

ERASMUS UNIVERSITY ROTTERDAM
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Master Thesis Economics and Business

Excise Taxes and Aviation: The German
Departure Tax

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Abstract

This paper studies the effects of the introduction of the German departure tax in the beginning of 2011 on the demand for air travel. Research is done on passenger numbers for different countries over the period of 2005 to 2020 using a Difference-in-differences approach. Results show that the tax decreases the total number of passengers. The study also focusses on possible heterogeneity of effects for long-haul and short-haul flights, and we find that long-haul flights suffer more from the introduction of the tax than short-haul flights. Lastly, no evidence was found for spillovers to neighbouring countries.

I. Introduction

The world is ever-changing due to the climate crisis caused by global warming. In recent years there has been a shift in focus towards climate change and its causes. We now know that global warming is caused by the emission of greenhouse gasses such as carbon dioxide and methane that release with the combustion of fossil fuels. Nowadays, it is hard to imagine a world without these fossil fuels and it is, therefore, also difficult to move away from. We do, however, observe changes towards sustainable practices such as the generation of sustainable power sources and the increasing number of electricity powered vehicles. From an economic perspective, some sectors are more challenging to move away from fossil fuels than others as they rely more heavily on these power sources.

One industry in particular is interesting to follow during its path to sustainability: the aviation sector. In 2022 the aviation industry accounted for 2% of all the global carbon dioxide emissions (IEA – International Energy Agency, n.d.). This may not seem like a substantial amount, but study has shown that the emissions from the aviation industry are increasing at a faster rate than total global emissions due to the fact that the aviation industry is still a growing industry (Bows-Larkin, Mander, Traut, Anderson & Wood, 2016). The expectations are, that by 2050, the aviation industry will be the most polluting industry accounting for 22% of the total global carbon dioxide emissions (Cames, Graichen, Siemons & Cook, 2015). The aviation industry is one that will need to undergo massive changes if it is to be operational in a sustainable manner, and this change will not happen overnight since short-term solutions are limited. One way of decreasing aviation emissions on the short-term is by simply flying less and using greener alternatives instead. Discouraging consumers from certain types of consumption is done by taxation, more specifically, by excise taxes. Here in the Netherlands, there has been a recent introduction of a passenger tax in 2021 that has since increased multiple times and currently stands at a flat rate of 29 euros per passenger per flight, for which transfer passengers are exempted, but the new plan of the government is for this tax to be differentiated by distance, which fits the policy of the government that the people that pollute more should pay more (BNR, 2024). This change would mean that the tax would be more similar to the one that was introduced in the Netherlands in 2008 (Gordijn &

Kolkman, 2011). This tax, which existed of two different rates based on distance, was withdrawn quickly after due to the lack of the desired effect. There was an eyed decrease in passengers, but these passengers simply moved to other foreign airports for their flights to avoid taxation, which also put Dutch airports and airlines in a disadvantageous position in the market (Gordijn & Kolkman, 2011). The United Kingdom has taxation in place on air travel since 1994 (Mayor & Tol, 2007). This appears to be one of the first cases of a flight tax that is to be paid by the passengers. In the United States, there have been extra charges for passengers since 2001 following the 9/11 incident to improve security, which are therefore levied with different reasons than most air taxes that are mainly climate or pollution oriented.

Another way to lower carbon emissions is provided by the European Union in the form of an Emissions Trading System (ETS). Since 2012, airlines operating in EU states are ought to be more considerate with their emissions via monitoring, reporting and verifying them (Reducing Emissions From Aviation, n.d.). The ETS is a system where airlines get tradeable allowances for emission, and these airlines can only emit what is allowed by these allowances. Since they are tradeable, airlines can emit more against the price of buying more allowances, which also provides incentive to produce in a more sustainable way. By providing only a set number of allowances, the EU can control the total emissions generated by the aviation sector. This system for aviation emissions is since 2021 not limited to EU states but operates globally to reduce emissions. The excise departure tax is a tax levied additionally on the passengers of the flights in order to offset people from flying as well as generating income for the government. The ETS may also influence ticket prices for passengers, but there is a bigger picture in place to reduce emissions by providing incentives and through regulation. Due to the competitive nature of the aviation market, airlines need to offer competitive prices for their tickets and are therefore likely to not completely levy the departure tax on the passengers (The Air Travel Tax Weakens the Competitiveness of the German Aviation Industry, n.d.).

The aim of this study is to investigate the effects of a departure tax introduced by Germany in 2011. The study predominantly builds on a previous study by Falk and Hagsten (2018) where the same case is studied. This study, however, will use a different approach and focus more on the heterogeneity of the effect in terms of long-haul and short-haul flights. This addition of researching heterogeneity is something new compared

to the already existing literature and will give more insights in what type of passengers are affected by the tax the most and whether the goal of reducing emissions is reached satisfactorily. This is also where this study will earn its relevance to society: it aims to expose the actual consequences of excise taxation in aviation and compares whether this complies with the different goals for which the tax could be deployed, such as discouraging behaviour, but also regulation of externalities (Cnossen, 2005). As mentioned before, levying taxes, besides discouraging behaviour, also earns revenue for the government which can then be used towards other goals. The Bundesverband der Deutschen Luftverkehrswirtschaft (BDL) used airline reports to compute an estimation of the revenues generated for the government by the departure tax in 2017 (The Air Travel Tax Weakens the Competitiveness of the German Aviation Industry, n.d.). They estimate an annual income of approximately 1.1 billion euros, which for the majority, is reported by German airlines.

In the following sections of this paper, I will; discuss the theory behind excise taxes and review previous studies to formulate my hypotheses; summarize the data and methodology used for empirical testing; show the empirical findings in relation to my hypotheses; check the results for robustness; discuss the results and possible flaws of the study and draw a conclusion.

II. Theoretical framework

A) Types of taxation

Common economic theory states that price increases lead to demand decreases. It is not uncommon for policy makers to use taxation and in particular indirect taxes such as excise taxes on consumer goods as an instrument to increase prices to discourage consumption of this good. Regulation is one of the three goals of taxation as described by Avi-Yonah (2005) besides revenue and redistribution. Regulation is often reached more efficiently by consumption taxes in the form of excise taxes. In the Netherlands for example, excise taxes are in place on some consumer products that damage health such as tobacco and alcohol. Chaloupka, Peck, Tauras and Yürekli (2010) investigate different taxes on tobacco and conclude that the negative effect of the tax on consumption is stronger when a specific excise tax is utilized. Excise taxation is often also operationalized to control externalities, as introduced by Pigou (1920): taxes are levied as

charges for external costs that are experienced by people other than the consumer and the producer (Cnossen, 2005). In other words, when there is a transaction that is not efficient due to externalities, indirect taxes or Pigouvian taxes can be used to correct for these inefficiencies by holding the producer or consumer of the externalities accountable through a price that reflects the harm that is done to the third parties that suffer (Sandmo, 1975). In the case of aviation, the ones that experience the costs could be people that are harmed by the changing climate but are more likely to be the people that live near airfields and therefore experience externalities such as noise pollution and pollution from fuel emissions more locally, when taking the perspective of a national government. Taxation does not come without disadvantages, and one of the main issues regarding Pigouvian taxes is translating externalities, in this case pollution, to monetary terms in order to compute the optimal tax level such that the market is distorted in the smallest possible way (Sandmo, 1975). Also, Ebert (1991) shows that the optimal tax rate is best computed through a formula that also accounts for market structure, which in the case of airlines appears to be an oligopoly as there is a limited number of producers.

The market structure is also important for the pass-through of indirect taxation (Kenkel, 2005). Indirect taxation is taxation where the one that pays the taxation should not be the one that feels the burden of the taxation, the prime example is Value Added Tax (VAT) that is paid by retailers to the government, but they pass the tax through to consumers via increased product prices. In perfectly competitive markets, the tax is expected to be fully passed through to the consumers (Kenkel, 2005). Kenkel (2005) provides evidence that in the Alaskan beverage market, the taxation is not fully passed through to consumers in markets that can be more described as a monopoly. Kenkel (2005) states that when firms have high market power and are already charging prices near the level of profit-maximization for monopolies, they have less incentive to pass through taxation as they will lose profits through demand losses. Projecting these findings on the German aviation market leads to believe that there will be pass-through of taxation as there seems to be no case for a monopoly market structure. This is important for the German government, because if there was no pass-through, there would likely not be a consumer response to the tax since there is no increase in consumer prices.

Taxation can also be placed on intermediate goods such as fossil fuels themselves: gas and oil. However, jet aviation fuel is tax exempt and therefore taxation is impossible in this setting (IATA, n.d.). The idea behind taxing intermediate goods, in this case kerosene, is to increase the price of any consumer goods that make use of these intermediate goods in the production process. The ETS has many similarities with intermediate taxation, but is more market based. Many green initiative organizations argue that the tax exemption on kerosene should be lifted in order to accelerate the movement towards greener alternatives, but IATA insists that taxing kerosene only reduces the pace at which airlines move towards greener alternatives due to reduced financial capacity (IATA, n.d.). This study, therefore, focuses on excise taxes on final goods, which in this case are flight tickets.

B) Taxes and aviation

With recent developments in the awareness of global warming and the damaging emission of greenhouse gasses, large emitting sectors, such as the aviation sector, have seen the introduction of taxation.

The effects of these taxes seem to be dependent on the level of the taxes. There is often differentiation between long flight tariffs and short flight tariffs. In the UK, the Air Passenger Duty (APD), which is present since 1994, consists of a low tariff for travel to other countries in the European Union and European Economic Area, which at time of introduction amounted 5.5 GBP; and a higher tariff for all other flights, which amounted 22 GBP (Mayor & Tol, 2007). The rates have since changed multiple times (Historic rates for Air Passenger Duty, 2024). Using the Hamburg Tourism Model to predict passenger flows in different tax environments with simulations, Mayor and Tol (2007) find that a doubling of the APD results in passengers moving away from shorter flights towards longer flights for flights within the EU as well as flights outside the EU. Meaning that travellers care more about relative prices when choosing their destinations. This mechanism could eventually lead to a perverse effect where the flight tax eventually leads to higher carbon emissions overall.

Falk and Hagsten (2018) investigate the introduction of a departure tax in Germany and Austria in 2011. This tax was, similar to the APD in the UK, split into different tariffs: 7 euros for the shortest flights and 35 and 45 euros for longer flights (LuftVSTG -

Luftverkehrsteuergesetz, n.d.). The results that they find with a difference-in-differences analysis do not make distinctions between long and short-haul flights, but only observes the overall decrease of 8.7 percent in passengers as a result of the tax in the year of introduction followed by a decrease of 5 percent in the following year. In a working paper, Stråle (2021) studies the effect of a flight tax in a Swedish setting using a Synthetic Control Method. Stråle also finds a negative impact of the tax introduction on passenger demand, which increases from 6 percent shortly after introduction, to 11 percent in latter stages of the study. Gordijn and Kolkman (2011) estimate the effect of the passenger tax for Origin-Destination (OD) passengers in the Netherlands to be -6.9% on average when studying only Schiphol airport. So, while previous studies differ in many ways, one result that is common across most literature is the fact that overall demand decreases when excise taxes are introduced. Therefore, I formulate my first hypothesis in a similar manner:

H1: The introduction of a departure tax results in an overall decrease of demand.

