.19)
Rooms								23.57	22.98	26.59
								(17.67)	(17.53)	(18.45)
Female									-43.00	-60.53
									(55.76)	(57.58)
Year FE:s									YES	YES
State FE:s										YES
Constant	1,426***	104.3	-683.5	-736.9	-955.0	-662.0	-836.0	-1,047*	-1,500***	-1,536***
	(34.58)	(108.7)	(594.0)	(601.3)	(593.9)	(571.9)	(569.9)	(564.0)	(581.6)	(581.6)

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

In Table 7, the results of the step-wise addition for total leisure travel expenditures in the US are presented. As can be seen, it is crucial to control for the total expenditure of the household. Without that variable, no effect of retirement is present (although, it is in itself quite interesting that the effect is not negative without total expenditure included). After the inclusion of total expenditure, the estimated effect of retirement on the households that have a positive expenditure on leisure travel is however stable for the inclusion of all other covariates. Similar stability is found for the expenditure on air travel, as well as on the probability to have a positive expenditure on leisure travel in the US, as can be seen in Tables A7 and A9 in Appendix A.2.

Finally, the definition of the retirement variable (or more specifically: the definition of who is not retired) might also be important, and the estimates should be stable to variations in this definition. In the main estimation, retired individuals are compared with everyone else that is not retired. This

Table 8: Comparison of effects with different definitions of not being retired for Sweden. All covariates included in all estimations, but not included here.

VARIABLES	Probit dom.	OLS dom.	Probit int.	OLS int.	Probit. tot.	OLS tot.
Retired	0.0341**	-587.1	-0.0615***	222.5	-0.0440**	182.8
	(0.0158)	(624.0)	(0.0216)	(1,818)	(0.0217)	(210.2)
Retired2	0.0231	-519.0	-0.0769***	1,105	-0.0613***	158.6
	(0.0175)	(617.8)	(0.0233)	(1,727)	(0.0234)	(211.1)
Retired3	0.0317**	-678.8	-0.0695***	113.8	-0.0520**	152.3
	(0.0161)	(634.9)	(0.0218)	(1,836)	(0.0219)	(212.5)

Standard errors in parentheses

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

includes e.g. unemployed individuals. This might seem counter-intuitive as we are interested in the increase in leisure time that comes from retirement, and unemployed individuals have the same amount of leisure time as retired individuals (as they are not working). However, since we do not know the background of those who are retired, and some individuals likely retired from unemployment, this definition is considered to be the most representative. Nevertheless, it is important to investigate whether the specific definition of the retirement variable is driving the results. This is done in Table 8 and 9, where Retired is the definition that is used in the main estimations, Retired2 defines a non-retired individual as an employed individual (in the US, a full-time employed individual) and Retired3 defines a non-retired individual as someone who has any type of work, not just those who are employed.

As can be seen, the estimates are stable to the type of retirement variable that is used. In particular, the effect on leisure and air travel expenditure in the US is very stable. The same goes for the effects of retirement on the probability to travel in Sweden. The exact definition of the retirement variable does therefore not seem to be driving the results.

Overall, the US estimates of the effect of retirement seem to be robust. The effects in Sweden continue to be non-significant for the expenditure estimations, and some instability is found on the effect of retirement on the probability to travel. In particular, the probability seems to be affected by age, and that this

Table 9: Comparison of effects with different definitions of not being retired for the US. All covariates included in all estimations, but not included here.

VARIABLES	Probit total	OLS total	Probit airfare	OLS airfare
Retired	0.0211***	262.5***	0.00150	104.2**
	(0.00579)	(57.57)	(0.00391)	(47.90)
Retired2	0.0230***	266.8***	-0.00204	89.19
	(0.00743)	(72.82)	(0.00499)	(55.76)
Retired3	0.00579	243.4***	-0.00465	98.44**
	(0.00630)	(58.91)	(0.00430)	(46.29)

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

effect is not completely captured by controlling for age due to the relatively narrow age groups that are used in the estimations. The robustness checks on the effect of turning 40 enforces the main estimation, where no effect is found on either the probability to travel nor the expenditure levels.

8 Discussion

The theoretical model that is derived in section 3 predicts that the effect on the demand for a time intensive good when leisure time increases will be different depending on the starting level of leisure time. The lower the level of initial leisure time is, the higher the increase in demand for the time intensive good when the individual retires. Using the derived model, the effects of retirement in the US and Sweden are simulated using the average annual working hours per employee in each country. The model predicts that the demand for leisure travel should increase in both Sweden and the US, but that the increase in demand is larger in the US than in Sweden, as a result of the lower level of baseline leisure time in the US.

The empirical results support these theoretical predictions insofar that the effects are considerably larger in the US than in Sweden. The estimated effects, in terms of differences between Sweden and the US, do however seem to be bigger than what the theoretical model predicts. For households who have a positive expenditure on leisure travel in the US, the effect of retirement is an increase on travel expenditures by more than a thousand dollars per year. Compared to the average expenditure on leisure travel, conditional on being a traveler (as given in Table 1 in section 4), this is an increase of almost 18 percent. In Sweden, the corresponding figure is 183 Swedish crowns per year (roughly 20 dollars), which would correspond to an increase by less than 1 percent if the effect was significant. While absence of significant results does not provide evidence for a nonexistent effect, the standard errors in this estimation are relatively narrow, indicating that an effect (if present) is small at best. The empirical results therefore suggest that the point where increases in leisure time has a negligible effect on the demand for leisure travel comes sooner than what the theoretical model predicts, potentially already at 5-6 weeks of vacation time since no significant effect of turning 40 is found either.

