"The Effects of LCCs Subsidies on the Tourism Industry"

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Abstract

This paper studies the relationship between air transportation, tourist flows, and subsidies to Low Cost Carriers (LCCs), a policy used by many national and local governments to stimulate tourist arrivals. To test the policy empirically, we use a two-stage empirical model. In the first stage, we estimate a structural model applied to air transport, and in the second stage, we link passenger arrivals to regional tourism flows. In this way, we use exogenous shocks (subsidies to LCCs) in airline supply to analyze the causal link with tourist arrivals. This model is applied to tourist flows from European regions to Italian regions from 2016 to 2018. Our counterfactual analyses consider two regimes for implementing subsidies to LCCs, following the literature coming from Oates (1993, 1999) contributions: a centralized, uniform policy for all regions and a decentralized policy in which subsidies are adopted by a single region. Our simulations reveal that subsidies to LCCs are effective in stimulating tourism, and that a centralized regime is more effective than a decentralized one. In fact, the latter generates externalities in regions that do not implement the subsidy, making the decentralised policy economically sub-optimal and unsustainable.

JEL classification: R41, R48, O18
Keywords: Air transportation and tourism, structural model

1 Introduction

It is well known that good accessibility by air is a crucial factor for tourism (Brueckner, 2003; Green, 2007; Bel and Fageda, 2008; Seetaram et al., 2016). For example, Koo et al. (2017) report that the aviation sector supports approximately 58 million jobs in the global economy, and 35 million of these jobs are in the tourism sector. Recent data show that in the U.S., the travel and tourism industry is worth \$1.6 trillion in 2017, of which \$270 million comes from air travel (Forbes and Kosová, 2023). Globally, the travel and tourism sectors generated 10.4% of the global GDP in 2019, and these industries have been a major source of job creation, accounting for one in four net new jobs in the 2014–2019 period (WTTC, 2020). Empirical evidence confirms the existence of a positive relationship between air transport and tourism (see Forbes and Kosová, 2023; Tsui, 2017; Alderighi and Gaggero, 2019; Chow et al., 2021; Tang et al., 2023), usually through reduced form models.

In parallel, the development of Low Cost Carriers (LCCs) in Europe has been a transformative force in the aviation industry during the last 20 years, following the 1998 market liberalization. As a result, the LCC market share in Europe has grown from around 5% in 1996 to over 40% by 2019, reshaping travel patterns and accessibility. Indeed, the low fare policy of LCCs stimulates the typically price-sensitive tourist segment of air travel; their point-to-point network model allows for direct connections between origin and destination cities. Finally, LLCs' use of secondary airports allows access to regions with high seasonal tourist attractiveness, but few full-service airline connections. This expansion has not only made air travel more affordable for consumers, but has also stimulated economic growth in regional areas, including the tourism sector. Bilotkach et al. (2019) examine the relationship between the presence of LCCs and international passengers in Asia and find a positive effect. Alderighi and Gaggero (2019) show that LCCs had a beneficial impact on tourist flows in Italy over the 1999–2010 period (see also Papatheodorou and Lei, 2006; Donzelli, 2010; Castillo-Manzano et al., 2011; Rey et al., 2011; Massidda and Etzo, 2012).

Based on this empirical evidence, national and regional governments in many European countries have adopted policies to subsidize LCCs in order to stimulate tourist arrivals. These policies are not specific to Europe. In the Greater Bay Area, relating to the Guangdong in Mainland China, Hong Kong and Macau, a mega-city the size of Great Britain, there is a heated debate for greater coordination among various governments to implement air transportation policies as a stimulus for the tourism sector.[1] Fageda et al. (2018) stated that Spain spent 250 million euros on subsidies between 2007 and 2011, underlying the different types of subsidies granted

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[1]See the news in South China Morning Post, https://www.scmp.com/news/hong-kong/hong-kong-economy/article/3261639/hong-kong-government-can-boost-tourism-better-coordination-alignment-bay-area-plans-industry-leaders.

to LCCs, including co-marketing agreements, direct subsidies, and discounts on landing and terminal charges. In Italy, LCCs received about 391 million euros in subsidies in 2019, of which approximately 260 million went to *Ryanair* and 75 million to *EasyJet*.[2] In the European Union (EU), these subsidies have often been classified as state aids under competition laws. Recently, however, some contributions (Malavolti and Marty, 2017, 2019) have shown that LLCs subsidies can actually correct (and not introduce) distortions in airlines (and airports) competition. In addition, studies of the relationship between LCCs subsidies and their impact on tourism thus far have used a reduced-form approach (e.g., Wu et al. (2020); Salesi et al. (2022)), which implies that quantifying the impact of the subsidies has not been efficiently addressed.

In this paper, we develop a structural model of air transport that we link to the local tourism market to assess the impact of a change in LCC subsidy policy. In our model, potential air travelers living in a European region decide whether to fly to Italy for the summer holidays. If they decide to do so, they then choose among different available options. We model this decision with a standard discrete-choice demand model with differentiated products *à la* Berry (1994). In this setting, a product is a direct or connecting flight from the region in the European origin country to the Italian destination airport. At the same time, we model the pricing strategy of the European airlines that compete in price to attract potential consumers.

The regional flows of Italian tourists from the different European regions are derived from a model in which each region receives international tourist flows arriving by air and other transport modes. Tourists arriving by air might stay where they land or move to a nearby region. Thus, the air transport equilibrium model feeds regional tourist flows directly (passengers land and stay at a regional airport) and indirectly (nearby regions receive tourists from neighboring airports). We have therefore established a link between the air transport sector and the tourism sector.

We apply our model, thanks to the availability of specific data on international tourism flows,[3] to study tourist flows from European countries to Italian regions in the 2016–2018 period during the summer semesters (from April to September), when the majority of arrivals are concentrated. The Italian tourism market is an interesting case both in terms of air connections and from a tourism point of view. Most Italian regions are well served by the main European LCCs, while the legacy carriers have connections to the main Italian airports and alliances with *Alitalia-ITA Airways*, the former Italian flag carrier. As a tourism market, Italy ranks fifth in terms of international arrivals, which translates to approximately 27 million in 2020 (WTO, 2023). Its tourism sector is particularly important, contributing over 13% of GDP with an international tourist expenditure of €45.6 billion, which represents 8.0% of total exports. In addition, tourism

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[2]See the Italian national newspaper *Corriere della Sera*, https://www.corriere.it using the keywords *sussidi low cost italia*.

[3]Based on data availability, our model can be applied to any spatial context.

in Italy is highly decentralized, as the tourism and hotel industry have been supervised by regional governments since the Italian constitutional law of 1948. Finally, significant differences exist in the intensity of tourism between regions, as Italy has the highest number of UNESCO World Heritage Sites that are unevenly distributed across the country.[4]

After estimating this model on data, we are able to quantify the relationship between air transport and tourist flows. In particular, our model can be used to predict any change in the economic environment of the European air transport industry. Here, we consider a change in the subsidy policy for LCCs. In particular, this policy change generates non-trivial substitution effects on the passenger-choice process, which in turn affects tourist flows in the different arrival regions. Our structural model allows us to detail and quantify these effects. Specifically, following the debate around Oates (1993, 1999), this paper aims to analyze whether a centralized, uniform subsidy policy over the entire territory of a country is better than a decentralized subsidy policy in which individual regional governments implement subsidies to LCCs that land only in their region, a popular policy in many European regions to attract tourists.

The equilibrium is perturbed by the introduction of different LCC subsidy policies to perform the counterfactual analysis and identify a more effective type of public intervention. Following the debate originated by Oates (1993, 1999) on the comparison between centralized (implemented by national governments) and decentralized (under the responsibility of subnational institutions) economic policies, we conduct two counterfactual analyses: one in which the subsidy policy is controlled by the central government and uniform across all Italian regions, and another in which the subsidy is granted by a single region.

Our results show that the central government's uniform subsidy is more effective in increasing tourist flows than the decentralized regime. Both regimes increase tourist flows, but the former requires only about €35 per additional tourist, while the latter has a large majority of outcomes in which the amount of euros required to generate one additional tourist is higher. In the few cases in which this amount is slightly lower, serious implementation problems exist due to externalities generated by a single region's subsidy in other regions. In fact, our counterfactual analysis shows that when the subsidy is adopted in a decentralized manner by a single regional government, it creates three different effects on tourist flows: (1) an increase in tourists in the region that adopts the subsidy; (2) a decrease in tourists in several other regions due to the new equilibrium created in the air transport sector; and (3) an increase in tourists in some regions, without any monetary investment, due to the movement of some tourists to regions neighboring the one that invests in the LCC subsidy. The second effect is problematic because it creates competition between regions and is therefore hardly stable. The third effect, on the other hand, highlights the fact

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[4]See the UNESCO website at https://whc.unesco.org/en/list.

that the entire subsidy investment made by the regional government is not internalized, which leads to economic inefficiency. However, the second and third effects are not determined if the subsidiary policy is implemented in a uniform manner by the central government.

The rest of the paper is structured as follows. Section 2 describes the literature review. Section 3 details the structural model and how we link air arrivals to tourist flows. Section 4 displays the data set and provides some descriptive evidence. Section 5 presents and discusses our estimates of the model. Section 6 displays the results of our counterfactual analysis that compares the two subsidy policies, while section 7 draws the main conclusions. In an appendix, we provide further details on our estimation methodology, more detailed information on the construction of some variables, tables on the instrumental variables adopted, and the results by individual region of the counterfactual analyses in the decentralized policy.

2   Literature Review

Our work contributes to the literature that studies the determinants of tourism (Papatheodorou, 1999; Seetaram et al., 2016) and the relationship between air transport and tourism, and seeks to identify a causal relationship between these two factors. Empirical research on the determinants of tourism demand highlights the importance of income, general transport costs, and destination attractiveness. Regarding the relationship between air transport and tourism, the contributions of Papatheodorou and Lei (2006); Donzelli (2010); Castillo-Manzano et al. (2011); Rey et al. (2011); Massidda and Etzo (2012); Alderighi and Gaggero (2019) examine the impact of air transport activities on tourism in Great Britain, Italy, and Spain, focusing on the impact of LCCs, while Tsui (2017); Koo et al. (2017); Bilotkach et al. (2019); Chow et al. (2021); Law et al. (2022); Kuok et al. (2023); Tang et al. (2023); Shen et al. (2023) analyze this relationship in Australia, Cambodia, China, Laos, Myanmar, New Zealand and Vietnam. Forbes and Kosová (2023) study how airline competition affects hotel performance in the U.S. All of these papers are based on a reduced form and find (with the exception of Kuok et al., 2023) that air transport is a positive determinant of tourism and that LCCs are the main factors characterizing this relationship.

Furthermore, our paper completes the list of the few contributions that have examined the effects of LCCs subsidies on various economic outcomes. Surveys of aviation subsidies and their effects have been conducted by Fageda et al. (2018); Wu et al. (2020), while Barbot (2006) presents a model that studies the effect of subsidies to the European LCC *Ryanair* and shows a positive effect on the Irish airline's performance while penalizing its competitors. Fageda et al. (2016) examine the impact of subsidies granted to airlines (and in particular to *Ryanair*)

under public service obligation programs implemented in Spain to improve connections to remote regions and islands. They do not find any evidence that the subsidies lower prices while comparing the subsidized to the non-subsidized routes. Chow et al. (2021) investigate the relationship between subsidies, aviation activity, and tourist flows in China and find a positive effect only when airlines serve small- to medium-sized airports. Salesi et al. (2022) provide some evidence that tourism is boosted by aviation subsidies in some South Pacific regions. Our work differs from all of these contributions both in terms of methodology and the quality of the data available. In terms of empirical methodology, we provide more structure to the empirical relationship between aviation, tourism, and the impact of LCCs subsidies; we also have data on market transactions related to ticket prices and reservations that allow us to quantify this relationship.