C) Tax avoidance

In their research, Falk and Hagsten (2018) make distinctions between border airports with foreign airports in near proximity, which they use as treatment group, and inland airports, which serve as the control group. This design results in focus on cross-border substitution effects: when border airports that are close to foreign airports where there is no or less taxation suffer from more demand loss than inland airports, it is logical to think that the underlying mechanism is one of substitution to neighbouring airports. DeCicca, Kenkel and Liu (2013) researched the effects of heterogenous tax policies on tobacco across states in the US and concluded that consumers avoid taxes by consuming in lower tax states. Falk and Hagsten (2018) aim to confirm this mechanism by exposing demand increases for foreign low tax airports in neighbouring countries, but they find no significant effects resulting from the departure tax introduction in Germany and Austria. Gordijn and Kolkman (2011) studied a similar introduction of tax for departures introduced in the Netherlands and their results are in line with the results of DeCicca et al. (2013) regarding cross-border tax avoidance. All in all, results show that there is a case to be made for tax avoidance and cross-border substitution, but in the case of air

transport, results are mixed when focussing on neighbouring countries. Since this study is based on the same setting that was studied by Falk and Hagsten, I hypothesize the following regarding spillover effects and cross border substitution to neighbouring countries:

H2: The introduction of a departure tax has not stimulated cross-border substitution to neighbouring countries.

The air transport industry has made the world more connected and travelling long distances has never been easier and quicker. With tobacco it is unlikely that someone is willing to fly long distances to consume at places where taxation is lower than at home, but when travelling, passengers often engage in transfer flights. To study the effects of excise taxation in air transport it is therefore important to understand different mechanisms in the airline industry.

D) The airline industry

The airline industry can be divided into two different types of carriers: legacy carriers and low-cost carriers (LCCs). Legacy carriers are historic carriers that started their operations when there was strict regulation in the aviation market for safety. Regulation was done through minimum prices (Starkie, 2002; Chang & Williams, 2002). Due to the limits on price-competition, carriers competed through service quality. Legacy carriers commonly operate from a home airport, the hub, and feed passengers from different countries to the hub to eventually make big intercontinental flights. When passengers make stops at the hub before flying to the final destination, this called a transfer flight. This way of operating is often referred to as a hub-and-spoke network. A typical example of a legacy carrier is KLM, which operates from its hub: Schiphol. When the airlines faced deregulation, many of the legacy carriers were still obliged to contracts made prior to deregulation. This is when LCCs made their way to the market (Francis, Humphreys, Ison & Aicken, 2006). With no limits on price competition, LCCs could offer flights at lower prices: the prime example for a LCC is RyanAir. LCCs often operate point-to-point networks and do not settle at an airport as base (Alderighi, Cento, Nijkamp & Rietveld, 2012). Originally, LCCs operated continental flights only, but recently there have also

been developments towards long-haul low-cost flights (Albers, Daft, Stabenow & Rundshagen, 2020).

Prices for transfer flights are generally lower than prices of direct flights due to the extra uncertainty and inconvenience of an additional stop: luggage may be lost in the process, time costs and inconvenience costs (Fujii, Mak & Im, 1992). All this additional uncertainty needs to be represented in the price in order to be competitive. Transfer flights can have transfers at many different places, including both EU and non-EU countries. Since short flights were taxed at a lower rate of 7 Euros, transfer flights with the transfer in EU countries are relatively cheap. Passengers would pay a tax of 7 euros for the entire journey when we assume that the country from which they take the transfer flight does not tax this flight. For some passengers it may be a reason to move away from direct long-haul flights, since these are now heavily taxed, towards transfer flights with the transfer taking place elsewhere in Europe. With this mechanism, which is also in line with the findings of Mayor & Tol (2007) regarding the importance of relative prices, the expectation is that demand for short-haul flights is affected relatively less by the introduction of the tax than long-haul flights since more long-haul passengers now become short-haul passengers from the point of view of Germany, the country in which the tax was introduced. The tax of 7 euros may be taken for granted given that the time of total travels is likely to be shorter when using a transfer flight rather than using alternative transportation to a foreign airfield where there is no taxation.

The first instinct when predicting the heterogeneity of the tax effect, however, could be that for long haul flights there are simply less alternatives and therefore this type of flight would be affected relatively less by the tax. However, given the fact that transfer flights are in this case also alternatives, I suspect that this mechanism prevails and therefore formulate the following hypothesis:

H3: Long-haul flights experience a more negative effect of the introduction of the departure tax than short-haul flights.

This hypothesis is also consistent with the findings of Falk and Hagsten (2018) on airports that predominantly serve LCCs. In their research, they find that these airports suffer more from the introduction of the departure tax than other airports. Given that

LCCs offer mostly direct continental flights, there is no boost in the number of short-haul flights due to the passengers increased demand in transfer flights, as transfer flights are booked as a whole at a lower price and therefore both flights are operated by the legacy carriers.

III. Data & methodology

A) Data

The dataset, computed from data taken from the Eurostat database (Database - Eurostat, n.d.), originally consisted of the 28 EU countries from 2005 to start of 2020.

There are however countries in this dataset that also have introduced similar excise duties regarding air travel.

Irish travellers were subject to an air travel tax from March 2009 till April 2014. The rates changed at the beginning of 2011. To make sure that our estimates estimate what they intend to measure, the effect of the introduction of the departure tax in Germany in 2011 on air travel demand in Germany, Ireland is removed from the control group. The UK introduced the Air Passenger Duty (APD), which was touched upon earlier when discussing the results of the paper from Mayor and Tol (2007), in November 1994. The rates are subject to change every year and for this reason, the UK is also removed from the control group. Sweden also introduced a tax on air travel in April 2018. This tax is in practice very similar to the German departure tax. Even though the tax was introduced a significant amount of time later than the German tax, the decision was made to also drop the observations from Sweden due to balance issues in the dataset that would occur with the inclusion of Sweden in the control group. Both Croatia and Bulgaria were dropped from the dataset as these countries did not have data that reached as far as 2005 and this would also cause balance issues. Also, Italy, France, Austria and the Netherlands had a similar tax active in the period of the study and therefore have also been dropped from the control group. I decided not to remove neighbouring countries of Germany from my dataset, instead, I estimate potential spillover effects in the model to test the second hypothesis. In later tests in this study, some countries that were originally excluded from the main analysis, will be included in the dataset (France, the Netherlands and Austria).

After this cleaning of the dataset, data for 19 European countries from 2005 till 2020 remained for the main analysis. The dataset contains monthly information on the

number of outgoing air travellers per country and this is divided into two types of flights. The first flight type is intra-European, meaning from one of the European countries to another. The other type of flight is extra-European, meaning intercontinental flights. I categorize the flights within Europe as short-haul flights and the intercontinental flights as long-haul flights for my third hypothesis. These variables, measuring the number of *Passengers*, are aggregated to quarterly data and form the dependent variables in my analysis in their natural logarithmic form.

Additionally, I have gathered quarterly data on some economic and demographic factors. The first covariate I intend to use in my model is *Population*, which is a measure of the total population of the country. In the model I will include the natural logarithm of this value. Secondly, I control for the wealth within the countries by including the *GDP per Capita* as covariate. In the model I use the natural logarithm of the value. Lastly, *% Employed* is included in the model which represents the employment rate for each country at different time periods. Data on all covariates were also taken from the Eurostat database. Besides these covariates, a variable that accounts for *Spillover effects* to neighbouring countries that are represented in the control group is also included in the model. This variable is identical to the *Treatment variable* for the treatment group: a dummy that is 0 for all countries in the model in the pre-treatment period, and 1 for countries that are affected by treatment in the post-treatment period. The only difference in the *Spillover effects* variable is that it takes value 1 not for countries affected by the treatment, but for its neighbouring countries. This variable is used for the second hypothesis to identify possible spillover effects. All summary statistics for the main variables used in my analysis can be found in table 1.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Total passengers	1586	15.327	1.452	11.344	18.168
Short-haul passengers	1586	14.883	1.421	10.665	17.798
Long-haul passengers	1586	14.268	1.535	10.638	17.144
GDP per Capita	1586	8.652	.623	6.541	10.203
Population	1586	15.897	1.456	12.906	18.236
% Employed	1586	0.456	0.038	0.361	0.547
Treatment variable	1159	.032	.176	0	1
Spillover effects	1586	.093	.291	0	1

Notes: Data on passenger flows is aggregated to quarterly data and reported in logarithmic form; GDP per Capita and Population are presented in logarithmic form; % Employed is the share of the total population that is employed. Time is also an important variable and these are measured as dummies for every quarter or year depending on the model used.

B) Method

As for the method, I intend to use a difference-in-differences (DiD) approach. This approach suits the panel dataset that I have gathered well and uses the shock of the implementation of the departure tax to estimate causal effects. The DiD approach compares two groups, treatment and control, at two different time frames: pre- and post-intervention. The main idea is that the control group provides the trend of the treatment group had there been no intervention in the treatment group. With this logic, the differences before the treatment can be subtracted from the differences after the treatment and we would find the treatment effect. This method therefore allows for differences between treatment and control group, conditionally on the fact that these differences remain constant over time. The effectiveness of the DiD method in finding causal effects is reliant on two conditions that should hold. The first assumption is the assumption of parallel trends: trends of the outcome variable should be similar for control and treatment group. In other words, the trend of the control group should represent the trend of the treatment group if there had been no intervention. The second assumption is the ‘Stable Unit Treatment Value Assumption’ (SUTVA). This assumption holds when there are no relevant interactions between treatment and control group and

there is no response from the treated or untreated units to the existence of the other group. Only when these assumptions hold, we can estimate the true treatment effect.