This analysis does however stand on the credibility of the estimated results, and as mentioned in section 5 there are several potential biases and other issues to consider. One potential issue is that individuals could self-select into an earlier retirement to travel more, which would cause an upwards bias to the estimated effects of retirement. Given the stability of the US estimates when different age groups are used, this is however unlikely to be a major issue in the estimation. A similar issue could be that individuals make the trip of their lifetime to celebrate that they are retired. This could very well be the case, but in a way this is part of the effect that we try to estimate as the amount of available vacation time likely is a limiting factor in the "trip of a lifetime" scenario. As there are no effects from retirement on the expenditure on leisure travel in Sweden, this also speaks for the fact that if a "trip of a lifetime" scenario is present it is only present in the US.

A third potential issue is that retired individuals on average have a lower income than when they were working and, as a result of the income control variable, are compared with working individuals that have the exact same income level. The retired individual could therefore perceive themselves to be part of a higher "income class", or have a different set of travel behaviors due to their previous income class, than the working individuals that they are compared with. It might be that these individuals travel more due to past habits, from the previous income level, which would bias the results upwardly. Once again however, this would be the case in both Sweden and the US (assuming that the travel behaviors due to previous income classes are the same in these countries of course), and since we only see a positive effect from retirement in the US this behavioral, or cultural, effect from previous income levels is also likely to be limited.

Another potential issue is that the dependent variable in the expenditure estimations does not correlate perfectly with distance traveled or number of trips, since the cost of traveling changes over the year, being more expensive in popular times than less popular times. As the retired individuals have a much higher flexibility for booking trips than working individuals, it is likely that they can travel more for the same amount of money. This would result in a negative bias for the estimated coefficients. It is therefore likely that the true effect of retirement in the US is higher than observed, while there might also be actual effects from retirement on the expenditure levels in Sweden too. Since this data issue does not affect the probability estimation however, and we see negative probability effects at the aggregate level in Sweden, this does however speak for the case that retirement has a low effect on the demand for leisure travel in Sweden, if any.

The limitations in data when it comes to the estimation of the effect of getting more vacations days are also very large. Approximately 33 percent of the sample that is used should get more vacation days when they turn 40, and given that the sample size already is quite small for the age groups that are considered it is not unlikely that the absence of effects on travel demand comes from the lack of more exact data. Given how big the increase in vacation time is for the group that gets it however, it is not unreasonable that an effect, if present, should be visible in the estimation, even if it would be negatively biased. The state employees get 4 more days, an increase of 13 percent, and the municipal and regional government employees (which together accounts for 25 percent of the workforce in Sweden) get 6 more days, an increase of a whopping 24 percent. While this estimation is less robust than the retirement estimations, the lack of significant effects at least tells us that an effect of more vacation days, if present, likely is small.

9 Conclusion

In this paper, the effect that increased leisure time has on the demand for leisure travel, when the starting level of leisure time is different, is examined theoretically as well as empirically estimated. A simple theoretical model is derived, where the demand for a time intensive good is compared with a good that does not require any time to consume, and it is shown that the amount of baseline leisure time an individual has affects how the demand for the time intensive good changes when leisure time is exogenously increased. If the starting level of leisure time is high, the effect on the demand for the time intensive good is smaller than when the starting level is low, given that income is held constant.

To test this empirically, we compare the effect of retirement in two countries that have different levels of baseline leisure time, namely Sweden and the US. The results are that retirement has a clear positive effect on the demand for leisure travel in the US, both on the probability to participate in leisure travel as well as on the expenditure levels, given that you have a positive expenditure on leisure travel. In Sweden on the other hand, no significant effects on the expenditure levels are found, neither for domestic or international travel, while the total probability effect is negative: i.e. that retirement has a negative effect on the probability to travel, when the aggregate of international and domestic travel is considered. In addition, we use turning 40 as a proxy variable for getting extra amount of vacation days in Sweden, as roughly 33 percent of the working population get between 4–6 more vacation days at this age, to estimate if there is an effect on the demand for leisure travel from getting more vacation time in Sweden. No such effects are however found either, neither on the probability to travel nor on the expenditure levels.

The empirical results therefore support the theoretical predictions, since the effects from retirement are larger in the US than in Sweden, but the difference in the estimated effects is larger than what is predicted by the model. In particular, the empirical results suggest that increases in leisure time have a positive effect on the demand for leisure travel, but only up to a certain point where further leisure time alone has little to no effect on the demand for leisure travel. While the effect of more leisure time becomes smaller and smaller in the derived model, it does not capture a complete stagnation in the demand for the time intensive good. Since most individuals that retire in Sweden have around 6–7 weeks of vacation, the evidence suggests that this is the level of baseline leisure when the demand for leisure travel is more or less unaffected by further increases in leisure time (given that the income levels do not go up at the same time). The lack of an effect when individuals turn 40 could suggest that this level comes even earlier, but due to data restrictions this lack of effect can not be interpreted as confidently as the results from the retirement estimation. Of course, we must also be careful not to interpret the lack of significant effects in the retirement estimation as zero effects, simply because no significance is found. It is possible that there are positive effects present in Sweden as well, even if no significance is found. The standard errors in the Swedish estimations are however relatively narrow, which indicates that the effects, if present at all, are small.

These results have several implications. Firstly, the results have implications for potential environmental effects from either a deliberate "down shift" of from decreased work-time due to increased automation. If income is kept when the leisure time increases, the results indicate that the demand for leisure travel will increase up to a point, likely around 6-7 weeks of vacation, and then stagnate. If income is lowered while leisure time increases, a small rebound effect is likely to happen if the starting leisure time is low, but not when the individual has a high enough level of baseline leisure time. A down shift strategy might therefore work quite well, especially if workers already have access to ample vacation time. Secondly, the results also give an indication of how close to an optimal work time workers in the studied countries are. Since the effect on leisure travel in the US is so large, this indicates that the US population is overemployed, i.e. that they work more than they would like to if they were free to choose. In Sweden on the other hand, the workers are likely closer to an optimal working time.