Our model is taken from the literature on the demand for differentiated products used in industrial organization (IO). Some contributions apply it to the airline industry, mostly in the U.S. domestic market. For example, Berry et al. (2006) introduce discrete taste heterogeneity (leisure and business) among passengers and quantify their willingness to pay for different products. In a similar model, Berry and Jia (2010) report the shift in demand preferences towards direct flights between 1999 and 2006. Ciliberto and Williams (2014) study tacit collusion between airlines that repeatedly operate in the same markets. Chen and Gayle (2019) study the post-merger quality of an airline as a function of its past level of competition. Bontemps et al. (2022) propose an ex-post evaluation of the recent merger between American Airlines and US Airways, taking into account product repositioning for both the merged entity and its competitors.

Finally, our paper contributes to the literature comparing the effects of policy decentralization implemented by subnational institutions (e.g. regional governments) with the outcomes achieved by a central regime. Oates (1993, 1999) provide the first studies that show the superiority of decentralized regimes over centralized ones, due to better information on the target population and higher accountability, in a context of heterogeneous preferences across regions. Brueckner (2006) shows that economic growth is higher under decentralization. However, one problem with decentralized regimes is that they induce competition between subnational governments (see Balia et al., 2018). Specifically, they do not internalize the possible spillover effects of their policies on other regions and therefore determine suboptimal intervention levels. For example, Di Novi et al. (2019) show that decentralization in the Italian health sector has not reduced inequalities between regions. To the best of our knowledge, our paper is the first to empirically investigate the effect of decentralization in air transport subsidy policy. Our results show that, contrary to what Oates (1993, 1999) claim from a theoretical point of view, a centralized and uniform regime across all regions provides better effects on tourist flows than a decentralized one due to the presence of positive and negative externalities.

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3 The Model

In this section, we present our structural model used to analyze the relationship between the European airline sector and the tourism sector in Italy. The model is divided into three parts, which we explain in detail. First, we propose a demand model in which potential air travelers decide whether to fly to Italy for their summer holidays and, conditional on flying to Italy, choose their preferred destination. We then model the pricing strategy of airlines competing to carry travelers from each European city/region to Italy. Finally, we convert passenger flows into tourist flows using an allocation model described at the end of the section. The estimation strategy is presented in a final subsection.

3.1 Demand

To simplify the notation, we omit the year index t in this section. In our context, the definition of a market differs slightly from the usual origin-destination market. A potential air traveler, living in a European region, decides between going on holiday to Italy for the summer season by flying to one of the Italian airports or consuming an "outside option"—i.e., going to another country, not going on holiday, or traveling to Italy by other means of transport.

As a result, the market is defined by the traveler's origin region and is labeled m. In such a market, the list of products proposed to the potential consumer i (in addition to the outside option) is composed of the list of final destinations served by all European airlines from the origin region. Therefore, a product is defined as a seat on a flight from an airport in the region of departure[5] to an airport in Italy on a given airline and with or without a connecting flight. For example, in 2018, a consumer living in the Toulouse region (France) can fly from Toulouse/Blagnac airport to Naples with *Air France* with a connecting flight, or directly to Milan with *Easyjet*, among 35 other flight options. We denote the total number of products offered in market m (excluding the outside option) by J_m, and the products are indexed from 1 to J_m, leaving the subscript 0 for the outside option. The additional product characteristics are price, departure frequency, and the business model of the airline proposing the product (e.g., Full Service Carrier [FSC] vs. Low Cost Carrier [LCC]). Our specification captures the competitive dynamics between (Italian) regions, which compete through their "air products" to attract tourists by providing incentives to airlines to serve European destinations to/from their local airports.

We assume that consumers are homogeneous, and we model their consumption choices by the maximization of a utility function defined on the space of product characteristics. Consumption

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[5]Some European regions have more than one airport. For example, from Paris, passengers can depart from Orly, Charles de Gaulle, or Beauvais.

of product j in market m (from 1 to J_m) gives each consumer i an indirect utility, which can be decomposed into:

$$u_{ijm} = X_{jm}^\top \beta + \alpha p_{jm} + \gamma f_{jm} + \xi_{jm} + \eta_{ijm}(\sigma), \tag{1}$$

where X_{jm} is a vector of exogenous characteristics of product j (including some fixed effects), p_{jm} is its price, f_{jm} is the per-semester frequency of departures, and ξ_{jm} is a product-specific characteristic observed by consumers and airlines, but not by the applied economist.

Finally, the random utility term $\eta_{ijm}(\sigma)$ follows the generalized extreme value distribution necessary to derive the usual nested logit formula (see, among others, Galichon, 2022, for further details). This distribution depends on a parameter $\sigma \in [0,1($ that controls the degree of correlation of the random term across products of the same nest. If σ is equal to zero, the random terms are independent and we are back to the logit case. When σ tends to 1, the correlation between the random terms of the air products tends to 1 and substitution occurs only within the nest and not with the outside option.

As a result, with the notation $\delta_{jm} = X_{jm}^\top \beta + \alpha p_{jm} + \gamma f_{jm} + \xi_{jm}$ and $\lambda = 1 - \sigma$, the model predicts the market share of the outside option in market m, s_{0m}, as well as the market shares of the air products, $j = 1, \ldots, J_m$, s_{jm} (see, for example, Berry, 1994, for further details):

$$s_{0m} = \frac{1}{1 + \left(\sum_{k=1}^{J_m} e^{\delta_{km}/\lambda} \right)^\lambda}, \tag{2}$$

$$s_{jm} = \frac{e^{\delta_{jm}/\lambda}}{\sum_{k=1}^{J_m} e^{\delta_{km}/\lambda}} \left(1 - s_{0m} \right). \tag{3}$$

3.2 Supply

We assume that airlines in each market m compete *à la* Bertrand with differentiated products, having constant marginal costs. In the following, mc_{km} is the marginal cost of product k proposed in market m.

Let $h = 1, \ldots, H$ be the index of airlines and $\mathcal{J}_{h,m}$ be the subset of indices of products offered by airline h in market m (i.e., a subset of $\{1, \ldots, J_m\}$). Airlines set their prices independently in each market, taking the strategies of their competitors into account via the market shares defined in (2) and (3). The optimal prices of products $j \in \mathcal{J}_{h,m}$ offered by airline h satisfy the

first-order condition:

$$s_{jm} + \sum_{k \in \mathcal{J}_{h,m}} (p_{km} - mc_{km}) \frac{\partial s_{km}}{\partial p_{jm}} = 0. \tag{4}$$

In Eq. (4), the airline takes into account the effect of a change in its product prices on the market shares of its other offered products in the same market through the term $\frac{\partial s_{km}}{\partial p_{jm}}$, which is known from the demand side. This potential cannibalization effect leads, at the equilibrium, to the same markup for all products offered by the same airline in market m.

3.3 Predicting tourist flows from passengers

Remember that our objective is to relate the flow of air passengers to the flow of tourists visiting Italy in the summer. The structural model captures the dependence of air passengers on different characteristics. Here, we focus on the summer part of the year and on the discount-economy category. Implicitly, we assume that an air passenger is a tourist, and as such, we adopt a very broad definition of a tourist. In fact, air passengers travel for both tourism and business. However, the data on the tourism sector available in the official statistics compiled by the Italian Institute for Statistics (Istat) classifies tourists as the presences at accommodation facilities (hotels, Airbnb, and so forth.). In particular, Istat defines a tourist as "an individual who travels to a location distinct from their customary surroundings and resides for a minimum of one night in the destination visited".[6] Therefore, air passengers traveling on business and staying at accommodation facilities are also classified as tourists. The only passenger component that should therefore not be considered in tourist flows is that of people staying with relatives and friends. However, no official statistics are available to quantify the share of air passengers residing in European countries who travel to Italy and stay in non-commercial private accommodations, although it is reasonable to assume that the share of residents permanently abroad and with close social relations in Italy is quite low.

Moreover, tourists may arrive in Italy by other means of transport. Also, some regions do not have international airports and potential tourists have to land in another region, such as Trentino-Alto Adige and Valle d'Aosta for example, as shown in Figure 1. Finally, some airports may be located on the border of two regions, and people landing at such airports obviously have the choice of visiting at least one of these two nearby regions. Our goal is to estimate what proportion of passengers landing in a given Italian region k become tourists in a region r. In our data, we don't have the number of tourists visiting Italy by region of departure, but only by country of origin c. Therefore, we consider the following reduced form model:

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[6]See the official website https://www.istat.it/en/.

$$TOU_{cr} = \beta_{cr,0} + \sum_{k=1}^{16} \beta_{kr,1} \times PAX_{ck} + \varepsilon_{cr}, \tag{5}$$

where the dependent variable is TOU_{cr}, the number of tourists visiting the Italian region r and coming from country c, the covariates are the number of passengers PAX_{ck} departing from any airport in country c and landing in region k and ε_{cr} is the standard random term. $\beta_{kr,1}$ is the fraction of passengers landing in region k and visiting region r (note that k can be equal to r, since obviously people landing in a region will probably visit that region). The constant term $\beta_{cr,0}$ captures the average number of tourists visiting region r from country c who do not arrive by air. This is a country/region-specific parameter, as it depends on the size of the focal country and the availability of reasonable alternatives by other modes of transportation from that country to that specific region.

3.4 Estimation

We estimate the parameters of the demand and supply parts jointly from our aggregated data using the generalized method of moments (GMM), which is the standard approach. On the demand side, we know that we can invert the system of equations (2) and (3) to recover the values of ξ_{jm} given the observables. Following Berry (1994), we actually have the usual inversion formula:

$$\xi_{jm} = \log\left(\frac{s_{jm}}{s_{0m}}\right) - \left(\boldsymbol{X}_{jm}^{\top}\boldsymbol{\beta} + \alpha p_{jm} + \gamma f_{jm} + \sigma \ln \frac{s_{jm}}{1 - s_{0m}}\right). \tag{6}$$

In the above equation, the product characteristics $\boldsymbol{X}_{jm}$ are exogenous—i.e., $E(\xi_{jm}|X_{jm}) = 0$. However, p_{jm}, f_{jm}, and $\ln\frac{s_{jm}}{1-s_{0m}}$ are correlated with the unobserved characteristic ξ_{jm}. Therefore, we need to find additional instruments (at least 3) to consistently estimate the vector of demand parameters, denoted, from now on, θ_d. We describe our instruments in the empirical section. Let Z_{kjm}, $k = 1, \ldots, K$ be the K instruments used to estimate the demand, including X_{jm}; our K moments for the demand part are:

$$E\left(\xi_{jm}Z_{kjm}\right) = E\left(Z_{kjm}\left(\log\left(\frac{s_{jm}}{s_{0m}}\right) - X_{jm}^{\top}\beta - \alpha p_{jm} - \gamma f_{jm} - \sigma \ln \frac{s_{jm}}{1 - s_{0m}}\right)\right) = 0, \ k = 1, \ldots, K. \tag{7}$$

On the supply side, we assume that the marginal cost of production depends linearly on various product characteristics:

$$mc_{jm} = \boldsymbol{W}_{jm}^{\top}\boldsymbol{\psi} + \zeta_{jm}, \tag{8}$$

in which $\boldsymbol{W}_{jm}$ is a $L \times 1$ vector of observed characteristics $w_{l,jm}$, $l = 1, \ldots, L$ and ζ_{jm} a marginal cost shock. To estimate parameter $\boldsymbol{\psi}$, we rely on the L normal equations:

$$E\left(\zeta_{jm} w_{l,jm}\right) = E\left(w_{l,jm}\left(mc_{jm} - \boldsymbol{W}_{jm}^{\top}\boldsymbol{\psi}\right)\right) = 0, \; l = 1, \ldots, L. \tag{9}$$

Note that the latter system of moment equations includes both $\boldsymbol{\psi}$ and the demand parameters, θ_d, since the marginal costs are derived from (4)—i.e., the airline's optimal strategy that takes demand into account. The system of $K + L$ moment equations above is used for the estimation using the optimal weighting matrix computed from a first-step estimation. More details can be found in Appendix A.