Since there is likely correlation between the error term of the regression with short-haul passengers and the error term of the regression with long-haul passengers, I will run both regressions simultaneously in a Seemingly Uncorrelated Regression (SUR) model to test whether there is a significant difference between the effects on long-haul and short-haul flights. This model uses the correlation between the error terms to give more precise estimates with smaller standard errors. The models that are used are depicted in equational form below:

$$\begin{aligned}
1. & (\ln(\text{TotalPassengers}) \text{ or } \ln(\text{Long} - \text{haulPassengers}) \text{ or } \ln(\text{Short} \\
& \quad - \text{haulPassengers}))_{it} \\
& = \beta_0 + \beta_1 \text{TaxIntroduction}_{it} + \beta_2 \text{Spillovers}_{it} + \beta_3 \ln(\text{GDPperCapita})_{it} \\
& + \beta_4 \ln(\text{Population})_{it} + \beta_5 \text{EmploymentRate}_{it} + \beta_6 \text{Quarter1}_t \\
& + \beta_7 \text{Quarter2}_t + \beta_8 \text{Quarter3}_t + \lambda_t + \eta_i + \varepsilon_{it}
\end{aligned}$$

The first regression depicts the first model where time effects (λ_t) and panel effects (country fixed effects: η_i) are taken into consideration. Time effects in this model are represented by a dummy for each year-quarter that is present in the period of the study, in total there are 61 quarters in this period. The dummies for quarters, that are also shown in the formula, estimate the quarterly fixed effects for the total period (e.g. this dummy shows that there is a constant preference for passengers to fly in quarter 3, which is the summer, compared to all other quarters). i and t represent the country and time respectively. This model is used to gather accurate estimates of the effects for the three different dependent variables.

$$\begin{aligned}
2. & \ln(\text{Passengers})_{itr}^T \\
& = \beta_1 \text{TaxIntroduction}_{it} + \beta_2 \text{Spillovers}_{it} + \beta_3 \ln(\text{GDPperCapita})_{it} \\
& + \beta_4 \ln(\text{Population})_{it} + \beta_5 \text{EmploymentRate}_{it} + \beta_6 \text{Quarter1}_t \\
& + \beta_7 \text{Quarter2}_t + \beta_8 \text{Quarter3}_t + \beta_9 \text{Quarter4}_t + \beta_{10} \text{Germany}_i \\
& + \beta_{11} \text{Neighbours}_i + \beta_{12} \text{PostTreatment}_{it} + \lambda_t + \eta_g + \varepsilon_{itr}
\end{aligned}$$

With correlation between $\varepsilon_{it, \text{Long-haul}}$ and $\varepsilon_{it, \text{Short-haul}} = \rho$

The second equation represents the SUR model with $r = \text{long-haul or short-haul passengers}$, $i = \text{country}$ and $t = \text{time}$. In this model, there are no country fixed effects, instead the dataset is divided into different groups (g): the control group, the treatment group and a group within the control group that consists of neighbouring countries for

Germany. This way, we control for some fixed effects specific to the country groups (η_g). Also, the time fixed effects that are included in this model are yearly dummies instead of the quarterly dummies used in the previous model. This is purely due to practical reasons when running the commands in Stata (StataCorp, 2023).

IV. Results

Table 2: The effect of the introduction of the departure tax on passengers

	Passengers		
	Total	Long-haul	Short-haul
Tax introduction	-0.120** (0.051)	-0.164*** (0.050)	-0.097 (0.057)
Spillover effects	0.002 (0.125)	-0.018 (0.115)	0.014 (0.132)
GDP per Capita	0.722*** (0.163)	0.811*** (0.159)	0.696*** (0.178)
Population	-0.642 (0.789)	-1.624** (0.693)	-0.265 (0.842)
% Employed	-0.716 (0.982)	-1.018 (0.984)	-0.618 (1.113)
Quarter 1	-0.660*** (0.127)	-0.768*** (0.128)	-0.594*** (0.142)
Quarter 2	0.244*** (0.037)	0.197*** (0.038)	0.272*** (0.041)
Quarter 3	0.388*** (0.056)	0.374*** (0.061)	0.396*** (0.057)
TFE (Q)	Yes	Yes	Yes
CFE	Yes	Yes	Yes
Obs.	1159	1159	1159

*Notes: standard errors in parentheses; GDP per Capita, Population measured in logarithmic form; % Employed is the percentage of the total population that is employed; the Quarterly variables are dummies and the reference category is Quarter 4: Oct-Dec; TFE (Q) = Time Fixed Effects (Quarterly), CFE = Country Fixed Effects; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.*

Graphical diagnostics for parallel trends

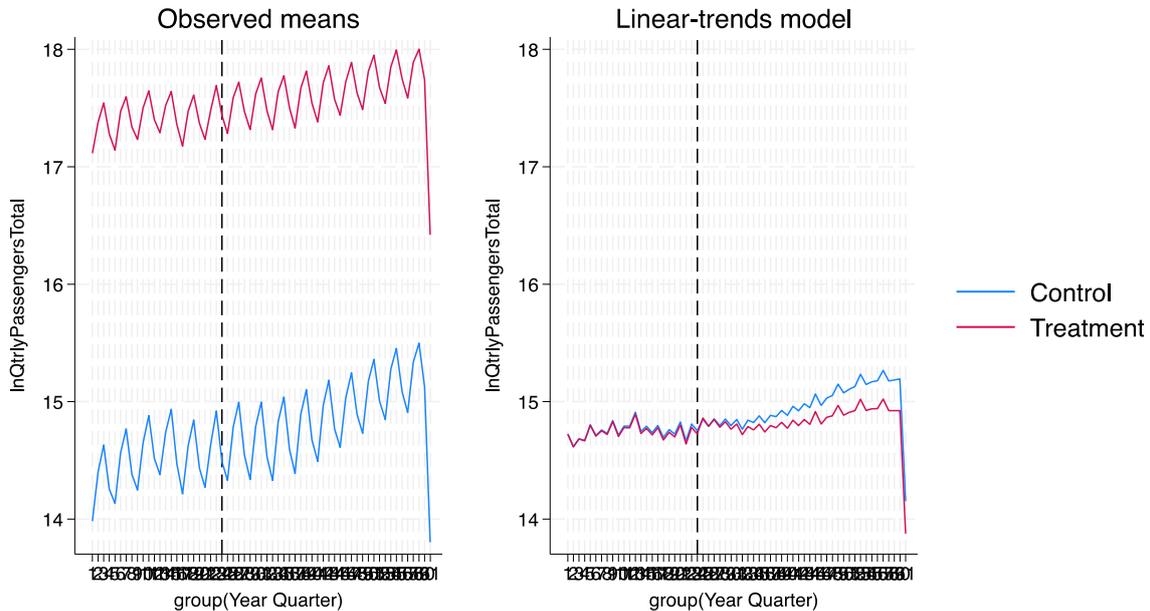


Figure 1: Visualization of parallel trends for total passengers.

A) Overall effects

In column 1 of table 2, a model is presented that estimates the effect of the tax on the total number of passengers in Germany. This form of DiD model corrects the estimates for both panel effects and time effects in order to estimate the true effect and its magnitude. The time effects are in this case expressed by quarters, so every quarter during the timeframe of the study is controlled for. I find that the introduction of the tax reduced the number of total passengers by 12% on average in Germany and that this effect is significant at a level of 5%. These findings confirm my hypothesis that there is an overall decrease in passengers as a result of the introduction of the departure tax. Also, there is no case of spillover effects to neighbouring countries, which is in line with the findings of Falk and Hagsten (2018) and my second hypothesis. After an additional Wald test for parallel trends, which tests whether the difference in trends in the pre-treatment period is equal to zero, I conclude that there are parallel trends in the period prior to treatment as the null hypothesis of the Wald test cannot be rejected ($P=0.757 > 0.10$). This provides evidence that the parallel trends assumption holds. Graphical evidence is also provided in figure 1.

When comparing the results to previous findings in the literature, and specifically the findings of Stråle (2021) and Falk and Hagsten (2018), the estimated decrease in

demand in this study is larger: 12% compared to the 9% decrease that Falk and Hagsten (2018) found, the 11% decrease that Stråle (2021) found and the 6.9 decrease found at Schiphol by Gordijn and Kolkman (2011). It is, however, important to mention that the 95% confidence interval is between 2% and 22%, meaning that we are 95% confident that the true value of the effect is between these 2 numbers and therefore it could be bigger or smaller than the 12% that is the centre of the interval. Falk and Hagsten (2018) only find a short-term effect of the tax introduction, but when comparing my study with the study of Stråle (2021), another notable similarity is that when looking at the graph in figure 1, the effect seems to be increasing over time.

In columns 2 and 3 of table 2, both the effect on long-haul passengers and on short-haul passengers are estimated separately using the same DiD method used previously in order to provide the most accurate estimates of the magnitude of the effects. When comparing the coefficients for the treatment variable in columns 2 and 3, we see that the effect on long-haul passengers is more negative and more significant: long-haul passengers decreased by 16.4%, significant at a level of 1%, after tax introduction compared to a 9.7% decrease in short-haul passengers which is not statistically significant, meaning that we cannot reject the null-hypothesis that this effect is zero. These findings provide some support for my third hypothesis that long-haul flights suffer from a larger demand blow following the tax compared to short-haul flights, but further testing using the SUR model is needed to verify whether the coefficients are truly different in magnitude. Again, the parallel trends assumption in these separated regressions seem to hold when looking at the pre-treatment period as can be seen in figures 2 and 3. Also, Wald tests cannot reject the hypotheses of parallel trends ($P=0.452 > 0.10$ & $P=0.700 > 0.10$).

Graphical diagnostics for parallel trends

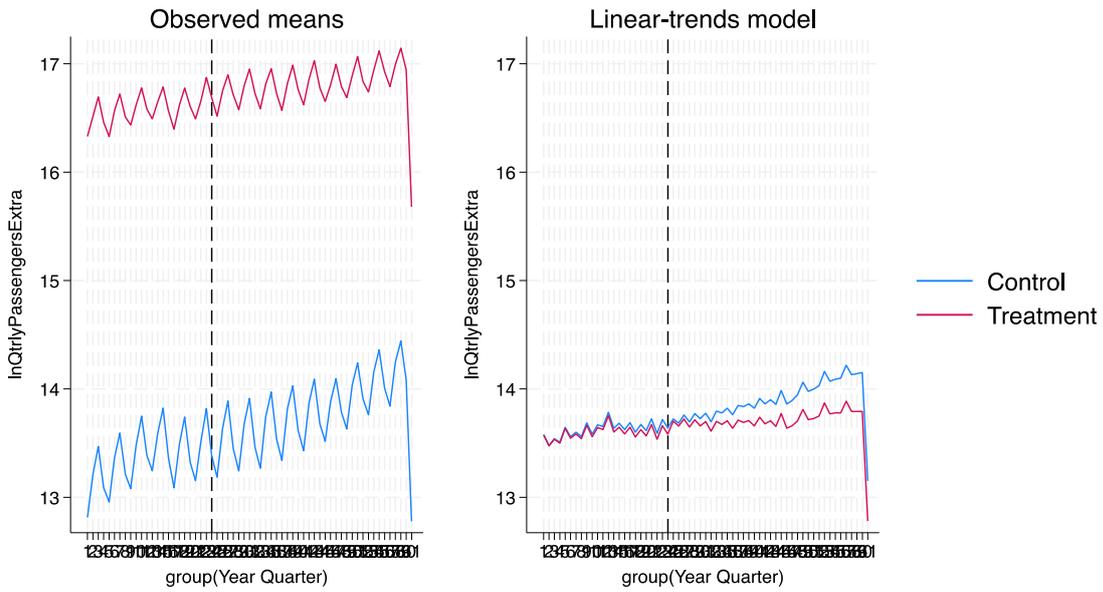


Figure 2: Visualization of parallel trends for long-haul passengers.