Further research is however needed. This paper compares two "extreme" countries in terms of vacation time: Sweden being one of the most generous and US one of the least generous countries. To strengthen the results, similar analyses in other countries are needed. It would be particularly interesting to analyze the effects in countries that are in between these two countries in terms of baseline leisure time. In addition, the causal effects need to be strengthened. The results in this paper should be considered to be more descriptive evidence, and similar estimates with a strong causal claim are very much needed. This could e.g. be achieved using exogenous changes in vacation laws together with detailed individual data on travel behavior. Different types of increases in leisure time is also an area that needs further research. In this paper, large increases in leisure time are considered, in particular more full days of leisure time, but there might be differences in individual behavior if e.g. the work day is shortened rather than an increase in the number of vacation days. The theoretical model used in this paper is also very simple, and while it provides a first attempt at analyzing the effects of exogenous increases in leisure time it does not capture the potential for leisure time satiety: a point where further increases in leisure time do not affect the consumption decision of monetary goods. Further theoretical work is therefore also warranted.

Appendix

A.1 Age group analysis, turning 40

Table A1: Different age spans in the estimation of the effects of turning 40. In all cases the full set of covariates is used, but for brevity only the estimated coefficients of interest are included here.

AGE SPAN:	35-44	36-43	37-42	38-41	39-40
Dom. travel, probability	0.0125	0.0203	0.0259	0.0383*	0.0535*
	(0.0132)	(0.0145)	(0.0165)	(0.0199)	(0.0288)
Observations	2,505	2,038	1,531	1,036	515
Dom. travel, expenditure	-73.84	-500.5	-838.4	-1,890	-2,722*
	(725.7)	(744.1)	(889.0)	(1,222)	(1,606)
Observations	318	255	187	124	67
Int. travel, probability	0.0225	0.0214	0.00521	-0.000751	-0.0369
	(0.0190)	(0.0211)	(0.0243)	(0.0294)	(0.0409)
Observations	2,505	2,038	1,531	1,036	515
Int. travel, expenditure	750.7	235.0	745.6	104.2	351.5
	(1,493)	(1,711)	(1,862)	(2,249)	(2,967)
Observations	1,215	979	734	486	247

Standard errors in parentheses

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

A.2 Additional step-wise robustness checks, retirement estimations

Table A2: Step-wise addition of covariates, international travel from Sweden (probability estimation using probit).

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Retired	-0.0937***	-0.0603***	-0.0776***	-0.0765***	-0.0661***	-0.0660***	-0.0633***	-0.0609***	-0.0630***	-0.0615***
	(0.0184)	(0.0184)	(0.0218)	(0.0219)	(0.0217)	(0.0217)	(0.0216)	(0.0215)	(0.0216)	(0.0216)
Total expenditure		6.89e-07***	6.88e-07***	7.00e-07***	6.44e-07***	6.33e-07***	6.03e-07***	5.51e-07***	5.53e-07***	5.48e-07***
		(7.39e-08)	(7.40e-08)	(7.86e-08)	(7.72e-08)	(8.43e-08)	(8.40e-08)	(8.36e-08)	(8.35e-08)	(8.29e-08)
Age			0.00498	0.00509	0.00422	0.00435	0.00379	0.00279	0.00296	0.00271
			(0.00344)	(0.00344)	(0.00343)	(0.00342)	(0.00340)	(0.00340)	(0.00339)	(0.00340)
Medical services				-6.75e-07*	-5.94e-07	-5.86e-07	-5.20e-07	-4.77e-07	-4.73e-07	-4.92e-07
				(4.01e-07)	(3.96e-07)	(3.98e-07)	(3.89e-07)	(3.89e-07)	(3.88e-07)	(3.89e-07)
Prescriptions				7.32e-07	1.03e-06	1.03e-06	8.46e-07	1.05e-06	9.42e-07	1.10e-06
				(1.35e-06)	(1.36e-06)	(1.37e-06)	(1.37e-06)	(1.34e-06)	(1.35e-06)	(1.34e-06)
High education					0.124***	0.125***	0.116***	0.106***	0.103***	0.101***
					(0.0205)	(0.0206)	(0.0206)	(0.0205)	(0.0206)	(0.0206)
Household members						0.00861	0.0144	-0.00372	-0.00116	-0.000572
						(0.0163)	(0.0163)	(0.0164)	(0.0164)	(0.0164)
Urban							0.109***	0.115***	0.115***	0.114***
							(0.0184)	(0.0184)	(0.0184)	(0.0184)
Owned living								0.0599***	0.0590***	0.0576***
								(0.0212)	(0.0212)	(0.0213)
Rooms								0.0182***	0.0182***	0.0183***
								(0.00653)	(0.00654)	(0.00655)
Female									-0.0310*	-0.0292*
									(0.0176)	(0.0176)
									(0.0176)	(0.0176)
Year FEs										YES

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

Table A3: Step-wise addition of covariates, domestic travel in Sweden (OLS for positive expenditure sub-sample).