To estimate the allocation model shown in Eq. (5), in order to limit the number of parameters to be estimated, the $\beta_{kr,1}$s are calibrated according to the annual survey of the Bank of Italy, while the $\beta_{cr,0}$s are estimated. To do this, we estimate a standard linear regression of the number of tourists on a constant term, keeping the values of $\beta_{kr,1}$ at their calibrated values.

4 Data and descriptive analysis

4.1 Data sources and sample selection

The data sources are diversified. The data on air transport come from the Official Airline Guide (OAG) platform.[7] We use two databases from this source: the Schedule Analyzer (SA) and Traffic Analyzer (TA). SA provides data on all direct commercial origin-destination flights in the world that airlines regularly schedule. It also provides information on frequencies, distance, flight time, and aircraft type for each flight. TA, on the other hand, provides data on prices[8] and quantities for origin-destination travel with or without connections. This information is broken down by booking class—from first class to discounted economy. Unlike the well-known U.S. Department of Transportation data (DB1B), we do not have individual data. TA information is aggregated monthly for each route used by passengers flying on a particular airline from an origin airport to a destination airport.

With these data we can build our air transportation data set, which consists of all the possibilities to fly from the regions[9] of 26 European countries to the 16 Italian regions that have an international airport. The list of countries and regions is given in Appendix B. Figure 1

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[7]https://www.oag.com/

[8]TA prices do not include airport taxes.

[9]We consider the NUTS 2 regions. The acronym NUTS comes from the French *Nomenclature des Unités territoriales statistiques*. It is a geographical nomenclature that divides the economic territory of the EU into regions at three different levels (NUTS 1, 2 and 3, from larger to smaller territorial units). A NUTS 2 region corresponds to the provinces in the vast majority of European countries.

shows a map of Italy with its regions, and the black dots indicate the airports with commercial air service and their international codes. Three regions (in red in the figure), Basilicata, Trentino-Alto Adige and Valle d'Aosta, have no airports. Tourists traveling by air who visit these regions land at nearby regional airports, as for example, indicated for Valle d'Aosta in the upper right part of Figure 1.

We have data for three consecutive years (2016 to 2018), and we only retain information for the summer semester (April to September). We focus on the summer period, as it is when the majority of tourist flows to Italy from Europe are most concentrated. In addition, since we are studying the relationship between air transport and tourism, we only consider the economy discount-booking class provided by the TA data. Also, trips with two connections within Europe are very rare. We limit the options to a maximum of one connection and eliminate the rare trips with more than one connection.

Finally, we remove some of the products with extreme characteristics. We drop all observations with less than 10 passengers per week, or with an average fare of less than 10 euros, or with a frequency of less than once a week. The calculation of the frequency of an origin-destination (O-D) flight with a connection is explained in Appendix B.

The data on tourist flows from the various European regions to the Italian regions come from the Italian Institute for Statistics (Istat). For each European origin region, the monthly data indicate the number of tourists in any Italian region, as recorded in the official registers of the tourist offices required to register personal data on arrival at the destination. In addition to the data provided by Istat, we use information from the annual survey on international tourism in Italy published by the Bank of Italy.[10] The survey collects individual-level data on inbound passengers arriving at specific airports and their holiday destinations. Finally, information on some control variables (i.e., GDP per capita and share of people with tertiary education, both at the regional level) is obtained from Eurostat.[11]

4.2 Airline data summary

Table 1 reports some summary statistics of the variables of our structural model. The top panel reports summary statistics at the product level, and the bottom one reports at the market level. All statistics are calculated across products regardless of the number of passengers assigned to

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[10]See the website https://www.bancaditalia.it/statistiche/tematiche/rapporti-estero/turismo-internazionale/index.html?com.dotmarketing.htmlpage.language=1. Since 1996, the Bank of Italy has been conducting a survey on international tourism based on interviews and the counting of resident and non-resident travelers at the Italian borders (road and rail crossings, international ports, and airports). To estimate the number of the international travelers, information collected through the survey are integrated into administrative data and, since the end of 2020, with mobile phone data.

[11]See https://ec.europa.eu/eurostat
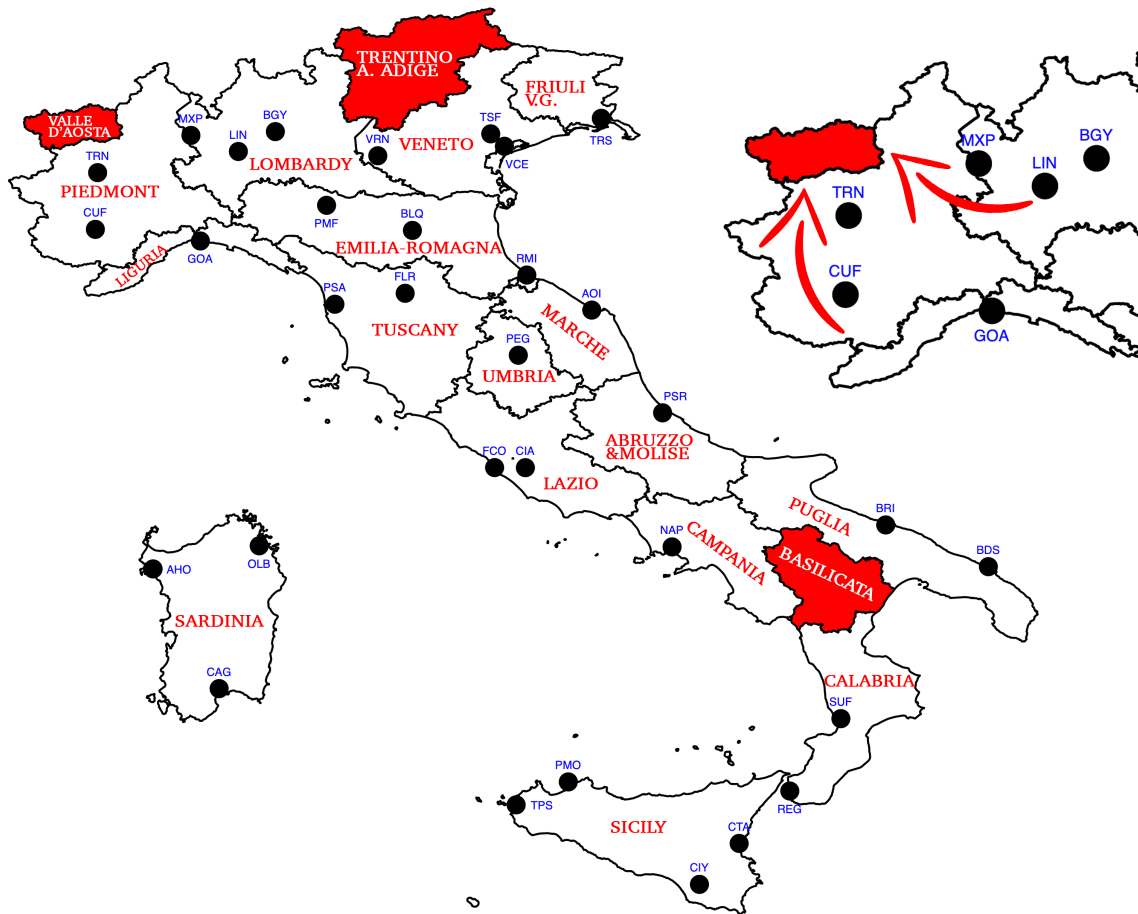
Figure 1: Map of Italian Airports and regions with no airports

each product in the first two columns. In the last two columns, these statistics are weighted by the number of passengers. Note the significant amount of heterogeneity across the 6,525 products and 397 markets. The mean number of passengers flying to Italy per semester (pax_{jmt}) is 5,527 with a standard deviation of 9,853, indicating a large variability. The mean price of directional tickets (p_{jmt}) is €101.31, with a standard deviation of €51.15, while weighting on passengers it averages €84.23, with a standard deviation of €37.10. The mean frequency of flights (f_{jmt}) is 457 (i.e., about 18 flights per week), with a standard deviation of 508, indicating a high variance.

Figure 2 shows the dispersion of airline fares. The vertical axis shows the frequency, which is separate for FSCs and LCCs and for direct and connecting flights at a gateway airport. It is evident that the LCCs fares are more concentrated on lower price levels than the FSCs fares. In addition, connecting flights, products offered by FSCs, have higher prices than direct flights, mainly offered by LCCs.
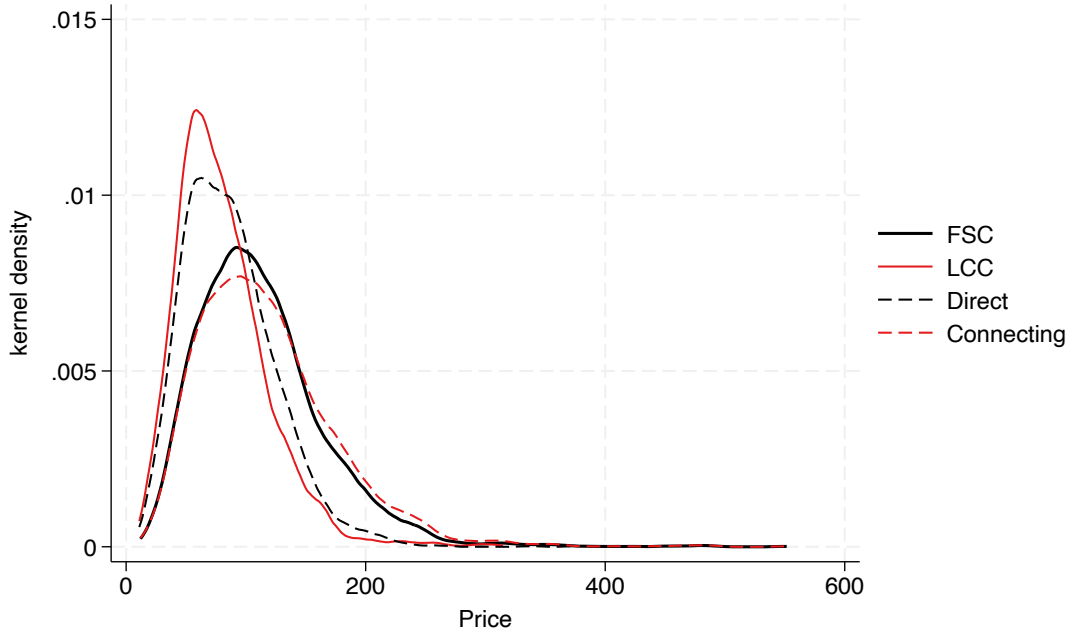
Figure 2: Fare Dispersion

Because of the specific market definition, we define the market size as the population of the NUTS 2 origin region provided by Eurostat. A common feature of airline data is that the average market share of a product, s_{jmt}, is very small, 0.3% in our case. If we consider only the people that decide to fly Italy, the average share of a product ($s_{jmt|a} = s_{jmt}/(1 - s_{0mt})$) is 6%, with a standard deviation of 0.12.