Graphical diagnostics for parallel trends

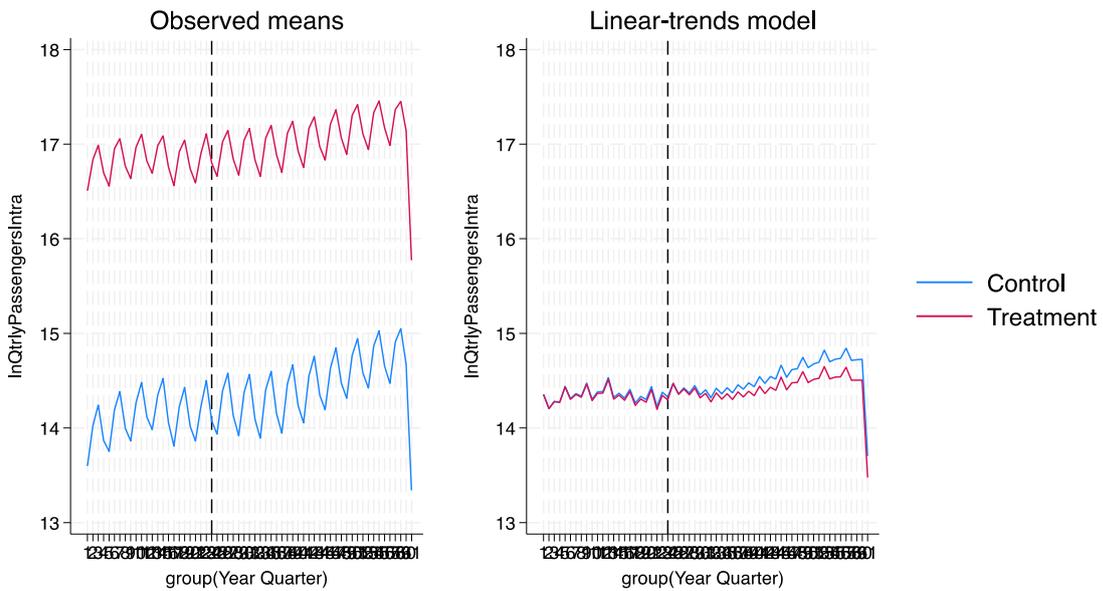


Figure 3: Visualization of parallel trends for short-haul passengers.

B) Heterogeneity of effects

To truly identify heterogeneity of the effects of the tax introduction, it is also useful to utilize a SUR DiD model. When using separate regressions, the effects remain almost identical as can be seen by comparing table 2 with table 3, but the biggest difference is that we now find an effect on short-haul passengers that is significant at a level of 10% (table 3 column 3). Other coefficients also vary across the two methods used. The main

difference in the way of estimation are the fixed effects that are used. In the models used in table 3, time fixed effects are estimated per year compared to the time effects that are estimated per quarter in the models in table 2. Also, in table 3, the models include fixed effects for the control group versus the treatment group and also a group that represents neighbouring countries, whereas in the models used in table 2 for each individual country the fixed effects were estimated. Unlike the model used in table 2, the SUR model used in column 4 and 5 of table 3, estimates the effects on long-haul and short-haul passengers simultaneously to increase estimation precision by using correlation between the standard errors of both regression equations.

Results in table 3 again show similar results to the method performed previously considering that the effect on long-haul passengers is more negative. I also formally tested whether the coefficients for the treatment variable are similar for the SUR model, meaning that the difference between these coefficients is zero. The test rejected the null hypothesis that the coefficients are the same ($P=0.03 < 0.05$) and therefore I conclude that there is indeed heterogeneity in the effect, which means that the third hypothesis is also verified by these results. So, evidence indeed shows that short haul flights are affected less by the introduction of the departure tax than long haul flights. However, in the build-up to the hypothesis of heterogeneity in effects, mechanisms behind these thoughts were explained and the main point taken from this explanation was that passengers look to evade the larger taxes on longer flights by making short flights to countries where there is no taxation on long haul flights. This reasoning is contrary to the Stable Unit Treatment Value Assumption, which will be discussed further in the discussion sector of this paper.

Table 3: The heterogeneity of the effect of the introduction of the departure tax on passengers using SUR model

	Passengers				
	Total	Long-haul	Short-haul	Long-haul (SUR)	Short-haul (SUR)
Tax introduction	-0.120** (0.056)	-0.164*** (0.061)	-0.096* (0.057)	-0.163*** (0.061)	-0.097* (0.057)
Spillover effects	-0.006 (0.030)	-0.024 (0.033)	0.004 (0.031)	-0.021 (0.033)	0.013 (0.030)
GDP per Capita	0.753*** (0.067)	0.831*** (0.073)	0.735*** (0.067)	0.827*** (0.072)	0.707*** (0.065)
Population	-0.232 (0.193)	-1.351*** (0.195)	0.222 (0.172)	-1.489*** (0.155)	-0.234** (0.112)
% Employed	-0.751* (0.410)	-1.050** (0.443)	-0.665 (0.412)	-1.053** (0.442)	-0.618 (0.408)
Quarter 1	-0.139*** (0.019)	-0.143*** (0.020)	-0.135*** (0.019)	-0.144*** (0.020)	-0.139*** (0.019)
Quarter 2	0.232*** (0.018)	0.199*** (0.019)	0.250*** (0.018)	0.198*** (0.019)	0.248*** (0.018)
Quarter 3	0.425*** (0.017)	0.415*** (0.019)	0.429*** (0.017)	0.415*** (0.019)	0.428*** (0.017)
TFE (Y)	Yes	Yes	Yes	Yes	Yes
GFE	Yes	Yes	Yes	Yes	Yes
Obs.	1159	1159	1159	1159	1159

Notes: standard errors in parentheses; GDP per Capita, Population measured in logarithmic form; % Employed is the percentage of the total population that is employed; the Quarterly variables are dummies and the reference category is Quarter 4: Oct-Dec; TFE (Y) = Time Fixed Effects (Yearly), GFE = Group Fixed Effects; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

In order to verify whether the SUR model actually provides more accurate estimates compared to running the models for different types of passengers separately, the standard errors can be compared. When doing this, the conclusion is that there is little difference between the precision of the estimates, especially for the estimates of interest: standard errors are identical for the Tax Introduction coefficient. All in all, the SUR model does not seem to drastically improve the estimates by simultaneously estimating the different models and using correlation between the error terms.

V. Robustness checks

To be sure that the effect I find is not just a random effect and the results are robust, multiple tests are performed in which all of my hypotheses are checked for robustness of results. This section of the paper will be divided into three subsections where the different checks used are discussed, starting with the placebo tests which are then followed by a deep dive into the case for Austria and a section that focusses on the second hypothesis regarding cross-border substitution.

A) Placebo tests

The first set of checks will consist of placebo tests where I perform a similar difference-in-differences model, but now I test for effects where I expect to find none. Explicitly, I use the control group that I used in the original analysis where Germany was the treated unit, but now I will assign treatment to the different units of the control group and see whether there is an effect on the total number of passengers in the country when the departure tax was introduced in Germany. By doing this, I try to exclude the possibility that the effect that I found in the original analysis is not due to a random shock affecting multiple countries. The results for the placebo tests for all countries in the control group can be found in table 4.

In table 4, we see that the results are mixed: there are some cases where we find significant effects, of which the signs also vary, but there are also cases where we observe no significant effects. When we then look at the Parallel Trends Assumption and the evidence or lack of evidence for whether this assumption holds, it is interesting to note that there are no other significant negative effects when the assumption of parallel trends holds. On the other hand, in the case of Portugal, there is a significant effect with a positive sign, which does not help with proving the results are robust. It means that there are other factors during the same period that, for Portugal, affect the number of passengers in a positive way. This means that the coefficient that I originally estimated may be overestimated even more. However, since only Portugal shows these positive effects, it is likely not a major issue. For countries where the PTA does not hold, the trends are published and can be found in the appendix.

Table 4: Placebo tests for all countries in the control group

	EE	ES	PT	FI	HU	RO	CY	EL	LT	LV	MT	SI	SK
Tax (placebo)	-0.136* (0.073)	-0.010 (0.073)	0.151*** (0.060)	0.026 (0.053)	-0.034 (0.085)	0.322*** (0.074)	-0.149 (0.105)	0.119 (0.079)	0.253 (0.153)	0.004 (0.147)	0.043 (0.149)	-0.326*** (0.045)	-0.458*** (0.056)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PTA test P-value	0.000	0.464	0.354	0.132	0.052	0.001	0.441	0.538	0.652	0.002	0.349	0.089	0.005
PTA	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	No	No
TFE (Q)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	1098	1098	1098	1098	1098	1098	1098	1098	1098	1098	1098	1098	1098

*Notes: all tests are run similarly to the original analysis and thus control for GDP per Capita, Population, Employment Rate and Quarter, but not for spillovers as these are not relevant for this analysis. The PTA row shows whether the Parallel Trend Assumption holds following a Wald test for parallel trends. TFE (Q) = Time Fixed Effects (Quarterly), CFE = Country Fixed Effects. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.*

B) The case for Austria

The second analysis performed to check for robustness of results studies the effects of the introduction of the same tax in Austria, which was introduced three months later. The expectation is that we observe similar patterns. Since the SUR-model did not provide a significant increase in the accuracy of the estimates in the case of Germany, it is excluded from this robustness analysis and the focus is on the DiD model used to estimate the true effects of the tax in the original analysis (table 2).