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Retired	-1,053**	-310.4	-606.7	-611.4	-535.7	-581.4	-585.9	-593.2	-638.5	-587.1
	(532.3)	(462.1)	(654.0)	(654.9)	(635.3)	(631.1)	(628.6)	(626.8)	(630.4)	(624.0)
Total expenditure		0.00719***	0.00720***	0.00710***	0.00676***	0.00564**	0.00547**	0.00530**	0.00549**	0.00550**
		(0.00226)	(0.00227)	(0.00234)	(0.00232)	(0.00235)	(0.00234)	(0.00239)	(0.00245)	(0.00241)
Age			79.54	81.70	81.31	97.74	92.83	84.86	88.00	87.30
			(109.5)	(109.9)	(109.4)	(108.8)	(108.3)	(108.8)	(109.1)	(108.4)
Medical services				0.0133	0.0124	0.0125	0.0130	0.0124	0.0107	0.0105
				(0.0237)	(0.0233)	(0.0230)	(0.0226)	(0.0228)	(0.0229)	(0.0224)
Prescriptions				-0.00945	-0.00521	-0.00221	-0.00223	0.00192	-0.00222	-0.000796
				(0.0440)	(0.0430)	(0.0430)	(0.0425)	(0.0431)	(0.0425)	(0.0431)
High education					757.0	868.0	870.5	853.6	774.2	819.3
					(572.3)	(576.6)	(574.0)	(584.7)	(581.8)	(579.8)
Household members						1,220***	1,265***	1,228***	1,314***	1,257***
						(456.1)	(458.9)	(473.6)	(478.2)	(476.5)
Urban							830.8*	836.7*	829.6*	769.8
							(474.1)	(483.8)	(483.1)	(486.4)
Owned living								856.7*	857.9*	952.0*
								(500.2)	(498.5)	(503.7)
Rooms								-8.174	-6.042	-4.010
								(185.5)	(183.5)	(185.8)
Female									-857.7	-891.6
									(575.1)	(581.0)
Year FEs										YES
Constant	5,360***	2,329***	-2,569	-2,708	-2,839	-5,772	-6,027	-6,033	-6,036	-5,018
	(432.1)	(786.4)	(6,732)	(6,742)	(6,734)	(6,740)	(6,745)	(6,737)	(6,771)	(6,837)

Robust standard errors in parentheses

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

Table A4: Step-wise addition of covariates, international travel from Sweden (OLS for positive expenditure sub-sample).

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Retired	-1,699	228.6	-648.6	-530.2	101.5	50.76	85.88	45.95	-109.1	222.5
	(1,568)	(1,496)	(1,796)	(1,807)	(1,823)	(1,825)	(1,826)	(1,839)	(1,833)	(1,818)
Total expenditure		0.0455***	0.0456***	0.0465***	0.0448***	0.0423***	0.0419***	0.0411***	0.0414***	0.0403***
		(0.00608)	(0.00609)	(0.00623)	(0.00611)	(0.00649)	(0.00647)	(0.00663)	(0.00660)	(0.00652)
Age			237.2	235.3	187.8	228.8	220.7	210.1	235.2	144.0
			(302.3)	(305.7)	(304.7)	(303.4)	(303.0)	(305.0)	(304.6)	(300.7)
Medical services				-0.0727**	-0.0679**	-0.0644**	-0.0644**	-0.0621**	-0.0637**	-0.0603**
				(0.0298)	(0.0293)	(0.0292)	(0.0292)	(0.0289)	(0.0290)	(0.0287)
Prescriptions				0.0423	0.0587	0.0604	0.0579	0.0533	0.0458	0.0485
				(0.105)	(0.102)	(0.103)	(0.103)	(0.103)	(0.103)	(0.101)
High education					4,845***	5,045***	4,928***	4,771***	4,550***	4,475***
					(1,564)	(1,561)	(1,552)	(1,542)	(1,544)	(1,543)
Household members						2,762**	2,876***	2,570**	2,822**	3,126***
						(1,089)	(1,092)	(1,101)	(1,122)	(1,127)
Urban							2,410*	2,484*	2,527*	2,974**
							(1,295)	(1,326)	(1,330)	(1,376)
Owned living								2,832*	2,730*	3,054**
								(1,497)	(1,501)	(1,543)
Rooms								172.5	175.9	141.8
								(479.5)	(481.7)	(494.3)
Female									-2,258*	-1,976
									(1,363)	(1,369)
Year FEs										YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A5: Step-wise addition of covariates, total travel in Sweden (probability estimation using probit).

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Retired	-0.0648***	-0.0330*	-0.0598***	-0.0568***	-0.0475**	-0.0476**	-0.0452**	-0.0427**	-0.0457**	-0.0440**
	(0.0183)	(0.0185)	(0.0218)	(0.0220)	(0.0218)	(0.0218)	(0.0217)	(0.0217)	(0.0217)	(0.0217)
Total expenditure		7.05e-07***	7.04e-07***	7.36e-07***	6.83e-07***	6.86e-07***	6.60e-07***	6.09e-07***	6.12e-07***	6.08e-07***
		(7.38e-08)	(7.39e-08)	(7.97e-08)	(7.81e-08)	(8.68e-08)	(8.67e-08)	(8.66e-08)	(8.60e-08)	(8.59e-08)
Age			0.00780**	0.00810**	0.00724**	0.00722**	0.00672**	0.00577*	0.00598*	0.00571*
			(0.00340)	(0.00340)	(0.00339)	(0.00339)	(0.00338)	(0.00338)	(0.00338)	(0.00338)
Medical				-1.09e-06***	-1.01e-06***	-1.01e-06***	-9.59e-07**	-9.16e-07**	-9.10e-07**	-9.31e-07**
				(3.84e-07)	(3.80e-07)	(3.82e-07)	(3.78e-07)	(3.78e-07)	(3.77e-07)	(3.79e-07)
Prescriptions				-4.37e-07	-1.71e-07	-1.72e-07	-3.11e-07	-1.07e-07	-2.54e-07	-1.85e-07
				(1.34e-06)	(1.35e-06)	(1.35e-06)	(1.35e-06)	(1.33e-06)	(1.33e-06)	(1.33e-06)
High education					0.112***	0.112***	0.105***	0.0962***	0.0911***	0.0893***
					(0.0208)	(0.0210)	(0.0210)	(0.0209)	(0.0209)	(0.0209)
Household size						-0.00171	0.00298	-0.0137	-0.0103	-0.00970
						(0.0163)	(0.0163)	(0.0164)	(0.0165)	(0.0165)
Urban							0.0878***	0.0938***	0.0933***	0.0924***
							(0.0183)	(0.0183)	(0.0183)	(0.0183)
Owned living								0.0554***	0.0541**	0.0541**
								(0.0210)	(0.0211)	(0.0211)
Rooms								0.0167**	0.0167**	0.0168**
								(0.00659)	(0.00660)	(0.00663)
Female									-0.0437**	-0.0430**

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A6: Step-wise addition of covariates, total travel in Sweden (OLS for positive expenditure sub-sample).