Concerning the airlines' different travel options from a European region to an Italian airport,

Table 1: Summary statistics of the main variables

	Product average			
	Unweigthted		Weighted on pax_{jmt}	
Variable	Mean	S.D.	Mean	S.D.
pax_{jmt}	5,527	9,853		
s_{jmt}	0.003	0.006	0.009	0.012
$s_{jmt|a}$	0.061	0.121	0.099	0.103
p_{jmt}	101.31	51.15	84.23	37.10
f_{jmt}	457	508	462	471
$fuel\_cost_{jmt}$	37.81	16.82	32.82	15.01
$direct\_fsc_{jmt}$	0.19	0.39	0.31	0.46
$direct_{jmt}$	0.53	0.50	0.93	0.26
lcc_{jmt}	0.35	0.48	0.62	0.49
$ryanair_{jmt}$	0.14	0.34	0.28	0.45
$easyjet_{jmt}$	0.07	0.25	0.17	0.37
$other\_non\_allied\_lcc_{jmt}$	0.05	0.21	0.06	0.23
$oneworld_{jmt}$	0.16	0.37	0.18	0.38
$star_{jmt}$	0.35	0.48	0.18	0.38
$skyteam_{jmt}$	0.22	0.42	0.12	0.33
Observations	6,525			
	Market Average			
	Mean	S.D.		
No. products	16.44	16.50		
No. carriers	4.51	3.45		
No. direct passengers	84,110	140,568		
No. connecting passengers	6,727	9,860		
No. FSC passengers	34,592	78,359		
No. LCC passengers	56,245	92,281		
s_{0mt}	0.957	0.072		
edu_{mt}	42.32	10.79		
gdp_{mt}	31,242	11,592		
No. of markets	397			
No. of European regions	138			

the LCCs represent 35% of the products (dummy *lcc*) for 62% of the passengers. Among them, the two main European LCCs, *Ryanair* and *Easyjet*, represent respectively 14% and 7% of the products for 28% and 17% of the passengers transported to Italy by air. The remaining passengers either fly with LCCs that belong to one of the three main alliances (such as *Vueling* or *Eurowings*) or are not members of one of them, (like *Wizz Air*). Most of the products offered by LCCs are direct flights (96%); among the 65% of products proposed by the FSCs, the direct ones correspond to 29% of these products, for a total of 19%. The three main alliances *Oneworld*, *Star Alliance* and *Skyteam* represent respectively 16%, 35%, and 22% of the products, and 18%, 18%, and 12% of the passengers. The remaining 2% of products correspond to flights operated by non-allied FSCs (e.g., *Air Baltic*).

The bottom panel of Table 1 reports the summary statistics at the market level. There are 397 markets in our data set.[12] On average, there are 16.44 possibilities to fly from a European region to Italy.

Although the market share of the outside option is —as known in the literature— quite high, [13] it is less important than in the standard O-D market. The average market share of the outside option is equal to 0.96, with a very low standard deviation of 0.07. In the majority of the European regions, most people do not fly to Italy for summer vacation.

As for the control variables, the percentage of the tertiary-educated population aged 30–34 in the NUTS 2 origin region (edu_{mt}) is 42.3%, with a standard deviation of 10.8%. The average GDP per capita in the region of origin, expressed in purchasing power parity (gdp_{mt}), is €31,242, with a standard deviation of €11,592.

4.3 Tourism data summary

We also construct a second data set related to the tourism market. In this data set, an observation is a tourist flow, during the summer months of one of the years 2016 to 2018, from a European country c to an Italian region r of destination. These flows are unevenly distributed among the Italian regions, as shown in Figure 3, which presents an indicator of tourism intensity—i.e. the total number of European tourists in a region compared to the local population. It can be seen that arrivals are particularly high in Veneto and Tuscany (where Venice and Florence are located), Lombardy (Milan), Lazio (Rome) and Sardinia. In contrast, the Southern regions have lower tourist intensity scores, which may open the field for policies to stimulate international tourist arrivals.

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[12]Some markets are not always active and are in the data set only for some years, e.g., Tyrol in Austria and Auvergne in France in 2016. We have 397 markets instead of 414 (138 NUTS 2 European regions for 3 years) if the data set had been balanced.

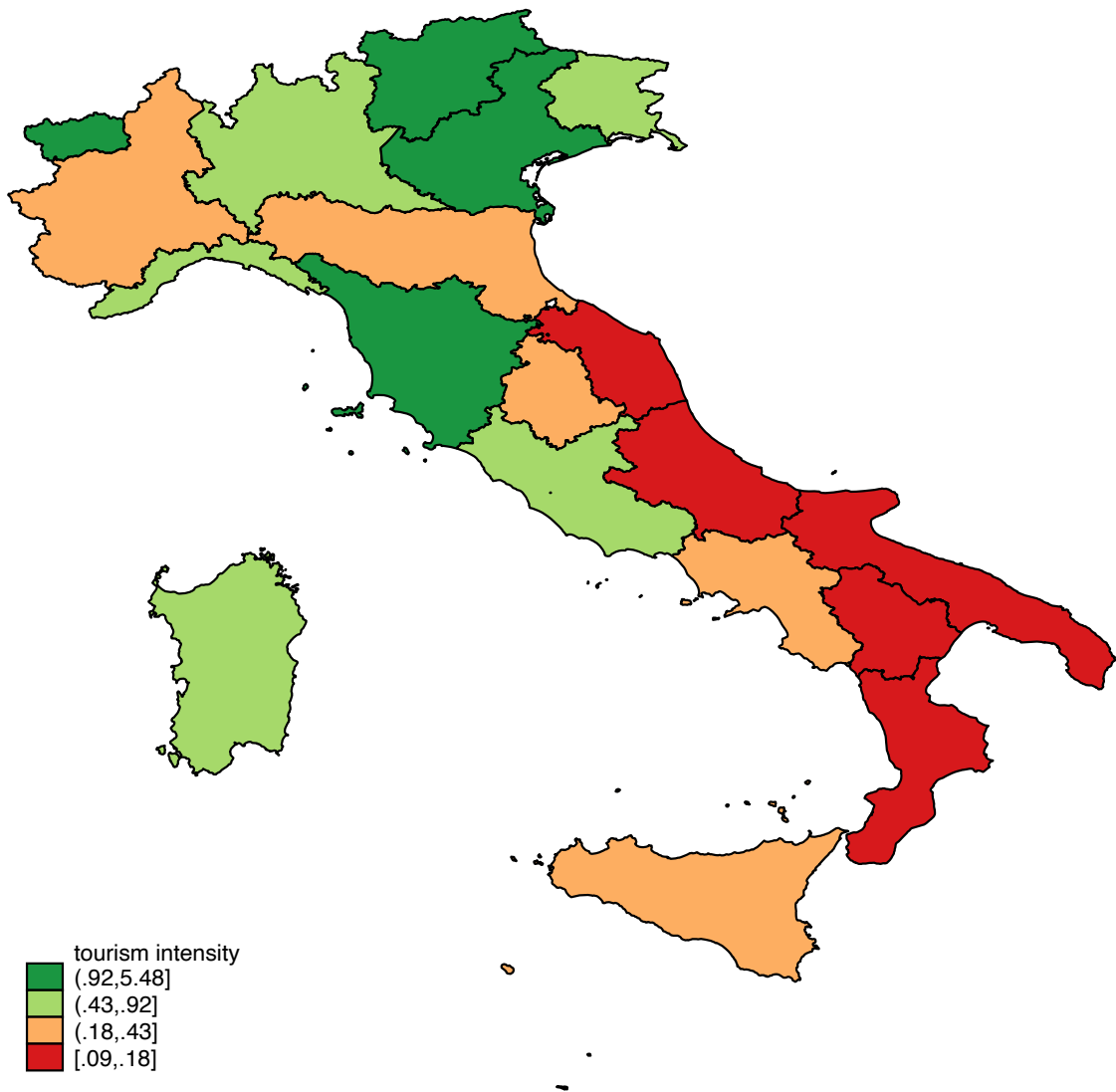[13]For example, Berry and Jia (2010) have a mean value of s_0 close to 99.5%.

Figure 3: Intensity of European tourism in Italian regions: tourists *vs* population

tourism intensity
(.92,5.48]
(.43,.92]
(.18,.43]
[.09,.18]

Table 2 presents the summary statistics of the tourist flows per Italian region from the 138 European regions considered in our model. Veneto, Trentino-Alto Adige, Lombardy, Tuscany, and Lazio have the highest average tourist flows among the 26 European countries. These regions include highly attractive cities, such as Trentino-Alto Adige, which offer a summer holiday in the mountains. Also, each summer, Veneto receives an average of 294,559 tourists from each of the 26 European countries included in our study, while Trentino-Alto Adige receives 224,016, and Lazio receives 120,015. The Southern Italy regions receive fewer European tourists per country during the semester in our data: Sicily 60,674, Campania (Naples) 51,824, Sardinia 50,837, Puglia 26,077, and Calabria 8,444.

Table 2 also displays summary statistics of the number of passengers who travel by air and land at Italian airports. Lazio records around 120,000 passengers from each European country during the summer season, similar to Lombardy (119,651). The most important airports are located in these two regions: Rome-Fiumicino (Lazio), Milan-Malpensa, Milan-Linate and Bergamo (Lombardy). The number of passengers landing in other regions is much lower and, as previously mentioned, Trentino-Alto Adige, Valle d'Aosta, and Basilicata do not have international airports. In total, around 37 million European tourists arrive in Italy every summer, including approximately 12 million by air.

The last column of Table 2 shows the share of passengers arriving by LCCs in each region. The figures are quite scattered, with an average of 62%. In all regions, with the sole exception of Liguria (35%), the share of LCCs passengers is higher than 50%. The importance of LCCs in terms of European passengers arriving in different regions of Italy is therefore evident, especially in the regions of Southern and Central Italy, where tourism is an important component of the local economy. This explains the decisions taken by some regional governments in recent decades to subsidize LCCs to open new regional airport routes to stimulate tourism demand. For example, local newspapers report that, in 2017, the Puglia region, in Southern Italy, approved an annual subsidy of around €20 million to LCCs operating at the Bari and Brindisi airports through commercial agreements.

5 Results

The parameters estimates related to demand and supply are first presented and discussed. We then present the model results for predicting tourist flows from tourist arrivals in the various Italian regions.