Graphical diagnostics for parallel trends

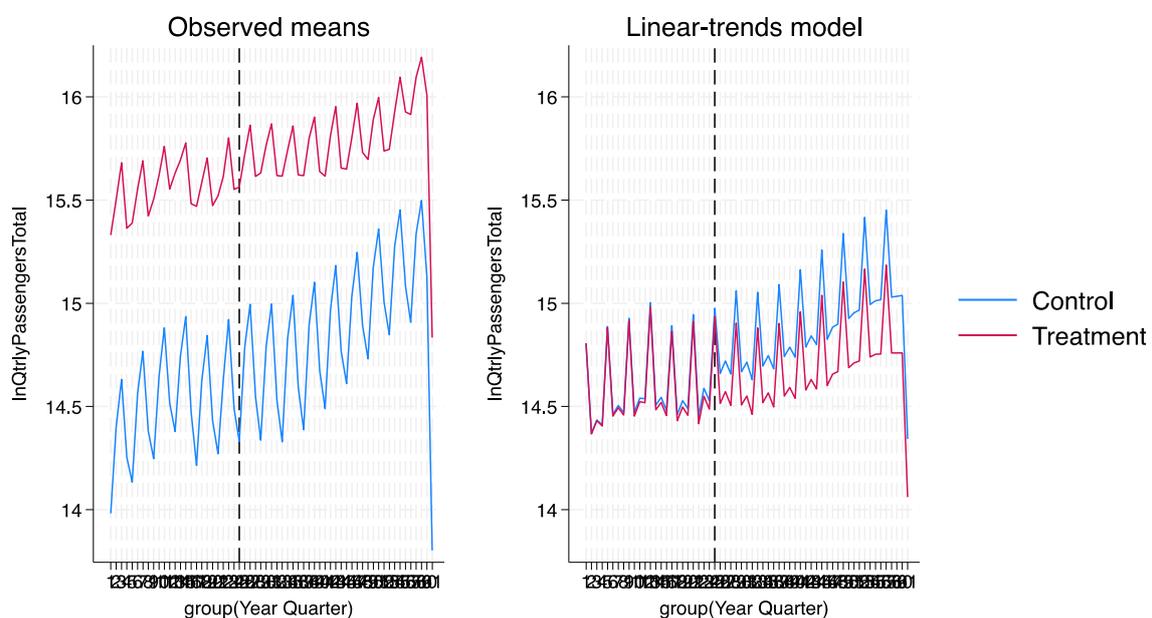


Figure 4: Visualization of parallel trends for total passengers in Austria.

After testing, using the same Wald tests that were used for all previous tests for parallel trends, I conclude that the PTA also holds in the case of Austria regarding the total passengers, which is also shown in figure 4 above. Similarly to the German case, there is an anticipation effect present which likely causes overestimation of effects. Further analysis showed that for the long-haul passengers, there was no evidence for parallel trends ($0.049 < 0.10$), meaning that the results that we find in column 2 of table 5 are likely not the true effects of the tax introduction and therefore it makes it difficult to make the comparison with Germany. Visual evidence for the violation of parallel trends in the case of long-haul passengers in Austria is provided in figure 14 in the appendix.

Table 5: The effect of the introduction of the departure tax on passengers in Austria

	Passengers		
	Total	Long-haul	Short-haul
Tax introduction	-0.192*** (0.041)	-0.221*** (0.045)	-0.172*** (0.044)
Spillover effects	-0.353*** (0.072)	-0.314*** (0.055)	-0.383*** (0.086)
GDP per Capita	0.627*** (0.151)	0.731*** (0.143)	0.590*** (0.167)
Population	-0.792 (0.678)	-1.764** (0.616)	-0.426 (0.715)
% Employed	0.506 (1.144)	0.000 (1.202)	0.763 (1.225)
Quarter 1	-0.763*** (0.101)	-0.855*** (0.103)	-0.710*** (0.113)
Quarter 2	0.235*** (0.040)	0.191*** (0.040)	0.260*** (0.044)
Quarter 3	0.379*** (0.059)	0.369*** (0.063)	0.383*** (0.059)
TFE (Q)	Yes	Yes	Yes
CFE	Yes	Yes	Yes
Obs.	1159	1159	1159

Notes: standard errors in parentheses; GDP per Capita, Population measured in logarithmic form; % Employed is the percentage of the total population that is employed; the Quarterly variables are dummies and the reference category is Quarter 4: Oct-Dec; TFE (Q) = Time Fixed Effects (Quarterly), CFE = Country Fixed Effects; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

In the results of the analysis in table 5, we find that there is also a negative effect of the tax on the number of passengers in the case of Austria. The results and patterns are rather similar, but there are also some significant differences that need clarification.

Firstly, we now observe significant spillover effects where we did not in the case of Germany. The driving factor behind these results seems to be the inclusion of Slovenia and Slovakia in the group for neighbouring countries that is used to compute the spillover effects. In table 4 (columns SI and SK), we also observe that these two countries showed significant negative coefficients in the placebo tests. During these placebo tests we did, however, also conclude that the assumption of parallel trends was not satisfied (see figures 11 and 12 in the appendix). There appears to be another driver for these effects, however, it is unclear what specifically.

The second interesting difference is the difference in magnitudes of the effects: results show that Austria's passenger numbers suffered more from the tax introduction than Germany. This is, however, likely an overestimation of the effect due to spillover effects from Germany. Since Austria was not part of the control group in the German case, it was also not used for the computation of the spillover effects, but since the treatment in Austria was implemented three months later than in Germany, it is possible that German travellers opted for aviation in Austria during these three months. This means that the drop in passengers measured after the introduction of the tax in Austria, is not just the drop of Austrian passengers, but also the German spillovers. To test for spillovers, I ran a separate DiD model with the three months between the treatments as the treatment period and found that there is indeed a case of positive significant spillovers in this period which provides evidence that the coefficients in table 5 are overestimated (see Table 7 in appendix). These results are in contrast with the previous results regarding spillovers, but this will be discussed in more detail in section C of these robustness checks, where robustness checks for my hypothesis about spillovers are presented.

For now, I also committed to performing synthetic control analysis to check for robustness of the results, by using a different model to expose similar effects. There is however an issue with this model when it comes to Germany. This is due to the fact that Germany is by some distance the biggest European country when it comes to the use of aviation in travel, especially in my dataset where numerous large countries within the EU were dropped because they had similar taxes in the studied timeframe. This means that when the Synthetic Control Method is employed to compute a 'synthetic Germany', it will use the second biggest country in aviation use to minimize the differences between Germany and 'synthetic Germany'. The model would then assign all the weight to Spain, even though the trends of these two countries were visually different. In order to still make use of the SCM, since I believe it to be a good check for the robustness of the results, I use the case of Austria instead. This way, the model works best due to the relative size of Austria and its aviation sector.

Results, based on monthly data of passenger flows, show that there is a negative average treatment effect over the posttreatment period on the total passengers of 8.80%, meaning that, on average, the total number of passengers in Austria dropped 8.80%

compared to the synthetic control group. Figure 5 shows the comparison of trends of the treatment group and counterfactual or synthetic control group before and after treatment.

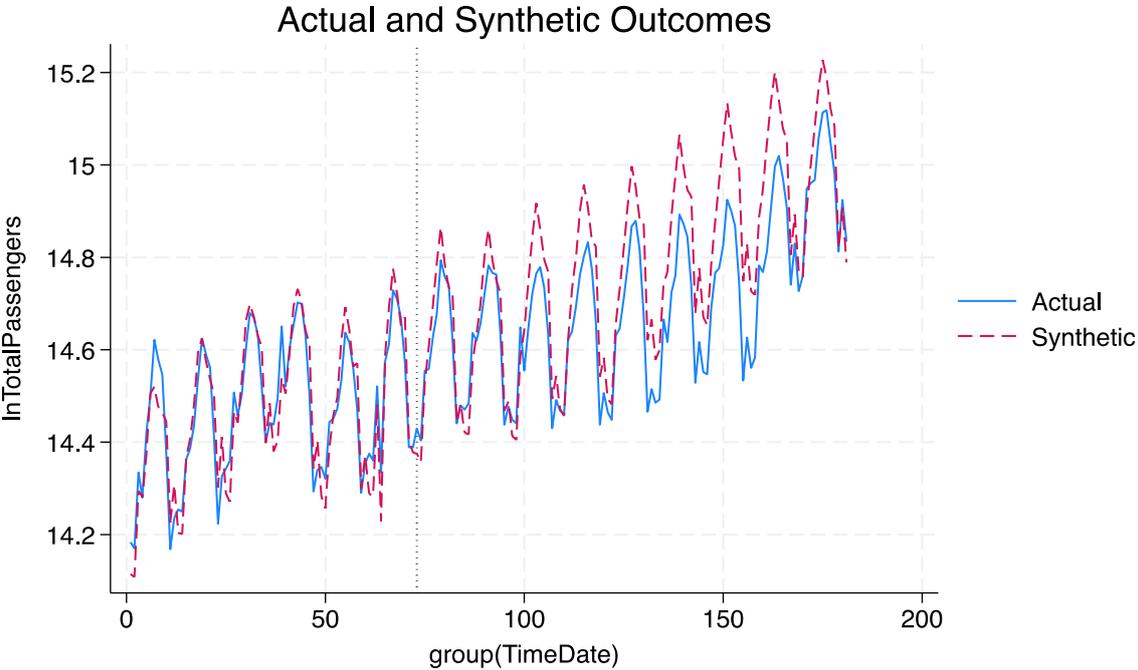


Figure 5: Trends total passengers of Austria and counterfactual using Synthetic Control Method.

With eye on the hypothesis of heterogenous effects of the tax, I performed the same analysis for short-haul flights and just long-haul flights. The focus on short-haul flights shows that there is a negative average treatment effect of 11.74%. We expect that the effect on long-haul flights is more severe and therefore more negative. Results show this to be the case: the average treatment effect on long-haul flights is -15.35%.

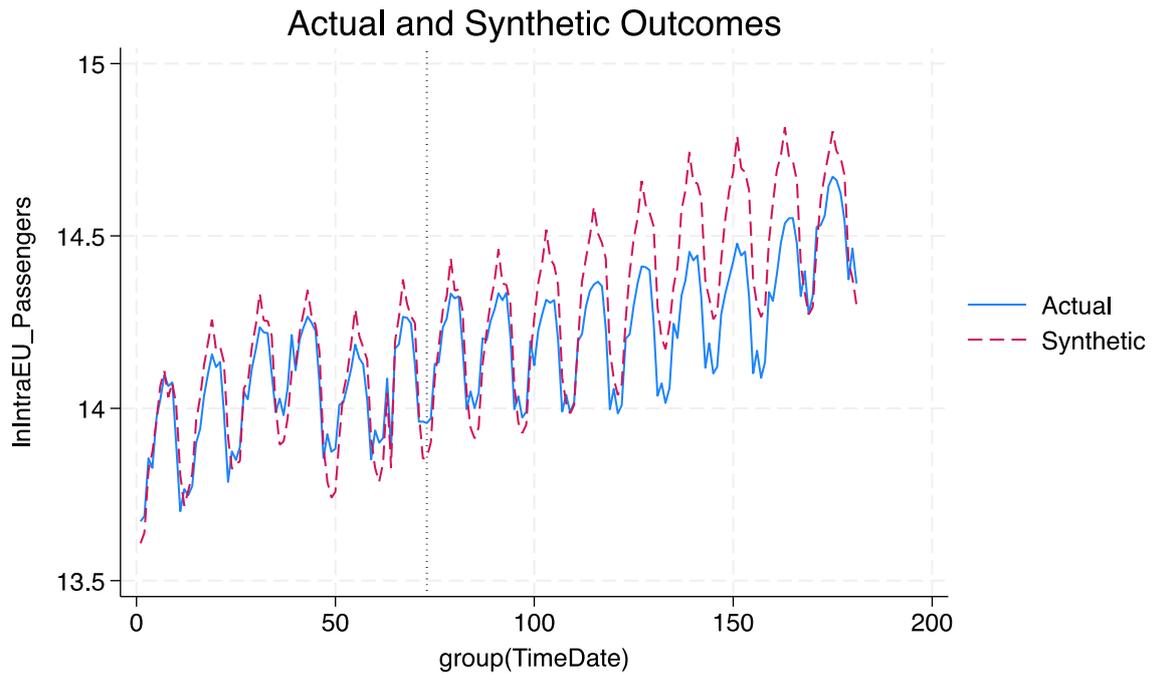


Figure 6: Trends short-haul passengers of Austria and counterfactual using Synthetic Control Method.