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Retired	-2,997**	-498.9	-1,020	-944.1	-253.6	-281.5	-237.6	-253.9	-410.5	-176.1
	(1,479)	(1,409)	(1,702)	(1,712)	(1,722)	(1,722)	(1,718)	(1,728)	(1,724)	(1,717)
Total expenditure		0.0466***	0.0466***	0.0470***	0.0450***	0.0420***	0.0413***	0.0404***	0.0407***	0.0397***
		(0.00616)	(0.00617)	(0.00633)	(0.00619)	(0.00654)	(0.00651)	(0.00665)	(0.00665)	(0.00658)
Age			141.8	132.7	91.39	137.3	126.3	103.1	121.8	44.11
			(289.8)	(292.8)	(291.6)	(289.5)	(288.6)	(290.7)	(290.5)	(287.2)
Medical services				-0.0502	-0.0452	-0.0414	-0.0421	-0.0392	-0.0407	-0.0377
				(0.0315)	(0.0307)	(0.0304)	(0.0306)	(0.0300)	(0.0300)	(0.0297)
Prescriptions				0.0703	0.0914	0.0922	0.0892	0.0866	0.0799	0.0853
				(0.107)	(0.104)	(0.104)	(0.104)	(0.104)	(0.104)	(0.102)
High education					5,789***	6,057***	5,899***	5,675***	5,445***	5,252***
					(1,532)	(1,530)	(1,517)	(1,509)	(1,511)	(1,511)
Household size						3,316***	3,501***	3,066***	3,317***	3,465***
						(1,098)	(1,101)	(1,114)	(1,131)	(1,138)
Urban							3,497***	3,602***	3,644***	3,904***
							(1,242)	(1,266)	(1,268)	(1,301)
Owned living								3,171**	3,085**	3,307**
								(1,413)	(1,416)	(1,447)
Rooms								274.1	285.0	269.9
								(462.6)	(464.7)	(475.5)
Female									-2,284*	-2,031
									(1,322)	(1,330)
Constant	28,483***	9,918***	1,224	1,656	2,786	-5,391	-7,268	-8,355	-8,845	-7,606
	(853.3)	(2,207)	(18,458)	(18,638)	(18,593)	(18,277)	(18,298)	(18,277)	(18,273)	(18,136)

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A7: Step-wise addition of covariates, air travel in the US (OLS for positive expenditure sub-sample).

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Retired	-72.58	65.61	54.34	79.05*	92.97**	92.71**	93.12**	96.04**	98.43**	104.2**
	(51.45)	(44.49)	(45.60)	(46.80)	(45.83)	(45.65)	(45.75)	(46.75)	(46.58)	(47.90)
Total expenditure		0.0347***	0.0347***	0.0361***	0.0354***	0.0355***	0.0355***	0.0357***	0.0354***	0.0353***
		(0.00851)	(0.00853)	(0.00893)	(0.00908)	(0.00924)	(0.00925)	(0.00973)	(0.00962)	(0.00968)
Age			5.508	6.064	6.714	6.460	6.416	6.480	7.386	6.114
			(7.919)	(7.966)	(7.882)	(7.579)	(7.570)	(7.504)	(7.700)	(7.577)
Medical				-0.0657	-0.0680	-0.0678	-0.0679	-0.0673	-0.0725*	-0.0694
				(0.0419)	(0.0419)	(0.0416)	(0.0417)	(0.0431)	(0.0435)	(0.0429)
Prescriptions				-0.330***	-0.321***	-0.321***	-0.321***	-0.317***	-0.292***	-0.299***
				(0.101)	(0.102)	(0.100)	(0.100)	(0.100)	(0.0978)	(0.109)
High education					139.2***	137.9***	138.7***	141.8***	138.4***	153.3***
					(48.58)	(51.15)	(50.87)	(45.76)	(44.21)	(47.85)
Household members						-7.166	-7.130	-3.470	-2.603	-3.701
						(27.32)	(27.31)	(23.19)	(21.83)	(20.92)
Urban							-29.40	-19.98	-44.53	-89.48
							(76.50)	(77.57)	(79.74)	(87.68)
Owned living								31.83	33.84	35.21
								(61.17)	(61.83)	(64.49)
No. of rooms								-10.55	-9.857	-9.568
								(19.67)	(19.41)	(20.34)
Female									-11.74	-17.46
Year FE:s									YES	YES
State FE:s										YES
Constant	982.3***	266.4*	-74.48	-69.26	-174.3	-144.0	-114.1	-101.5	-93.81	-23.98
	(35.30)	(154.7)	(581.5)	(576.1)	(561.1)	(513.7)	(509.5)	(483.5)	(508.6)	(499.3)
Observations	3,284	3,284	3,284	3,284	3,284	3,284	3,284	3,254	3,254	3,254
R-squared	0.000	0.159	0.159	0.165	0.167	0.167	0.167	0.167	0.173	0.183

Robust standard errors in parentheses

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

Table A8: Step-wise addition of covariates, air travel in the US (probability estimation using probit).