Table 2: Summary statistics of the tourist flows

	Region	# Tourists		# Pax		% LCC
		Mean	Std.dev.	Mean	Std.dev.	
North	Emilia-Romagna	73,600	102,212	22,824	33,801	70%
	Friuli-Venezia Giulia	40,620	94,713	1,199	2,845	53%
	Liguria	55,411	91,960	2,876	7,433	35%
	Lombardy	198,366	290,667	119,651	156,768	67%
	Piedmont	59,050	99,898	6,934	13,313	59%
	Trentino-Alto Adige	224,016	744,928	-	-	-
	Valle d'Aosta	15,160	25,417	-	-	-
	Veneto	294,560	543,473	57,952	93,256	56%
Center	Abruzzo-Molise	5,413	8,064	2,120	4,207	99%
	Lazio	120,016	153,682	120,132	146,100	55%
	Marche	10,368	14,254	1,423	3,996	79%
	Tuscany	147,484	204,175	33,687	52,826	65%
	Umbria	14,038	18,127	921	3,071	100%
South	Basilicata	2,847	4,142	-	-	-
	Calabria	8,445	14,883	3,237	7,525	62%
	Campania	51,825	85,764	28,825	45,003	65%
	Puglia	26,078	36,599	13,974	20,362	72%
	Sardinia	50,838	89,233	17,663	31,668	64%
	Sicily	60,675	95,014	28,917	43,852	62%
	Italy	76,779	248,848	24,333	68,154	62%

Average and standard deviation over the 26 European countries of our sample and over the three years of observations

5.1 Demand parameter estimates

As mentioned in Section 3, we need at least three instruments to consistently estimate Eq. (6) to address the endogeneity of the ticket price (p_{jmt}), the frequency (f_{jmt}), and the product market share given that people decide to travel to Italy by air, $s_{jmt}(1 - s_{0mt})$, that we denote, from now on, $s_{jmt|a}$. These instruments are introduced in the next part.

Instruments

Following the literature, we first consider a cost shifter to instrument for the price. Berry and Haile (2022) show that the nonparametric identification of a demand model for differentiated product requires a cost shifter.

The cost shifter we use is an indicator of an aircraft's fuel cost on each flight. Aircraft fuel consumption is not easy to compute because it is not available in official statistics and depends on several factors (e.g., aircraft and engine models, load factor, utilization, etc.). Our approach is to calculate a proxy for an airline's fuel consumption based on several pieces of information that we collect and multiply by the average yearly price of jet fuel. An airline's annual fuel consumption is calculated from three parameters: (1) the age of the fleet, (2) the distance flown, and (3) the number of passengers carried. The OAG data set provides the aircraft model and the distance flown for each product. Furthermore, for each aircraft model b, it is possible to identify the age as the difference between the year of observation and the year of that model's first flight.[14] We then calculate a "relative" fuel cost in US\$ according to the following equation: $fuelcost_{jt} = \sum_{b=1}^{B} \frac{seats_{bjt} \times distance_{bjt} \times (1+0.0288)^{age_{bt}}}{100} \times price_t$, where B is the total number of aircraft used to operate flight j, $price_t$ is the average jet fuel price per gallon in year t,[15] $seats_{bjt}$ is the number of available seats (a measure of size), $distance_{bjt}$ is the flight distance, and 0.0288 is an annual penalty for each additional year of age due to the aircraft's technological obsolescence.

In fact, Chèze et al. (2011) shows that energy efficiency improvements over the 1983–2006 period were 2.88% per year. This means that for every year an aircraft is older, it consumes more fuel than a new-generation aircraft by about +3%, a factor that leads to an increase in airline costs. An additional component of this formula is provided by Open-Airlines (2022), which states that fuel consumption in commercial aviation is about 1 gallon of kerosene per passenger carried per 100 kilometres of flight.[16] This explains the factor $\frac{seats}{100}$, i.e., we use seats as a proxy for

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[14] The year of the first flight is taken from various sources, mainly information available on the aircraft manufacturer's website and data available on the internet.

[15] According to the Jet Fuel Price Monitor by IATA, average prices were 1.29 $\frac{US\$}{GAL}$ in 2016, 1.50 in 2017, and 2.11 in 2018.

[16] See the website https://blog.openairlines.com/how-much-fuel-per-passenger-an-aircraft-is-consu

passengers. Fuel cost is therefore expressed per seat.

We then consider two so called "BLP instruments" for the market share within the nest, $s_{jmt|a}$—i.e., specific functions of characteristics of competing products. We consider the number of competing airlines offering a direct flight on the same O-D route. Such a competing product is indeed a close substitute to the product considered. An increase in the number of competing products corresponds to an increase in the competitive options and decreases the market share of the airline's product. Finally, another instrument is a binary variable that takes the value 1 if an airline's connecting flight product has at least one competing product that links directly the origin and destination cities. Again, the presence of a competing product offering a direct route to the destination puts pressure on the price level, as consumers prefer to reach their destination in the shortest possible time and is negatively correlated with the market share of the given product.

Finally, as in Berry and Jia (2010), the instrument for the frequency we use is the fitted value of the median regression of the frequency on various exogenous variables, which are detailed in Appendix B.

Table 11 in Appendix C shows the estimated coefficients of the three first stage regressions—one for each endogenous variable—and some diagnostic tests for the validity of our instrumental variables. All instruments are statistically significant and have the expected sign. For example, the cost of fuel increases the price, decreases the frequency, and decreases a product's market share. The number of competing products on a direct flight leads to a lower price, higher frequency (to compensate for the longer flight), and lower market share. With respect to diagnostic tests, we observe high F-test statistics, suggesting that we do not face problems related to weak instruments (Stock and Yogo, 2002).

Estimates

In the demand equation (6), we consider many additional exogeneous regressors and control variables. First, the dummy $direct\_fsc$ and the market characteristics gdp and edu are part of these regressors. We also include a set of dummies that take into account various fixed effects: year, Italian region of destination, European country of origin, alliance, *Ryanair*, *Easyjet*, and all other non-allied LCCs.

In the left panel of Table 3, we report estimated coefficients of the regressors in the demand equation using the optimal two-step GMM procedure jointly with the marginal cost equation (8) (see Eqs. (12) and (13) in Appendix A). Standard errors are reported in parenthesis as well as some level of significance.

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ming.

Table 3: Estimates of coefficients for demand and cost components in air transport

Demand estimates		Marginal cost estimates	
Regressors		Regressors	
p_{jmt}	-0.0341***	$direct_{jmt}$	-4.0758**
	(0.0051)		(1.8766)
$\log(s_{jmt\mid a})$	0.5639***	$fuelcost_{jmt}$	0.1588***
	(0.0736)		(0.0539)
f_{jmt}	-0.0005	$gateway\_hub\_fsc_{jmt}$	26.4464***
	(0.0004)		(2.2391)
$direct\_fsc_{jmt}$	0.3320***	$Constant$	92.1573***
	(0.0758)		(9.1630)
gdp_{mt}	0.00004***		
	(0.000005)		
edu_{mt}	-0.0370***		
	(0.0045)		
$Constant$	-1.9226**		
	(0.8574)		
No. observations	6,525	No. observations	6,525
Year dummies	YES	Year dummies	YES
Italian region dummies	YES	Italian region dummies	YES
European country dummies	YES	European country dummies	YES
Airline/Alliance dummies	YES	Airline/Alliance dummies	YES
Standard errors in parentheses ***p-value<0.01, **p-value<0.05, *p-value<0.1			

The estimated coefficients of the demand regression in Table 3 have the expected signs and are statistically significant, with the exception of frequency f and edu. We cannot reject the hypothesis that frequency does not change the level of tourist demand at the first order (the p-value for this test is greater than 10%). Again, a tourist is probably less sensitive to the departure time of her flight than a regular passenger flying for business or pleasure.

The nesting parameter σ, related to the variable $log(s_{jmt|a})$ in the regression, lies between 0 and 1, indicating substitution exists between the outside option and the nest given by all the possible air products. As expected, we find a preference for direct flights. Since most of the products offered by LCCs are direct flights, the dummy in the regression only concerns the direct FSC flights. On average, a passenger is willing to pay around 9.7 euro more[17] to fly direct with a FSC—i.e., around 8.6% more. This is of the same order of magnitude as in Berry and Jia (2010) for the tourist traveler in 2006 (around 12.4%), though lower, because European tourist passengers are more price sensitive than U.S. tourist passengers (see below).

The variable representing income per capita in the region of origin (gdp_{mt}) has a positive and significant effect on air travel demand, as expected. Finally, the coefficient of edu is statistically significant but negative. One possible explanation for this result is that regions with a higher proportion of graduates may have consumers who travel more for business or to destinations beyond Italy, either elsewhere in Europe or further abroad, thereby opting for the outside good.

Price elasticities, marginal costs and markups

The demand estimates allow us to calculate the elasticities of demand with respect to price, which are shown in Table 4. We calculate the elasticity for each product and then the average at the market level—i.e. the NUTS 2 region of origin. We find an average own-price elasticity of -7.28% (with a standard deviation of 2.84%). Our estimates of price elasticity for air transport products are slightly higher in magnitude than those found in previous studies. For example, Berry and Jia (2010) has an estimate for tourist travelers of -6.55% in 2006, Ciliberto and Williams (2014) estimate price elasticities for the same category around -6.1% for the 2006–2008 period, and both are calculated from nested logit models with two types of travelers. In a model without consumer heterogeneity, Bontemps et al. (2022) estimate an aggregate price elasticity of -4.16% in 2011 and -3.49% in 2016. All these works are derived from U.S. data, and to the best of our knowledge, little evidence exists for European elasticities. Brons et al. (2002) report estimated price elasticities with reduced-form models for a somewhat dated period when the European market was less mature and LCCs were marginal in the landscape.

A possible explanation for the more elastic European air transport sector could be the ex-

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[17]Given by the ratio between the coefficient of $direct\_fsc$ and the price coefficient.

istence of a close substitute even for long-distance travel: Europe has a good rail network with many high-speed connections (Brons et al., 2002). The mean of the cross-elasticities of the market means is 0.71% and the standard deviation is 1.09.

Table 4: European air transport: own and cross price elasticities

	Mean	S.D.
Own price elasticity	-7.28	2.84
Cross price elasticity	0.71	1.09

Estimation of each product's marginal cost can be obtained by solving Eq. (4) using the demand-parameter estimates. From there we can calculate the markups both for the sample as a whole and for the subsamples of LCCs, FSCs, direct, and connecting flights. Table 5 reports the averages of these quantities across all products. The average estimated marginal cost is about €85, with a large difference between LCCs (around €61) and FSCs (around €98). Marginal costs are much higher for connecting flights (€103) than for direct flights (€69). The average markup is around €16, with LCCs averaging €19 and FSCs €15. The markup is higher (€18) for direct flights than connecting flights (€15).

Table 5: European aviation markups and marginal costs estimates

	Markup		Marginal Cost	
	Mean	S.D.	Mean	S.D.
All flights	16.33	4.90	84.98	52.08
LCCs	18.92	6.01	61.43	40.29
FSCs	14.93	3.44	97.74	53.29
Direct	17.86	5.48	68.88	40.33
Connecting	14.62	3.44	102.91	57.55

5.2   Estimates of the supply parameters

The right panel of Table 3 shows the estimated coefficients for the different components of the marginal cost. *Stricto sensu*, we do not need to perform this regression for our counterfactual analysis, but it is interesting to analyze some of the marginal cost determinants.

As expected, direct flights generate lower marginal costs: The estimated coefficient of *direct* is equal to about -4.08 and is statistically significant. Fuel cost has a positive effect on marginal costs: the estimated coefficient of *fuelcost* is about +0.16 and significant. As this is an index, the value of the estimate has no direct interpretation.

We also introduce the variable $gateway\_hub\_fsc_{jmt}$ into our regression, which captures the differences in marginal costs between direct flights and connecting flights for O-D trips offered

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by FSCs. The variable is a dummy variable built as follows. For each trip offered by a FSC with a connection, we count the number of options offered by the same airline at its hub— i.e., the connecting airport. If there are many hub options, we calculate a weighted average of the numbers (weighted by the number of passengers actually transported by this FSC). Our variable is equal to 1 if the resulting figure is among the top 25% of the figures calculated for all the connecting products proposed by all FSCs. It means, when it is equal to 1, that passengers are transported via the main European hubs.