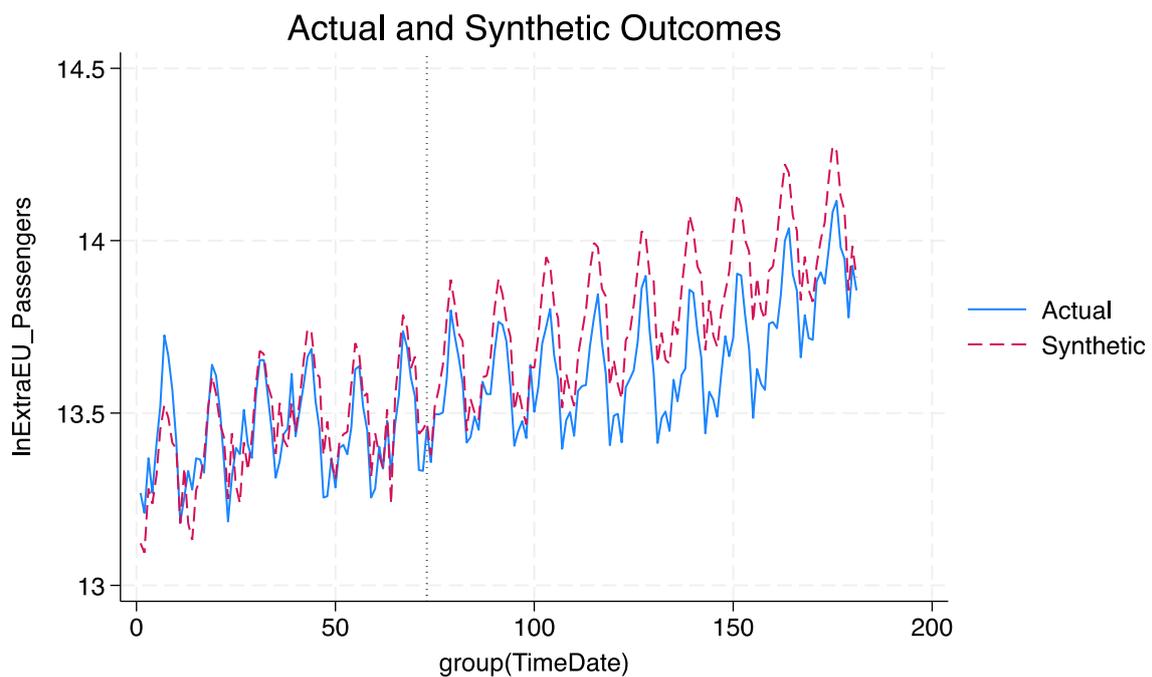


Figure 7: Trends long-haul passengers of Austria and counterfactual using Synthetic Control Method.

Although the type of taxes and introduction period in Germany and Austria are largely similar, there is one difference, however, that should be taken into account when trying to compare the coefficients of the two countries. The effects found by the SCM may not be fully representative for Germany as in Austria the tax was halved in 2018, which is also

visible in figures 5, 6 and 7, as there appears to be an increase in the last two years on the graphs, which are 2018 and 2019.

C) Spillover to all neighbouring countries

As mentioned before, the findings regarding spillovers in the Austria case showed that there were positive spillovers from Germany to Austria and these results are in contrast with the previous results regarding spillovers, which were in line with my hypothesis that there are no spillovers. In order to give more clarity about whether there are spillovers or not, a DiD model was run to expose spillovers. This model includes all of the countries neighbouring Germany (apart from Switzerland for which I do not have data). So, this model also includes the Netherlands, France and Austria which were previously dropped from the study as these countries deploy or deployed a similar passenger tax to Germany in the studied timeframe. The model controls for the taxes in these countries and estimates the spillovers from Germany towards the neighbouring countries. Results are documented in table 6.

Results in table 6 show no evidence for significant spillovers from the German point of view, which, again, is in line with my second hypothesis that there are no relevant spillovers in the studied setting. To explain why there was a case of positive spillovers in the case of Austria, the size of the respective countries seems the major driver behind these findings: The number of travellers that diverted from German airports to Austrian airports may be significant for Austria and not for Germany as the passengers numbers in Austria are much lower than in Germany due to the fact that Germany is a much larger country with more inhabitants.

All in all, this extra analysis of the Austria case and the check for possible spillovers using all neighbouring countries provide some evidence for the robustness of my results and with that also some support for my three hypotheses.

Table 6: Spillover effects to all neighbouring countries

	Total Passengers
Spillover effect (Germany→Neighbours)	-0.000 (0.096)
Tax Austria	-0.095 (0.056)
Tax Netherlands	-0.063 (0.040)
Tax France	-0.057 (0.070)
GDP per Capita	0.779*** (0.164)
Population	-0.636 (0.793)
% Employed	-0.890 (0.906)
Quarter 1	-0.598*** (0.122)
Quarter 2	0.234*** (0.033)
Quarter 3	0.371*** (0.049)
TFE (Q)	Yes
CFE	Yes
Obs.	1342

*Notes: standard errors in parentheses; GDP per Capita and Population measured in logarithmic form; % Employed is the percentage of the total population that is employed; Tax Austria, Tax Netherlands, Tax France cover periods in which taxes were present in the relevant countries; Quarters are dummies, reference category is Quarter 4 (Oct-Dec); TFE (Q) = Time Fixed Effects (Quarterly), CFE = Country Fixed Effects; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.*

VI. Discussion

A) Model assumptions

This research does not come without its flaws and therefore it is important to discuss those flaws and how they possibly influence the research and results. For all the regressions there is a setback regarding the Stable Unit Treatment Value Assumption mentioned earlier in the methodology sector. This assumption holds when there is no response of either the treatment group or the control group on the existence of the other group. As discussed before when formulating the hypothesis, there likely is a reaction from the treatment group and given that the results support my hypothesis, it is likely that the SUTVA does not hold in this setting. Although I control for spillovers to neighbouring countries, the aviation industry makes it possible to easily divert to countries that are further away for transfer flights. This, in combination with the findings of Mayor and Tol (2007) that relative prices are most important to passengers, provides support for the concept of making transfer flights elsewhere to spread the lower tax tariff over the total travel journey, making it less significant. This mechanism becomes problematic for my research when these transfer flights exist of a short flight to another European country that is present in the control group of the dataset, followed by a long-haul flight from that location. This would lead to an underestimation of the effect on short-haul flights and an overestimation of the effect on long-haul flights. The reason for the underestimation of the effect on short-haul flights is the fact that more travellers make these short-haul transfer flights as a result of the tax. The reason that the effect on long-haul flights is likely overestimated is that travellers from Germany now take long-haul flights from other untaxed locations in Europe, and these are likely to be in my dataset and part of the control group which is used to estimate the effect. So, because of the fact that SUTVA does not hold, we do not estimate the true effect of the tax, but a biased estimator.

Another issue with the setting that is studied is the presence of anticipation effects. Tests that look to expose anticipation on the treatment show that there is evidence for anticipation ($P=0.000 < 0.05$ for all flight types), which would mean that passengers anticipate the treatment by planning their flights just before the introduction of the tax to evade the taxation on their flight. This mechanism is very much possible as the government announced the tax several months before introducing it. The consequence of this anticipation effect would be an overestimation of the effect:

passengers that would normally book a flight after the tax introduction, now move their booking forward meaning that more people fly pre-intervention and less fly post-intervention, leading to the coefficient being estimated more negative than the true average treatment effect on the treated. I do, however believe that in this study, the bias introduced by this anticipation effect is limited, because the timeframe of the research is quite large. It would be more problematic when estimating short-term effects.

So, for both the analysis of long-haul and short haul passengers, we find an overestimation of the effects due to anticipation effects. Additionally, in the case of short haul passengers, we find an underestimation of the effect due to the violation of SUTVA. And in the case of long-haul passengers, we find that the estimated effect is even more overestimated due to the violation of SUTVA.

B) Research setup

Besides the violation of assumptions relating to the DiD model, there are also some arbitrary choices that had to be made regarding the operationalization of variables.

The main issue that stands out is the distinction between long-haul flights and short-haul flights. In my research, I have made this distinction based on whether the flight is within Europe or intercontinental and while this for Germany may be reasonable, as Germany is quite central in Europe, for other countries it may be less plausible. In reality, the tax is based on multiple factors, but distance is the main driver between the distinction of the different tariffs deployed. Even for Germany, this distinction between long-haul and short-haul flights introduces complications. For example, flights from Germany to Portugal and Tunisia are approximately the same distance, but one is intercontinental and the other is not. This means that for some cases intercontinental flights are actually short-haul flights and a lower tax tariff is applied.

Ideally, I could make distinctions between flights by the distance, but that data was not available to me. Also, when flights can be linked to the airline that operates them, then it would be possible to make a distinction between direct flights and transfer flights, which would mean that I could verify the reasoning behind my hypothesis that the relatively smaller effect in short-haul flights is due to the transfer flights, but unfortunately, this data was also not available to me.

VII. Conclusion

A) Main findings and relevance of the study

All in all, this study may not expose the true effect of the departure tax, but it does give some valuable insights into the possible mechanisms that follow as the tax is introduced and it provides a broader explanation for some of the findings in the existing literature.

Results show a logical decrease in passenger numbers following the introduction of the departure tax, which is in line with previously conducted studies. The way that this study adds to that literature is by exposing possible heterogeneity in the effect when it comes to different types of flights, namely: long-haul and short-haul. This study showed that the introduction of the tax resulted in a relatively larger negative effect on long-haul flights passenger numbers. While this may at first seem counterintuitive as there are less alternatives for long-haul flights, it starts to make sense when we take into account the possibility of transfer flights. Passengers fly short distances against a low tax tariff to countries where there flights are not taxed in order to take a long-haul flight from there to avoid the heavier taxation on long-haul flights in Germany. This mechanism explains two previous findings in the literature.

Firstly, the mixed evidence for spillovers to neighbouring countries. When taking transfer flights into consideration, spillovers may not be limited to just neighbouring countries and that explains why in some studies, no evidence for spillover effects to neighbouring countries was found.