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Retired	-0.0117***	0.000757	0.00147	0.00137	0.00405	0.00382	0.00362	0.00200	0.00177	0.00150
	(0.00386)	(0.00363)	(0.00392)	(0.00392)	(0.00390)	(0.00390)	(0.00390)	(0.00392)	(0.00392)	(0.00391)
Total expenditure		4.76e-06***	4.76e-06***	4.72e-06***	4.20e-06***	4.28e-06***	4.25e-06***	4.19e-06***	4.21e-06***	4.07e-06***
		(1.80e-07)	(1.81e-07)	(1.87e-07)	(1.83e-07)	(1.89e-07)	(1.88e-07)	(1.90e-07)	(1.91e-07)	(1.88e-07)
Age			-0.000303	-0.000308	-6.03e-06	-0.000139	-0.000119	-9.39e-06	3.65e-05	2.71e-05
			(0.000570)	(0.000570)	(0.000568)	(0.000567)	(0.000567)	(0.000569)	(0.000569)	(0.000568)
Medical				2.39e-06	1.28e-06	1.26e-06	1.36e-06	9.87e-07	1.08e-06	7.65e-07
				(1.99e-06)	(1.98e-06)	(1.99e-06)	(2.00e-06)	(2.02e-06)	(2.03e-06)	(2.00e-06)
Prescriptions				1.34e-06	4.33e-06	4.75e-06	5.48e-06	3.99e-06	3.57e-06	7.63e-06
				(5.02e-06)	(4.91e-06)	(4.91e-06)	(4.88e-06)	(4.93e-06)	(4.95e-06)	(4.83e-06)
High education					0.0550***	0.0540***	0.0528***	0.0495***	0.0508***	0.0474***
					(0.00347)	(0.00348)	(0.00347)	(0.00356)	(0.00360)	(0.00358)
Household size						-0.00564***	-0.00579***	-0.00736***	-0.00703***	-0.00893***
						(0.00164)	(0.00164)	(0.00177)	(0.00175)	(0.00174)
Urban							0.0384***	0.0421***	0.0426***	0.0261***
							(0.00746)	(0.00754)	(0.00754)	(0.00839)
Owned living								0.0248***	0.0247***	0.0264***
								(0.00523)	(0.00523)	(0.00524)
Rooms								0.00113	0.00116	0.00234***
								(0.000816)	(0.000819)	(0.000808)
Female									0.00828**	0.00846**
									(0.00333)	(0.00332)
Year FE:s									YES	YES
State FE:s										YES

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

Table A9: Step-wise addition of covariates, total travel in the US (probability estimation using probit).

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Retired	-0.00560	0.0204***	0.0223***	0.0219***	0.0252***	0.0248***	0.0251***	0.0211***	0.0209***	0.0211***
	(0.00574)	(0.00542)	(0.00584)	(0.00584)	(0.00580)	(0.00580)	(0.00579)	(0.00581)	(0.00581)	(0.00579)
Total expenditure		1.20e-05***	1.19e-05***	1.17e-05***	1.06e-05***	1.09e-05***	1.10e-05***	1.03e-05***	1.03e-05***	1.02e-05***
		(3.86e-07)	(3.86e-07)	(4.03e-07)	(3.99e-07)	(4.18e-07)	(4.20e-07)	(4.22e-07)	(4.23e-07)	(4.25e-07)
Age			-0.000785	-0.000847	-0.000322	-0.000693	-0.000719	-0.000534	-0.000506	-0.000644
			(0.000864)	(0.000865)	(0.000858)	(0.000858)	(0.000857)	(0.000858)	(0.000859)	(0.000858)
Medical services				9.75e-06**	8.12e-06**	7.91e-06**	7.84e-06**	7.76e-06**	7.94e-06**	6.85e-06*
				(3.93e-06)	(3.79e-06)	(3.79e-06)	(3.80e-06)	(3.77e-06)	(3.77e-06)	(3.69e-06)
Prescriptions				1.08e-05	1.61e-05*	1.72e-05**	1.63e-05*	1.32e-05	1.26e-05	1.20e-05
				(8.60e-06)	(8.61e-06)	(8.69e-06)	(8.70e-06)	(8.49e-06)	(8.46e-06)	(8.48e-06)
High education					0.0937***	0.0908***	0.0921***	0.0811***	0.0810***	0.0787***
					(0.00542)	(0.00546)	(0.00547)	(0.00553)	(0.00557)	(0.00558)
Household members						-0.0158***	-0.0157***	-0.0206***	-0.0209***	-0.0204***
						(0.00240)	(0.00240)	(0.00253)	(0.00254)	(0.00254)
Urban							-0.0347***	-0.0256***	-0.0245***	-0.0142
							(0.00922)	(0.00924)	(0.00926)	(0.0109)
Owned living								0.0782***	0.0772***	0.0725***
								(0.00763)	(0.00763)	(0.00768)
Rooms								0.00482***	0.00487***	0.00511***
								(0.00133)	(0.00133)	(0.00134)
Female									-0.00807	-0.00625
									(0.00500)	(0.00498)
Year FE:s									YES	YES
State FE:s										YES
Observations	26,960	26,960	26,960	26,960	26,960	26,960	26,960	26,684	26,684	26,684

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

A.3 Step-wise robustness checks, effects of turning 40

Table A10: Step-wise addition of covariates, domestic leisure travel in Sweden (probability estimation using probit).

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Forty	0.0100	0.0101	0.0101	0.0121	0.0148	0.0147	0.0146	0.0146	0.0125
	(0.0133)	(0.0133)	(0.0133)	(0.0133)	(0.0133)	(0.0133)	(0.0133)	(0.0133)	(0.0132)
Total expenditure		8.56e-08***	8.84e-08***	6.95e-08**	1.09e-07***	1.13e-07***	1.02e-07***	1.02e-07***	1.06e-07***
		(2.90e-08)	(2.96e-08)	(3.02e-08)	(3.04e-08)	(3.05e-08)	(3.17e-08)	(3.17e-08)	(3.12e-08)
Medical services			4.69e-07	5.04e-07	5.13e-07	4.87e-07	4.77e-07	4.89e-07	6.26e-07
			(5.92e-07)	(5.85e-07)	(5.79e-07)	(5.75e-07)	(5.73e-07)	(5.73e-07)	(5.70e-07)
Prescriptions			-1.71e-06	-1.66e-06	-1.44e-06	-1.44e-06	-1.45e-06	-1.43e-06	-1.37e-06
			(1.47e-06)	(1.52e-06)	(1.52e-06)	(1.52e-06)	(1.51e-06)	(1.51e-06)	(1.41e-06)
High education				0.0539***	0.0495***	0.0518***	0.0510***	0.0518***	0.0491***
				(0.0137)	(0.0136)	(0.0137)	(0.0137)	(0.0138)	(0.0138)
Household size					-0.0189***	-0.0194***	-0.0211***	-0.0208***	-0.0172***
					(0.00513)	(0.00516)	(0.00582)	(0.00583)	(0.00571)
Urban						-0.0183	-0.0172	-0.0172	-0.0179
						(0.0153)	(0.0153)	(0.0153)	(0.0151)
Owned living							0.0174	0.0173	0.0209
							(0.0163)	(0.0164)	(0.0162)
Rooms							0.000912	0.000957	0.000630
							(0.00443)	(0.00444)	(0.00435)
Female								0.00709	0.00327
								(0.0134)	(0.0133)
Year FE:s									YES