It appears that the marginal costs are higher for flights connecting at these hubs. The estimated coefficient of $gateway\_hub\_fsc$ is around 26.45 and statistically significant. In fact, there are two effects. On the one hand, connecting via a main hub allows the airline to pool passengers with different destinations or origins in the same aircraft. On the other hand, such connections require coordination that can be costly at full-capacity airports, especially in terms of staff and terminal services. The latter congestion effect seems to dominate the first one. Berry and Jia (2010) found a similar pattern for trips of equivalent distance in the U.S. in 2006.

5.3 Predicted tourist flows and air traffic

Finally, we need to link passenger arrivals to regional tourism flows and, for this, we use the Eq. (5) allocation model. Parameters $\beta_{kr,1}$ are calibrated using the Bank of Italy survey, which also provides the number of passengers landing in a regional airport from the country of origin. Moreover, the survey shows their final destinations as tourists, which can be in the region where they land or in a different region. Hence, we calibrate the coefficients $\beta_{kr,1}$ by summing all passengers landing in a Italian region from the 26 European countries we have in our data set, and then computing the share staying in the landing region or moving to a nearby region. To eliminate casual observations, we eliminate all transfers to other regions that are less than 1% of the total number of passengers landed in the region. Table 12 in the appendix shows the calibrated matrix. The values per row then indicate the percentages of passengers who landed in the region and stay as tourists, and those who transfer to a neighboring region. For example, the first row in the table concerns the Abruzzo-Molise region. From the 26 European countries that land in Abruzzo-Molise, 94.46% of the passengers stay in the region, 2.99% move to the neighboring region Marche, 1.30% to Puglia, and 1.25% to Lazio.

However, the real number of tourists visiting a region r from a country c is often much higher than the number of passengers landing in the neighboring region. We estimate the constant terms—i.e. the parameters $\beta_{cr,0}$ of Eq. (5) by a linear regression. They represent the number of visitors of region r coming from country c not arriving by air.[18] In Table 6, we show, for

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[18]The estimates are available from the authors upon request.

each Italian region r, $\hat{\beta}_{cr,0}$, the estimated fraction of tourists visiting in summer region r and not arriving by air. This figure is calculated according to the following expression:

$$\overline{\beta}_r = \frac{\sum_{c=1}^{26} \hat{\beta}_{cr,0}}{\widehat{TOU}_r}. \tag{10}$$

.

The numerator is the sum over the 26 European countries of the estimated coefficients for region r—i.e., the forecast of the number of tourists arriving in that region by modes other than air. The denominator is the fitted value of total tourist flows in region r, calculated as follows:

$$\widehat{TOU}_r = \sum_{c=1}^{26} \left(\hat{\beta}_{cr,0} + \sum_{k=1}^{16} \tilde{\beta}_{kr,1} \times PAX_{cr} \right) \tag{11}$$

,

where, as previously mentioned, the $\tilde{\beta}_{kr,1}$ are the calibrated coefficients reported in Table 12.

Table 6: Predicted regional tourist flows not arriving by air

	Region	$\overline{\beta}_r$
	Emilia-Romagna	71.73%
	Friuli-Venezia Giulia	97.25%
	Liguria	86.90%
North	Lombardy	55.57%
	Piedmont	74.89%
	Trentino-Alto Adige	98.06%
	Valle d'Aosta	98.05%
	Veneto	78.07%
	Abruzzo-Molise	25.32%
	Lazio	14.32%
Center	Marche	78.20%
	Tuscany	69.91%
	Umbria	78.59%
	Basilicata	66.02%
	Calabria	63.65%
	Campania	34.01%
South	Puglia	51.51%
	Sardinia	62.11%
	Sicily	43.48%

Table 6 shows some interesting features related to characteristics of the Italian air transport network and tourist attractiveness of the different regions. In Lazio, for example, only 14% of European tourists do not arrive by air. This is because Rome-Fiumicino is the largest international airport in Italy, the hub of the national airline *Alitalia-ITA Airways*, with the best connections

to other European countries. The majority of tourists therefore arrive in Lazio by air. On the other hand, in the two Alpine regions of Trentino-Alto Adige and Valle d'Aosta—both of which are visited for their mountain excursions but lack commercial airports with international arrivals—almost no tourists (98%) arrive by air transport, and the remaining 2% land at an neighboring regional airport. This also applies to Friuli-Venezia Giulia, while in Lombardy the data are more balanced: 56% do not arrive by air while 44% land at a regional airport (there are three international airports and good air connections) or in a neighboring region. The two largest islands (Sardinia and Sicily) show different results: Sardinia can only be reached by air or sea, and 38% of tourists land at an airport in the region. Sicily, however, has better air connections and 57% of tourists land at a regional airport (or in a neighboring region).

6   Analysis of LCC subsidy policies

In this section, we analyze the impact of policy interventions in the aviation sector on the tourism sector. As previously mentioned, we focus on subsidies targeted at LCCs. These subsidies have generated much discussion in the air transport industry, and for decades the European Commission often classified them as state aid, preventing various agreements between regional airport management companies and LCCs (Malavolti and Marty, 2017). Examples of such agreements are reductions in airport taxes and funding the promotion of new routes, among other initiatives. The subsidies were considered to distort competition. In 2014, however, the European Commission issued new guidelines that changed the previous assessment of LCCs subsidies (Commission, 2014). The guidelines expanded objectives to the dimensions of sustainability and growth, based on a new economic approach in which an LCC subsidy may not be considered state aid if in line with the market economy operator principle (MEOP). In short, it is not state aid if a private agent would adopt the same strategy—i.e., providing discounts to LCCs equal (or similar) to those implemented with public subsidies (Malavolti and Marty, 2019). Furthermore, based on a theoretical model Malavolti and Marty (2019) recently show how subsidies to LCCs by airport-operating companies comply with the MEOP. Taking as a reference the fact that decisions of an airport operator can be analyzed via a two-sided economic model, Malavolti and Marty (2019) show that a profit-maximizing company can adopt an optimal policy of providing discounts to LCCs on airport charges because the company can (1) subsidize LCCs through commercial revenues related to non-aviation activities (shops, parking, etc.), and (2) thereby increase profits because the discounts allow to counterbalance the monopoly power of LCCs. Thanks to discounts, a regional airport can attract more passengers, which generates commercial revenues. This decreases the airport operator's dependence on aviation profits and thus the market power

of the LCCs. Similarly, if subsidies are provided by the national government and/or subnational institutions, they may not be classified as state aid. This scenario therefore makes it interesting to analyze which type of policy (centralized or decentralized) is more effective in terms of tourism growth.

The impact of such a policy is assessed by comparing the actual equilibrium of the air transport market with a counterfactual equilibrium calculated with lower marginal costs. Differences in passenger flows lead to differences in tourist flows.

More specifically, consider our counterfactual analysis in which a general subsidy of €1 is granted to all or to a subset of tickets sold by LCCs, which reduces the marginal cost of the corresponding products by €1. Therefore, following the standard approach used in similar settings, we calculate the new equilibrium prices charged by the airlines and the new passenger flows under this €1 subsidy policy, by iterating between the pricing equation (4) and the market share equations (2). Changes in the market shares of the different airlines—i.e., in the number of passengers landing in different Italian regions—lead to changes in the tourism sector—i.e., in the number of tourists in each region—through the predictive model of tourist flows.

Here, we present the results of two counterfactual analyses to compare the effectiveness of the two subsidy policies in terms of country tourist flows and investigate whether policy interventions produce better outcomes when managed by the central government or when decentralized to local governments (Oates, 1993). In the first counterfactual analysis—the centralized policy—the LCCs subsidy is controlled by the central government and uniform across all Italian regions. In the second counterfactual analysis—the decentralized policy—the LCCs subsidy is granted by a single region. Since we have 16 Italian regions to which the LCCs subsidy can be applied, in the decentralized policy, we analyze 16 region-specific counterfactual outcomes. To compare the two regimes, we use a tourist-flow indicator given by the amount of euros needed to generate one additional tourist at the national level. This indicator takes into account both the benefit of the subsidy—i.e., the possible increase in tourist flows—and the cost, given by the public investment in the LCCs. It is a relative indicator and therefore comparable.

In practice, in the counterfactual analysis of the centralized policy all LCCs operating in the country are given a €1 subsidy. The subsidy is therefore uniform and distributed to all regions with LCCs. In this case, the reference indicator is the ratio of the total amount of subsidies in all regions to the predicted number of additional tourists in the country. In the counterfactual analysis of the decentralized policy, the €1 subsidy is allocated by a regional government to the LCCs operating in that region, and the tourism indicator is always given by the ratio of the total subsidy to the predicted number of additional tourists in the country, not just in the single region implementing the policy.

6.1 Outcome of the centralized policy

Table 7 displays the main counterfactual outcomes of the centralized LCC subsidy policy. We report the total subsidy in each region, the "pass-through", the percentage variation in passengers separated for LCCs and FSCs, the variation in annual profits in the air transport sector, the variation in passenger surplus and the variation in total welfare in this sector. For the tourism sector, we report the percentage change in tourist arrivals.

The total subsidy amounts to about €7.7 million. The mean pass-through is equal to €0.91, meaning that most of the €1 subsidy is passed on to LCCs passengers in the form of a fare reduction. This indicates that competition in air transport is quite intense. Friuli-Venezia Giulia, Liguria, Abruzzo-Molise, Marche, and Puglia have a lower pass-through, between €0.83 and €0.89. It corresponds to the markets with low numbers of air passengers (see Table 2). The average percentage reduction in LCCs price is -1.24%. FSCs react to the subsidy by decreasing their airfare to compensate for the competitive advantage given to LCCs. On average, they decrease each ticket by an amount around €0.07—i.e. -0.07%. However, it is not enough to restore the former number of passengers transported. As a result, LCCs have a larger positive variation in passengers, equal to +3.76%, with all regions of Southern Italy having high positive variations since LCCs have high market shares in Southern Italy airports. Conversely, FSCs would observe a decrease in air passengers in each region with a national average of -1.34%. At the national level, the subsidy increases the total number of passengers by +1.82%, with a positive variation in all regions.

As expected, profits, passenger surplus, and welfare in air transport increase. The welfare increase is always higher than the subsidy amount (about €12 million *vs* €7.7 million overall), and the difference between the two figures is driven by the additional passengers flying to Italy due to the decrease in airfares.

In the tourism sector, the global increase in flows is equal to +0.58%, and we also observe increases in all regions, especially in Abruzzo-Molise (+1.68%), Lazio (+1.30%), Campania (+1.31%), Puglia (+1.04%), and Sardinia (+1.09%). At the national level, it means 218,702 additional tourists per year during the summer, of which 97,958 more tourists in the Northern Italy region, +67,451 in Central Italy regions, and +53,294 in the Southern regions. The highest percentage increase in Abruzzo-Molise corresponds to 2,364 additional tourists, while the increase in Sardinia is equal to +17,220 tourists. In summary, the centralized policy generates an increase both in the air transport sector's welfare and in tourist flows in all regions.