Secondly, Falk and Hagsten (2018) find that airports that mainly serve LCCs, experienced the negative consequences of the introduction of the tax the most. This can be explained by the fact that LCCs do not operate transfer flights. Transfer flights are operated by legacy carriers with the purpose to feed passengers to their hub from where bigger intercontinental flights are planned. Thus, airports that serve LCCs do not benefit from the substitution from direct flights to transfer flights.

So, even though this study may fail to provide unbiased estimators for the effect of the departure tax, it does provide some interesting results that are also somewhat robust, and with a short guide to how the aviation sector operates, they expose some explanatory mechanisms behind the findings that can also be applied to previous studies to gain a broader understanding of passenger behaviour and taxation. As for society, this study

also provides some relevant implications, specifically for policy makers regarding taxation.

B) Policy implications

The main takeaways from this study in combination with the already existing literature imply that excise taxes in aviation, such as the German departure tax, decrease passenger numbers, but at a cost. The main finding of this study is that there is evidence for a consumer reaction through transfer flights: long-haul flights are now taken in other countries in combination with a flight to that country.

When the main goal of the policy makers is to make changes that benefit the climate, an excise tax may not be the best way to go about. The substitution from direct to transfer flights means that there is now one more landing and take-off in the journey and most likely also a detour. The take-off is the most fuel intensive element of a flight as the engine operates on full thrust, which means that this phase also causes a lot of emissions (Masiol & Harrison, 2014). This leads to speculation on whether the consequences of the introduction of the tax really benefit the climate in total or whether there is just a transfer of emissions from one place to the other.

Also, previous studies such as the study by Gordijn and Kolkman (2011) have shown that this type of taxation comes with disadvantages for local airports and airlines. The tax makes it harder for these agents to compete in the market where they face airlines and hubs that do not experience such taxation and can therefore offer more attractive prices. This was also the reason why the Dutch government withdrew the tax after just one year (Gordijn & Kolkman, 2011). In the current taxation system for aviation in the Netherlands, transfer passengers are exempted from taxation (Belastingdienst, 2024). With this exemption, Schiphol remains as one of the most competitive connection airports and KLM remains competitive with other big legacy carriers. Using excise taxation as a discouragement from flying seems to be somewhat effective: the total number of passengers drops, but this does not necessarily mean that the emissions also drop. So, if the goal is to discourage flying in order to benefit the global climate, an excise tax may not be the answer in a setting where there is a possibility of tax avoidance such as the aviation sector in Europe.

As mentioned before, excise taxes are also often deployed for regulation purposes when externalities are present. In this setting the passengers are ought to pay for the pollution that they cause by flying, which harms others. Also in this case, the tax avoidance means that the passengers are not held accountable for the total pollution caused by them. However, if the government focusses only on locally harmed people, the tax does seem to satisfy its purpose: all departing passengers pay to compensate for local emissions and as short flights are often operated in smaller aircraft, which also emit less when taking off, the lower fee for short-haul flights is also justified.

C) Evaluation of tax and future research

To summarize, the effectiveness of the tax is decided by the goal with which the tax was introduced. In the case of excise taxes and the battle against global emissions, the tax' effectiveness is very much debatable in the current form where the tax is not global, but only deployed by a number of countries. When tax policy on aviation would be globally coordinated, the effectiveness regarding the reduction of emissions would increase substantially. For this coordination, there might be a big role for IATA, with for example the global introduction of taxation on flight tickets or lifting the tax exemption and introducing global taxation on kerosene.

Regarding future research, it would be interesting to find the true treatment effect, by making a distinction between transfer flights or by using a different control group where it is unlikely that there will be spillovers, such as the United States. Also, it would be relevant to make the link between emissions when discussing the tax as a climate regulation in order to estimate the effect of the tax on emissions and with that identifying the true effectiveness of the tax in a climate related setting.

VIII. Appendix

Graphical diagnostics for parallel trends

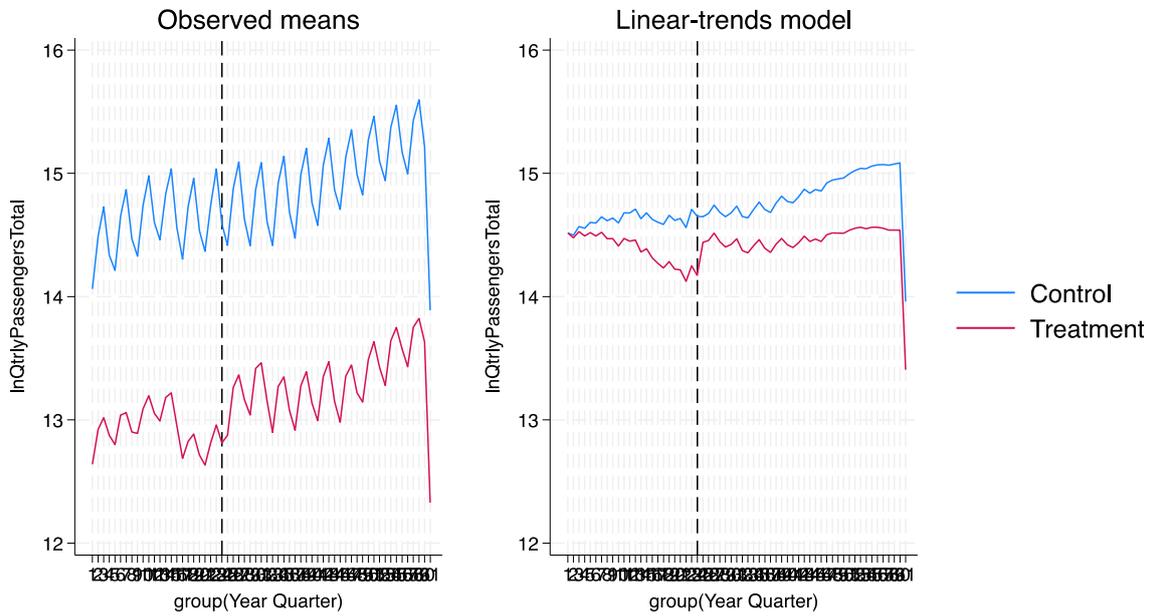


Figure 8: Visualization of parallel trends for total passengers in Estonia.

Graphical diagnostics for parallel trends

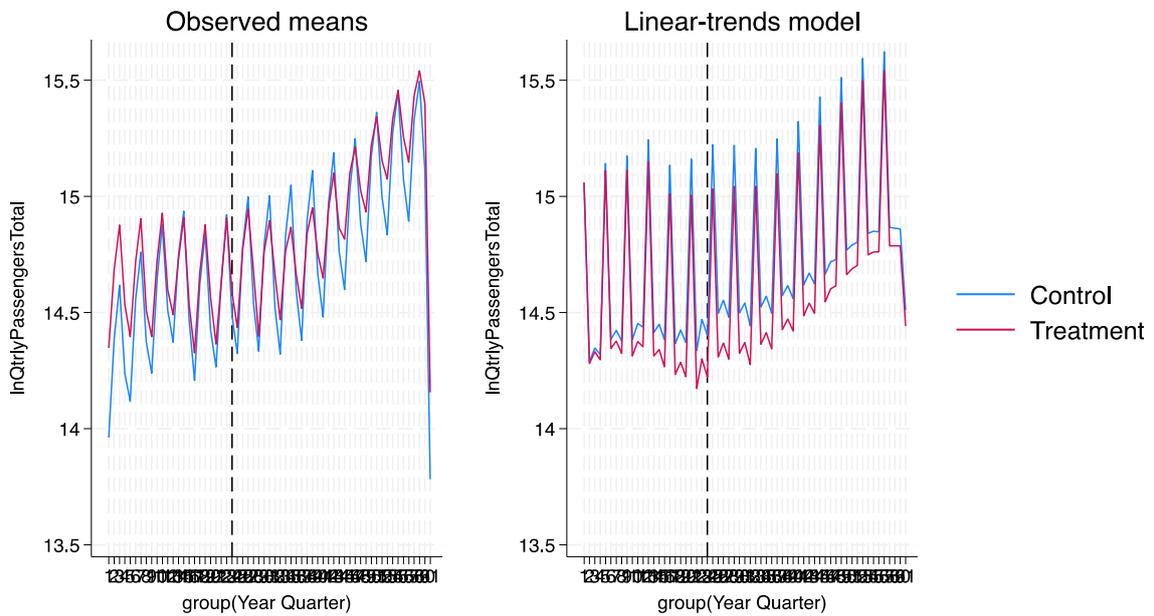


Figure 9: Visualization of parallel trends for total passengers in Hungary.

Graphical diagnostics for parallel trends

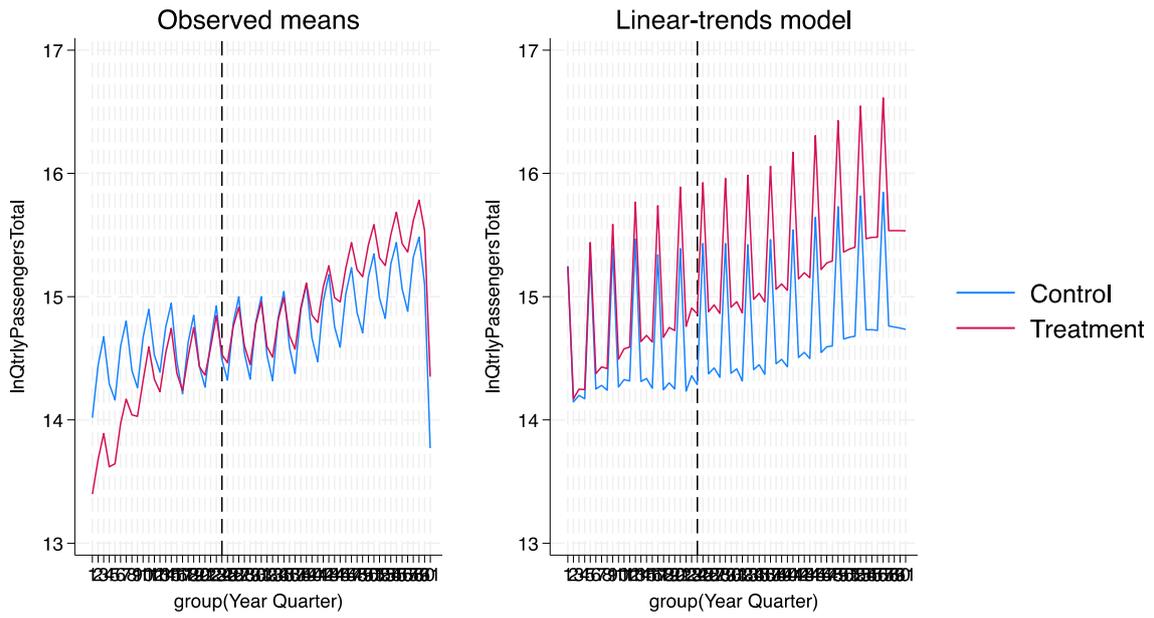


Figure 10: Visualization of parallel trends for total passengers in Romania.