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

Table A11: Step-wise addition of covariates, domestic leisure travel in Sweden (OLS for positive expenditure sub-sample).

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Forty	-13.94	2.566	-32.40	-30.89	3.480	-56.53	-77.36	-10.46	-73.84
	(736.5)	(689.2)	(695.0)	(694.2)	(690.4)	(698.0)	(699.0)	(713.1)	(725.7)
Total expenditure		0.0108***	0.0108***	0.0108***	0.0118***	0.0120***	0.0117***	0.0116***	0.0117***
		(0.00191)	(0.00199)	(0.00203)	(0.00210)	(0.00210)	(0.00221)	(0.00222)	(0.00227)
Medical services			-0.0237	-0.0237	-0.0218	-0.0248	-0.0255	-0.0301*	-0.0234
			(0.0174)	(0.0174)	(0.0168)	(0.0167)	(0.0167)	(0.0163)	(0.0166)
Prescriptions			0.00193	0.00195	0.00482	0.00403	0.00954	0.0109	-0.00728
			(0.0811)	(0.0813)	(0.0824)	(0.0845)	(0.0845)	(0.0819)	(0.0783)
High education				45.17	-114.4	33.56	7.791	-119.3	-31.81
				(706.5)	(714.5)	(712.4)	(716.2)	(729.7)	(747.3)
Household size					-470.2*	-484.0*	-585.5*	-634.0**	-658.1**
					(265.7)	(268.4)	(305.7)	(308.9)	(311.5)
Urban						-898.0	-804.1	-774.2	-810.3
						(804.1)	(783.6)	(791.3)	(782.4)
Owned living							-117.9	-173.6	-23.58
							(741.5)	(744.8)	(761.3)
Rooms							152.6	147.9	181.4
							(247.9)	(243.0)	(245.8)
Female								-1,285*	-1,235*
								(719.8)	(708.3)
Year FE:s									YES
Constant	5,844***	1,088	1,154	1,138	2,240**	2,858**	2,649**	3,601***	4,931***
	(482.6)	(888.3)	(882.0)	(892.9)	(1,020)	(1,284)	(1,296)	(1,242)	(1,457)

Robust standard errors in parentheses

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

Table A12: Step-wise addition of covariates, international leisure travel in Sweden (probability estimation using probit).

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Forty	0.0103	0.0119	0.0128	0.0177	0.0256	0.0257	0.0253	0.0252	0.0225
	(0.0200)	(0.0194)	(0.0194)	(0.0192)	(0.0191)	(0.0190)	(0.0190)	(0.0190)	(0.0190)
Total expenditure		6.18e-07***	6.34e-07***	5.84e-07***	7.19e-07***	7.06e-07***	6.77e-07***	6.77e-07***	6.82e-07***
		(5.04e-08)	(5.17e-08)	(5.15e-08)	(6.27e-08)	(6.29e-08)	(6.59e-08)	(6.60e-08)	(6.75e-08)
Medical services			-2.04e-07	-6.57e-08	-1.61e-07	-7.77e-08	-8.08e-08	-7.56e-08	8.99e-08
			(9.04e-07)	(8.80e-07)	(8.77e-07)	(8.76e-07)	(8.78e-07)	(8.78e-07)	(8.72e-07)
Prescriptions			-3.78e-06**	-3.56e-06**	-3.01e-06*	-3.01e-06*	-3.00e-06*	-2.99e-06*	-2.96e-06*
			(1.78e-06)	(1.80e-06)	(1.79e-06)	(1.79e-06)	(1.78e-06)	(1.78e-06)	(1.80e-06)
High education				0.125***	0.113***	0.104***	0.103***	0.104***	0.102***
				(0.0200)	(0.0201)	(0.0203)	(0.0203)	(0.0204)	(0.0205)
Household size					-0.0507***	-0.0482***	-0.0513***	-0.0512***	-0.0491***
					(0.00773)	(0.00773)	(0.00848)	(0.00850)	(0.00853)
Urban						0.0736***	0.0764***	0.0765***	0.0755***
						(0.0219)	(0.0221)	(0.0221)	(0.0220)
Owned living							0.0306	0.0305	0.0338
							(0.0229)	(0.0229)	(0.0229)
Rooms							0.00289	0.00291	0.00246
							(0.00653)	(0.00653)	(0.00651)
Female								0.00328	0.00179
								(0.0192)	(0.0192)
Year FE:s									YES

Standard errors in parentheses

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

Table A13: Step-wise addition of covariates, international leisure travel in Sweden (OLS for positive expenditure sub-sample).