Table 7: Counterfactual analysis: the centralised subsidy regime

Region	Air transportation								Tourism
	Total subsidy (€ year)	Pass through	Δ % pax	Δ % LCC pax	Δ % FSC pax	Δπ (€ year)	ΔCS (€ year)	Δ W air (€ year)	Δ % tourist
Emilia-Romagna	430,249	-0.90	+2.03	+3.43	-1.24	+280,476	+394,211	+674,686	+0.58
Friuli-Venezia Giulia	16,945	-0.84	+0.56	+2.42	-1.55	+10,461	+14,659	+25,120	+0.02
Liguria	26,579	-0.88	+0.07	+2.88	-1.41	+3,454	+28,682	+32,136	+0.19
Lombardy	2,163,266	-0.91	+2.13	+3.80	-1.27	+1,357,124	+1,993,599	+3,350,723	+0.93
Piedmont	109,823	-0.92	+1.53	+3.54	-1.34	+54,685	+106,046	+160,731	+0.47
Trentino-Alto Adige	-	-	-	-	-	-	-	-	+0.03
Valle d'Aosta	-	-	-	-	-	-	-	-	+0.03
Veneto	880,160	-0.90	+1.51	+3.74	-1.37	+479,007	+837,845	+1,316,852	+0.35
Abruzzo-Molise	56,499	-0.89	+3.00	+3.03	-1.94	+48,208	+49,404	+97,612	+1.68
Lazio	1,777,306	-0.91	+1.50	+3.96	-1.48	+964,262	+1,676,036	+2,640,298	+1.30
Marche	30,012	-0.83	+1.79	+2.55	-1.10	+24,638	+25,110	+49,749	+0.42
Tuscany	588,481	-0.90	+1.93	+3.64	-1.23	+381,690	+544,042	+925,731	+0.57
Umbria	24,536	-0.84	+2.45	+2.45	-	+21,180	+20,260	+41,440	+0.38
Basilicata	-	-	-	-	-	-	-	-	+0.73
Calabria	53,750	-0.90	+1.72	+3.51	-1.16	+38,859	+48,831	+87,690	+0.64
Campania	504,823	-0.92	+2.08	+3.93	-1.32	+296,227	+477,168	+773,395	+1.31
Puglia	271,588	-0.89	+2.15	+3.36	-1.03	+200,733	+245,334	+446,068	+1.04
Sardinia	304,183	-0.90	+1.86	+3.63	-1.27	+203,820	+278,415	+482,235	+0.71
Sicily	484,993	-0.90	+1.97	+3.93	-1.24	+312,790	+449,954	+762,745	+1.09
Italy	7,723,192	-0.91	+1.82	+3.76	-1.34	+4,677,615	+7,189,596	+11,867,211	+0.58

6.2   Outcome of the decentralized policy

Under the decentralized policy, the LCCs subsidy is paid in a single region. Therefore, in this regime, we have 16 counterfactual analyses. Table 8 shows the same outcomes as the previous Table 7 when the subsidy is provided by the Lombardy region. Tables for the other regions can be found in Appendix D.

The total subsidy when the policy is implemented only in Lombardy is about €2.2 million and the pass-through in the region is very high—€0.95. In fact, with the decentralized subsidy, there are different effects in the air transport market between subsidized and non-subsidized regions. In Lombardy, the subsidy generates an increase in total passengers due to a strong increase in LCCs passengers and a slight decrease in FSCs passengers, as shown below. Also in Lombardy, prices decrease for both types of airlines. These effects are similar, but of a different magnitude, than with the centralized subsidy.

In the other regions, however, effects between the two schemes are different in terms of price (not if we look at number of passengers, which decreases in all regions). FSCs prices fall and LCCs prices rise by a magnitude greater than the reduction in FSCs, thus driving a generalized increase in prices in the non-subsidized regions. This happens because the same LCC company—e.g., *Ryanair*—receives the subsidy in one region and not in others, and as such, total profits are maximized. As a result of the reduction in marginal costs, the airline lowers the price in Lombardy; however, to maintain the same profit in other regions, it raises the price (in the face of reduced demand). Similarly, in the subsidized region, the LCC pushes on the price reduction to consistently increase additional market share and thereby maintain a good profit level. This explains the higher pass-through with a decentralization policy than with a centralization policy in a subsidized region. Therefore, the number of passengers increases in the region where the subsidy is applied, here +4.18% in Lombardy, whereas it decreases in the other regions.

The number of LCCs passengers increases by 6.43% in Lombardy, because a substitution effect exists between the trips offered to that region and all the other products proposed—i.e., LCCs flights to other regions and FSCs flights to any region including Lombardy. Therefore, the number of LCCs passengers decreases in all other regions resulting in a small increase of LCCs passengers on a national level—i.e., +1.08%. The number of FSCs passengers decreases in Lombardy as well as in all other regions, and nationally the decrease is -0.4%. Overall, the number of passengers (LCCs or FSCs) increases by +0.52%. This result also occurs in all the other counterfactual analyses of the decentralized policy: (1) the number of air passengers increases in the region applying the subsidy, (2) the number increases at the national level, and (3) the number decreases in all the other regions.

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Like in the centralized regime, Table 8 shows also that airline profits increase in Lombardy by about €2.5 million, which is slightly below the total subsidy amount. Again the difference between the welfare increase and the policy cost is mainly driven by the additional passengers transported in this new regime, thanks to the decrease in airfares. The results for the other regions are similar.

The most interesting result obtained using the decentralized policy is related to the change in tourist flows, shown in the last column of Table 8. In Lombardy, the subsidy increases the number of tourists in the region by 1.74%, which corresponds to 89,796 additional tourists. In the other regions, the effects are different. In some regions (Emilia-Romagna, Liguria, Piedmont and Trentino-Alto Adige), the number of tourists increases. For instance, in Liguria the subsidy generates 3,335 additional tourists because some of the additional passengers who land in Lombardy travel to neighboring regions for tourism—that is, a spillover effect of regional subsidies to LCCs. These regions benefit without having to invest. The decentralized scheme therefore generates positive externalities in some regions. Such externalities occur in all regional counterfactual analyses, with the same exceptions limited to regions with very low LCCs activities (Friuli-Venezia Giulia, Umbria), isolated regions (Sardinia and Sicily), and those with high tourist attractiveness in summer (Campania and Liguria). Conversely, for the regions which are not visited by tourists landing in Lombardy, the same spillover effect is negative. For instance, Lazio loses 17,458 tourists, Campania 5,382, and Tuscany 4,482—due to the comparative advantage in costs of LCCs operating in Lombardy. For these regions, we have a negative subsidy externality.

6.3   Comparison of the two subsidy policies

In summary, the two policies have similarities in terms of certain effects, but there also are important differences. In the aviation market, the effects are similar: the number of passengers increase both in the regions where subsidies are implemented and at the national level, LCCs gain market shares, and FSCs lose them. Moreover, the welfare generated by the sector is always greater than the amount invested in subsidies. The important differences between the policies lie in the tourism market. The centralized policy brings benefits in terms of increased tourism flows to all regions and at the national level. By spreading the subsidy across all regions with air traffic, the centralized policy increases tourism flows in each region. The size of this increase depends on the importance of LCC in the region. In the decentralized regime, the region proposing the subsidy gives a large comparative advantage to the LCCs landing at its international airports, and thus induces negative spillovers to the other regions. The centralized regime balances this huge advantage given to each region and the induced negative spillovers, thus limiting the variation

Table 8: Counterfactual analysis: decentralised subsidy regime in Lombardy

Region	Total subsidy (€ year)	Pass through	Air transportation						Tourism
			Δ % pax	Δ % LCC pax	Δ % FSC pax	Δπ (€ year)	ΔCS (€ year)	Δ W air (€ year)	Δ % tourist
Emilia-Romagna*	-	-	-1.04	-1.34	-0.36	-117,632	-6,736	-124,368	+0.04
Friuli-Venezia Giulia	-	-	-0.94	-1.36	-0.47	-6,767	-880	-7,647	-0.03
Liguria*	-	-	-0.66	-1.14	-0.41	-11,724	+551	-11,173	+0.23
Lombardy	2,218,100	-0.95	+4.18	+6.43	-0.40	+2,530,838	+2,070,416	+4,601,254	+1.74
Piedmont*	-	-	-0.83	-1.13	-0.40	-29,762	+548	-29,214	+0.51
Trentino-Alto Adige*	-	-	-	-	-	-	-	-	+0.03
Valle d'Aosta	-	-	-	-	-	-	-	-	-0.02
Veneto*	-	-	-0.76	-1.03	-0.41	-207,349	-3,916	-211,265	-0.06
Abruzzo-Molise	-	-	-0.82	-0.82	-0.54	-10,862	-1,272	-12,134	-0.59
Lazio	-	-	-0.75	-1.00	-0.45	-411,476	-3,740	-415,217	-0.56
Marche	-	-	-0.89	-1.05	-0.31	-8,986	-1,434	-10,420	-0.21
Tuscany	-	-	-0.78	-1.02	-0.33	-132,052	-5,729	-137,781	-0.12
Umbria	-	-	-1.11	-1.11	-	-7,261	-1,321	-8,581	-0.18
Basilicata	-	-	-	-	-	-	-	-	-0.25
Calabria	-	-	-0.61	-0.84	-0.25	-10,576	-989	-11,564	-0.23
Campania	-	-	-0.81	-1.03	-0.39	-99,091	-5,569	-104,660	-0.40
Puglia	-	-	-0.75	-0.93	-0.26	-56,158	-3,310	-59,468	-0.36
Sardinia	-	-	-0.59	-0.75	-0.31	-50,295	-2,245	-52,540	-0.08
Sicily	-	-	-0.63	-0.81	-0.32	-86,518	-3,067	-89,585	-0.17
Italy	2,218,100	-	+0.52	+1.08	-0.40	+1,284,327	+2,031,309	+3,315,636	+0.16

* indicate regions in proximity to Lombardy.

in competitive advantages between regions. Therefore, the increase in passengers in a region is lower when the subsidy is national than when it is implemented only in that region.

On the one hand, the decentralized policy reduces tourist flows in many regions by changing the relative price of trips between regions. The region where the subsidy is applied gains a competitive advantage and takes market shares from other regions. On the other hand, it increases tourist flows in some regions at no cost to them. In other words, the regions investing in the LCCs subsidy policy do not internalize all the benefits of their investment. This is a typical case of policy sub-optimality. Table 9 summarizes these effects and presents the aggregate values when the LCCs subsidy is implemented only in Lombardy. In this region, tourists increase by 89,796, and in other regions with positive spillover they rise in aggregate by 13,521. In regions with negative spillover, however, the overall effect is -41,367 tourists. At the national level, the balance remains positive by 61,950.

Table 9: Summary of tourist effects with decentralization in Lombardy

Regions	Change in tourists
Lombardy	+89,796
Regions with positive spillovers	+13,521
Regions with negative spillovers	-41,367
Overall effect	+61,950

Lombardy is the region with the LCCs subsidy. Regions with positive spillovers are Emilia-Romagna, Liguria, Piedmont and Trentino-Alto Adige. Regions with negative spillovers are all the other regions.

We consider an indicator to compare the benefits and costs of the two schemes—i.e. the euros needed to generate one additional tourist. We calculate this primarily at the country-wide level, since the resources invested in subsidising LCCs must be evaluated for the effects they generate at the national level, not at the individual-region level. Second, we also look at the indicator in the region that implements the decentralized policy subsidy. Table 10 shows the results of the regime comparison based on the counterfactual analyses.