Graphical diagnostics for parallel trends

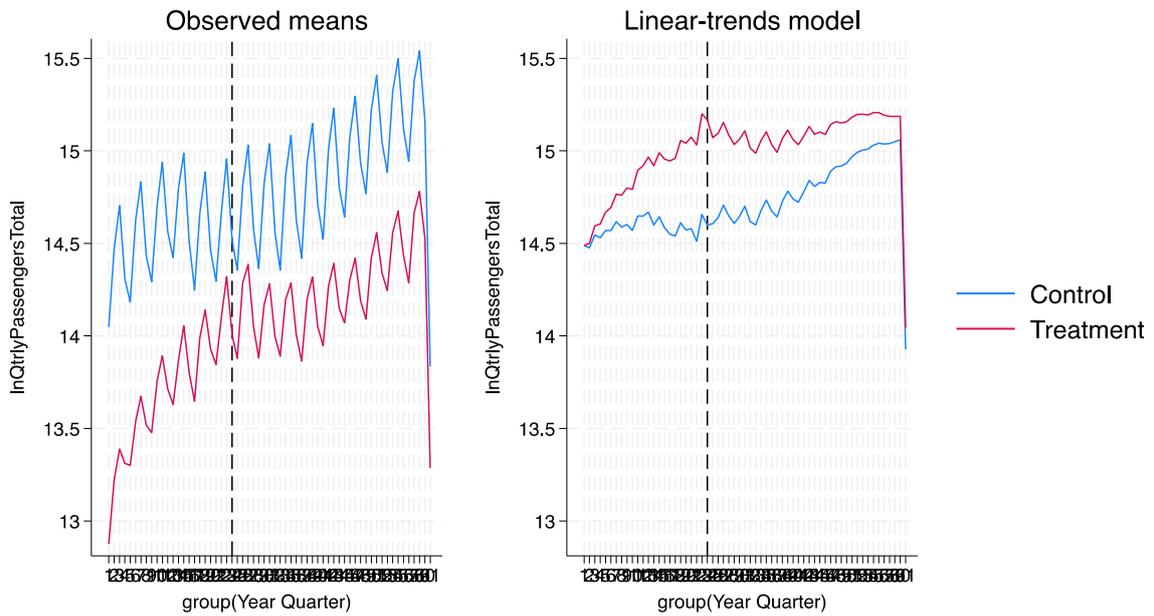


Figure 11: Visualization of parallel trends for total passengers in Latvia.

Graphical diagnostics for parallel trends

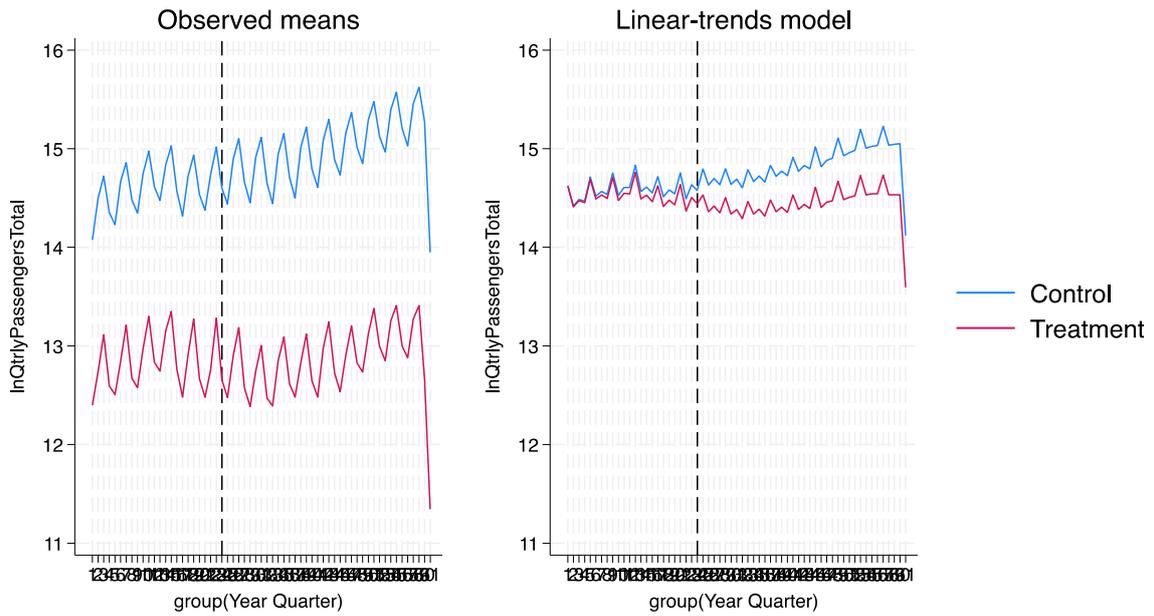


Figure 12: Visualization of parallel trends for total passengers in Slovenia.

Graphical diagnostics for parallel trends

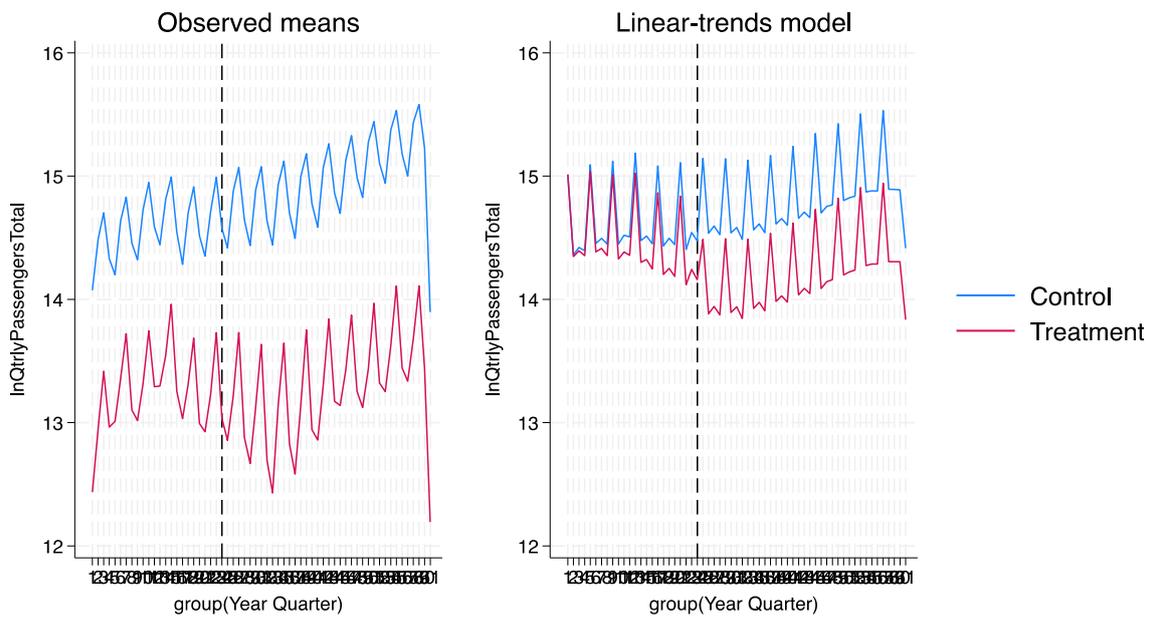


Figure 13: Visualization of parallel trends for total passengers in Slovakia.

Graphical diagnostics for parallel trends

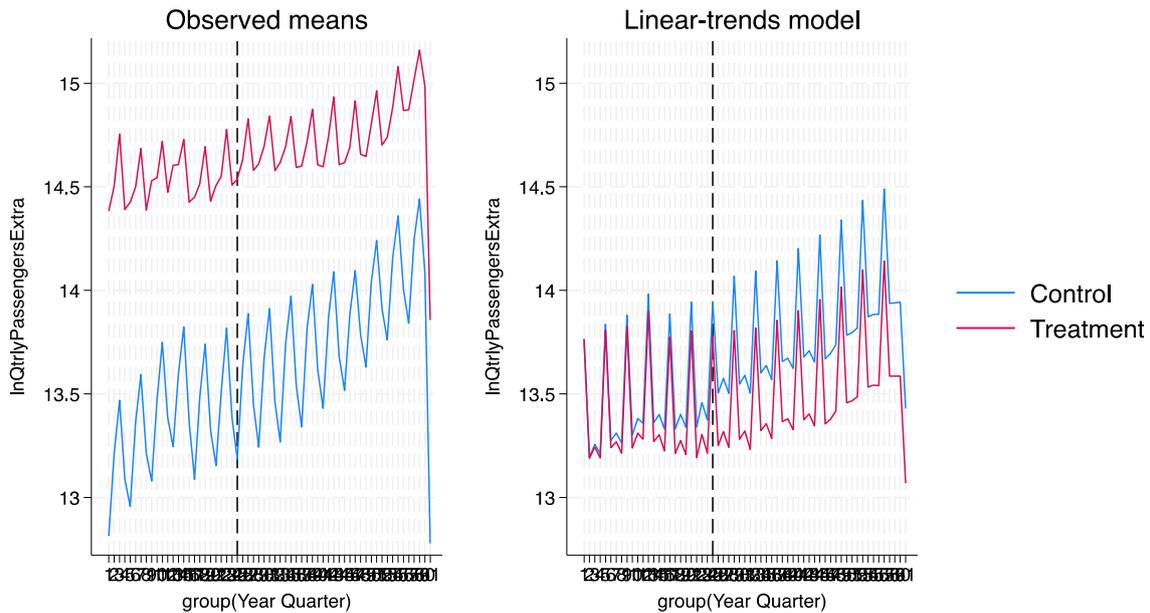


Figure 14: Visualization of parallel trends for long-haul passengers in Austria.

Table 7: Spillover effects in the Austrian case

	Total Passengers
Spillover effect (Germany→Austria)	0.188*** (0.063)
Tax Austria	-0.099* (0.052)
GDP per Capita	0.731*** (0.163)
Population	-0.644 (0.766)
% Employed	-0.779 (0.960)
Quarter 1	-0.659*** (0.132)
Quarter 2	0.242*** (0.038)
Quarter 3	0.386*** (0.057)
TFE (Q)	Yes
CFE	Yes
Obs.	1159

Notes: standard errors in parentheses; GDP per Capita and Population measured in logarithmic form; % Employed is the percentage of the total population that is employed; Tax Introduction Austria and Quarters are dummies, reference category for quarterly dummies is Quarter 4 (Oct-Dec); TFE (Q) = Time Fixed Effects (Quarterly), CFE = Country Fixed Effects; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

IX. References

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