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Forty	1,400	986.1	1,037	1,110	1,127	1,178	1,215	1,167	750.7
	(1,613)	(1,484)	(1,482)	(1,478)	(1,456)	(1,453)	(1,442)	(1,445)	(1,493)
Total expenditure		0.0476***	0.0488***	0.0483***	0.0485***	0.0479***	0.0479***	0.0478***	0.0472***
		(0.00580)	(0.00590)	(0.00583)	(0.00648)	(0.00649)	(0.00706)	(0.00707)	(0.00724)
Medical services			-0.0742	-0.0747	-0.0746	-0.0683	-0.0671	-0.0663	-0.0674
			(0.0655)	(0.0659)	(0.0658)	(0.0672)	(0.0676)	(0.0692)	(0.0696)
Prescriptions			-0.314**	-0.315**	-0.314**	-0.323***	-0.331***	-0.319***	-0.337***
			(0.122)	(0.123)	(0.123)	(0.123)	(0.124)	(0.123)	(0.123)
High education				2,112	2,100	1,656	1,647	1,940	1,626
				(1,478)	(1,456)	(1,496)	(1,501)	(1,504)	(1,502)
Household size					-72.15	17.70	135.2	240.3	339.1
					(645.7)	(647.2)	(669.5)	(668.3)	(663.5)
Urban						3,835**	3,757**	3,941**	3,859**
						(1,611)	(1,670)	(1,672)	(1,661)
Owned living							902.1	773.7	771.7
							(2,149)	(2,137)	(2,165)
Rooms							-268.9	-251.7	-226.3
							(609.3)	(606.0)	(606.2)
Female								3,336**	3,086**
								(1,468)	(1,449)
Year FE:s									YES
Constant	28,230***	6,437**	6,753***	6,045**	6,210**	3,295	3,492	1,273	-1,269
	(1,184)	(2,565)	(2,545)	(2,666)	(2,586)	(2,816)	(2,875)	(2,877)	(3,410)

Robust standard errors in parentheses

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

References

Aguiar, M. and E. Hurst (2005, 10). Consumption versus expenditure. *Journal of Political Economy 113*(5), 919–948.

Aguiar, M., E. Hurst, and L. Karabarbounis (2013). Time use during the great recession. *American Economic Review 103*(5), 1664–1696.

Amemiya, T. (1984, 1). Tobit models: A survey. *Journal of Econometrics 24*(1-2), 3–61.

Becker, G. S. (1965, 9). A Theory of the Allocation of Time. *The Economic Journal 75*(299), 493–517.

Bockstael, N. E., I. E. Strand, and W. M. Hanemann (1987, 5). Time and the Recreational Demand Model. *American Journal of Agricultural Economics 69*(2), 293–302.

Cesario, F. J. (1976, 2). Value of Time in Recreation Benefit Studies. *Land Economics 52*(1), 32–41.

DeSerpa, A. C. (1971, 12). A Theory of the Economics of Time. *The Economic Journal 81*(324), 828–846.

Dickens, W. T. and S. J. Lundberg (1985). Hours Restrictions and Labor Supply. *NBER Working paper series* (No.1638).

Feather, P. and W. Shaw (2000, 10). The demand for leisure time in the presence of constrained work hours. *Economic Inquiry 38*(4), 651–661.

Feather, P. and W. D. Shaw (1999). Estimating the cost of leisure time for recreation demand models. *Journal of Environmental Economics and Management 38*(1), 49–65.

Heckman, J. (1974, 7). Shadow Prices, Market Wages, and Labor Supply. *Econometrica 42*(4), 679–694.

Hong, G. S., S. Y. Kim, and J. Lee (2014). Travel Expenditure Patterns of Elderly Households in the us. *Tourism Recreation Research 24*(1), 43–52.

Huberman, M. and C. Minns (2007, 10). The times they are not changin': Days and hours of work in Old and New Worlds, 1870–2000. *Explorations in Economic History 44*(4), 538–567.

Jang, S. C. S. and S. Ham (2009). A double-hurdle analysis of travel expenditure: Baby boomer seniors versus older seniors. *Tourism Management 30*(3), 372–380.

Luengo-Prado, M. J. and A. Sevilla (2013, 6). Time to Cook: Expenditure at Retirement in Spain. *The Economic Journal 123*(569), 764–789.

Maye, A. (2019). No-Vacation Nation, Revised. Technical report, CEPR, Center for economic and policy research, Washington.

Miniaci, R., C. Monfardini, and G. Weber (2010, 3). How does consumption change upon retirement? *Empirical Economics 2009 38:2 38*(2), 257–280.

Moffitt, R. (1982). The Tobit Model, Hours of Work and Institutional Constraints. *The Review of Economics and Statistics 64*(3), 510–515.

Redmond, P. and S. McGuinness (2020, 10). Consumption in Retirement: Heterogeneous Effects by Household Type and Gender. *Journal of Population Ageing 2020*, 1–19.

Stråle, J. (2021, 7). Household level heterogeneity in the income elasticities of demand for international leisure travel. *Tourism Economics*, 1–22.

Tobin, J. (1958, 1). Estimation of Relationships for Limited Dependent Variables. *Econometrica 26*(1), 24–36.

Tummers, M. P. and I. Woittiez (1991). A Simultaneous Wage and Labor Supply Model with Hours Restrictions. *The Journal of Human Resources 26*(3), 393–423.

Acta Universitatis Agriculturae Sueciae

Doctoral Thesis No. 2022:24

This thesis consists of three papers that study the determinants of travel demand and their implications for environmental policy. Paper I estimates the effects of increased income on travel demand at a household level. Paper II estimates the effects of the Swedish aviation tax on the demand and price for international air travel and considers behavioral as well as price effects of the tax. Paper III evaluates the effects of increased leisure time on travel demand.

Jonathan Stråle received his PhD education at the Department of Economics, Swedish University of Agricultural Sciences, Uppsala, Sweden. He holds a MSc in Environmental Economics from the Swedish University of Agricultural Sciences, a BSc in Economics and a BSc in Statistics from Uppsala University.

Online publication of thesis summary: http://pub.epsilon.slu.se/

ISSN 1652-6880
ISBN (print version) 978-91-7760-923-0
ISBN (electronic version) 978-91-7760-924-7