The column "Country level" in the upper part of Table 10 shows the amount of subsidized euros are needed per additional tourist in the decentralized policy. For example, if the policy is adopted by the Emilia-Romagna region, €37.59 are needed per additional tourist visiting Italy. On the other hand, if the policy is targeted at the region of Sicily, €35.68 are needed. The average for this indicator is €40.17. The lower part of Table 10 shows the value of the same indicator in the centralized regime, which is €35.31—i.e., lower than the average of the national indicators calculated for the 16 decentralized policies. This additional cost due to the LCCs subsidies must be put in perspective when considering the possibility of increased revenue as a tourism expenditure. In this regard, the Bank of Italy survey reports an average expenditure of

Table 10: Comparison of LCCs subsidy policies

| | Decentralised policy | |
Region	Country level €	Region level €
Emilia-Romagna	37.59	21.49
Friuli-Venezia Giulia	55.42	14.57
Liguria	47.01	18.72
Lombardy	35.80	24.70
Piedmont	34.81	15.56
Veneto	36.24	16.42
Abruzzo-Molise	40.93	14.65
Lazio	35.01	20.47
Marche	51.11	17.19
Tuscany	37.64	19.18
Umbria	52.94	15.33
Calabria	37.54	15.42
Campania	32.75	15.51
Puglia	38.24	16.30
Sardinia	33.93	14.28
Sicily	35.68	14.42
Average	40.17	17.14
	Centralised policy	
Italy	€35.31	

tourists from the 26 European countries in our data set of about €1,115, thus well above the value of the subsidy.

The comparison between the two subsidy policies shows that from a national policymaker's point of view, the centralized policy of subsidising LCCs in order to stimulate the tourism demand dominates the decentralized policy. Regional policies lead to significant externalities between regions and do not allow for a full internalization of the subsidies' effects due to spillovers to other regions, thus creating distortions. Moreover, it is difficult to justify to public opinion the adoption of subsidies by a single region, as it erodes the tourism market shares generated in other regions. It would open a generalized race to adopt subsidies, thus tending towards a centralized system (but without uniformity between regions).

The last column of Table 10 shows how many euros are needed per additional tourist under the decentralized policy in the intervention region. It is obviously lower because the region implementing the policy does not take the spillover effects of its subsidy policy into account. For example, in Tuscany, €19.18 is needed per additional tourist. The increase in tourist arrivals in this region is equal annually to +37,197, and Liguria is the only region that has a positive spillover, generating +1,239 tourists. In all the other regions the negative spillover reduces the number of tourists, equal to -22,221.

In conclusion, the counterfactual analysis allows us to state that, contrary to theoretical contributions (Oates, 1993, 1999) and in line with some evidence from empirical related health-sector contributions (Balia et al., 2018; Di Novi et al., 2019), in the context of the relationship between air transport and tourist flows, a policy of stimulating LCCs to increase the tourist attractiveness of different regions should be uniformly implemented across countries by the central government. In this way, the spillovers generated by a decentralized regime are reduced, competition between regions is limited, and discrimination between the regions is not generated.

7   Conclusions

This paper analyzes the impact of LCCs subsidies on tourism flows, using data on movements from European regions to Italian regions in the 2016–2018 summer season. We estimate a two-stage model that links equilibrium in the air transport sector, determined in the first stage by a structural model to the tourism market. In the second stage of the model the market shares of the different products offered by airlines connecting European and Italian regions are one of factor affecting tourist arrivals. The counterfactual analysis introduces LCCs subsidies, which disturb the equilibrium in the airline industry and induce changes in the tourism market. We analyze two different implementation regimes for these subsidies, following the literature that

analyses the level of policy implementation (national or subnational) that is most effective. In our paper, we perform an initial counterfactual simulation in which the LCCs subsidy is adopted by the central government and implemented uniformly in all regions. This approach eliminates any possible competition between regions. A second set of counterfactual simulations examines the effect of subsidies when the policy is implemented in a decentralized manner—i.e. by each region—a scenario that introduces competition between subnational jurisdictions.

Counterfactual simulations show that LCCs subsidies are effective in increasing tourism flows, and that the centralized system produces better results in terms of stimulating tourism demand than the decentralized system. In fact, the latter leads to two situations that reduce its effectiveness. On the one hand, it generates significant externalities in regions that do not implement subsidies; on the other hand, the increase in tourism flows from the subsidizing region at the expense of other regions leads to competition to adopt the same type of policy in a possible race leading to a regime similar to the centralized one.

Our paper fills a gap in the literature that addresses the causal relationship between air transport and tourism flows, as existing contributions have always presented a reduced form. Our use of an airline industry structural model allows us to analyze the impact of exogenous shocks to aircraft operating costs on the volume of passengers carried and hence on tourism flows. Furthermore, a comprehensive approach should include a structural model of supply and demand in the tourism market, which was not possible due to lack of data. These extensions are left for possible future contributions.

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A   GMM estimation

Let θ_d denote the demand parameters to be estimated, i.e., $\theta_d = (\beta, \alpha, \gamma, \sigma)^\top$. The system of moment restrictions (7) and (9) can be rewritten with obvious notations, reintroducing the time subscript t:

$$E\left(\xi_{jmt} Z_{kjmt}\right) = E m_d\left(\tilde{X}_{jmt}, \tilde{Z}_{k,jmt}; \theta_d\right) = 0, \ k = 1, \ldots, K \tag{12}$$

$$E\left(\zeta_{jmt} w_{l,jmt}\right) = E m_s\left(\tilde{X}_{jmt}, \tilde{Z}_{k,jmt}; \theta_d, \psi\right) = 0, \ k = K+1, \ldots, K+L \tag{13}$$

where $\tilde{X}$ denotes the vector of all explanatory variables involved in the two equations above and $\tilde{Z}_k, \ k = 1, \ldots, K+L$ denotes the collection of instruments for both the demand and the supply side. $m_d(\cdot)$ and $m_s(\cdot)$ are respectively moments related to the demand and the supply side.

To estimate θ_d and ψ, we build sample analogs of the moment conditions (12) and (13) by averaging across products within a given market, then across markets (we have M markets), and finally across years ($t = 1, 2, 3$):

$$\bar{m}(\theta_d, \psi) = \begin{bmatrix} \frac{1}{3 \times M} \sum_{t=1}^{3} \sum_{m=1}^{M} \left(\frac{1}{J_{m,t}} \sum_{j=1}^{J_{m,t}} m_d(\tilde{X}_{jmt}, \tilde{Z}_{1,jmt}; \theta_d) \right) \\ \vdots \\ \frac{1}{3 \times M} \sum_{t=1}^{3} \sum_{m=1}^{M} \left(\frac{1}{J_{m,t}} \sum_{j=1}^{J_{m,t}} m_d(\tilde{X}_{jmt}, \tilde{Z}_{K,jmt}; \theta_d) \right) \\ \sum_{t=1}^{3} \sum_{m=1}^{M} \left(\frac{1}{J_{m,t}} \sum_{j=1}^{J_{m,t}} m_s(\tilde{X}_{jmt}, \tilde{Z}_{K+1,jmt}; \theta_d; \psi) \right) \\ \vdots \\ \frac{1}{3 \times M} \sum_{t=1}^{3} \sum_{m=1}^{M} \left(\frac{1}{J_{m,t}} \sum_{j=1}^{J_{m,t}} m_s(\tilde{X}_{jmt}, \tilde{Z}_{K+L,jmt}; \theta_d, \psi) \right) \end{bmatrix}.$$

The GMM objective function to be minimized (with respect to θ_d and ψ) is a distance of $\bar{m}(\theta_d, \psi)$ to 0; that is,

$$f(\theta) = \bar{m}(\theta_d, \psi)^\top \Omega \bar{m}(\theta_d, \psi),$$

where Ω is a $(K+L) \times (K+L)$ positive definite weighting matrix. We use a two-step procedure in which we obtain a first set of estimates $(\hat{\theta}_d^{(1)}, \hat{\psi}^{(1)})$ using the identity I_{K+L} as an initial weighting matrix before calculating the final set of estimates using an estimate of the optimal GMM weighting matrix calculated in $(\hat{\theta}_d^{(1)}, \hat{\psi}^{(1)})$.

B   Details about the data set treatment

Some general remarks   For air transport, we use data from the Official Airline Guide (OAG), and in particular the information provided by the Scheduled Analyser and the Traffic Analyser. The Scheduled Analyser (SA) provides scheduled timetables of proposed flights and airport locations. A flight with a stopover is the combination of two origin-destination flights. The Traffic Analyser (TA), on the other hand, provides data on flight prices and quantities sold (i.e., actual bookings). Prices and bookings refer to tickets sold by travel agents as well as those bought directly online by consumers. Information on tickets sold by travel agents is provided by a global distribution system (GDS). Information on online sales is provided by dedicated companies working on web-only data. TA information is monthly and at airline level for each individual flight. As we are investigating the relationship between air transport and tourism, we only consider the economy discount booking class.

Calculation of the frequency   The frequency for connecting flights is not available in the OAG databases. We therefore calculate them using via the connecting flights from the TA database. For example, suppose we have a proposed flight from O to D with a connection at airport G. From the SA data set we take the frequency of the route O-G and the frequency of the route G-D and the frequency of the product $O - G - D$ is defined as the minimum of the frequency of these two routes.

If the same airline proposes different options for the connecting airport, we define the frequency as the sum of all possible connecting airports of the frequency calculated above. We do not take different gateways and minimum connecting time into account, and therefore the calculated frequency for the connection is slightly overestimated.

Tourism data   The data on tourist flows come from Istat. In addition, we use information from the annual survey on international tourism in Italy published by the Bank of Italy. We use the non-resident data set, which counts almost 150,000 observations per year at the individual level. The survey collects individual-level data on inbound passengers arriving at specific airports and their holiday destinations, and provides tourist expenditure by country of origin.

Instruments for the frequency   The instruments used for frequency, which is endogenous in our demand regression, are the following: $latitude\_dif$, $distance$, dep_pop, $exog\_tourist$, $\#comp\_prod$, $dep\_destinations$ and hub_dest. $latitude\_dif$ is given by the difference in latitude between the region of origin and the region of destination, and it captures possible climatic differences in summer between the region of origin and the Mediterranean regions; this difference

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may have a positive effect on frequency, especially for Northern European regions, as there are relevant climatic differences within the Italian regions. *distance* measures the geodesic distance in kilometers between the centroid of the region of origin and the region of destination. *dep_pop* is the population in the origin region, while *exog_tourist* measures the tourist preferences of the destination region by counting the total number of tourists from all countries in the world arriving in the Italian destination region minus those arriving from the European origin region in our data. *#comp_prod* is the number of competing products, *dep_destinations* is the percentage of destinations available at the departure airport that are served by the airline, thus capturing the frequent flyer advantage. Finally, the variable *hub_dest* is a binary variable indicating whether the flight arrives in Rome for the *Skyteam* alliance, which represents the only hub in Italy.

We estimate the conditional median of the frequency given these instruments, and we compute the fitted frequency value $\widehat{f}$ that is used as an instrument in the general demand IV regression.

C First-stage estimation of the endogeneous explanatory variables

Table 11 shows the first stage estimates and highlights in particular that the F-statistic, which could be used to detect the possibility of weak instruments, is so high that we can safely assume that the standard asymptotic approximation for the distribution of the 2SLS estimator is valid.

Table 11: Demand Side: First-stage Endogenous Variables and Instruments

Independent variables	(1)	(2)	(3)
	Dependent variable		
	p_{jmt}	f_{jmt}	$ln(s_{jmt|a})$
$direct\_FSC_{jmt}$	10.5044***	44.4741***	-0.1262***
	(1.9056)	(13.3092)	(0.0485)
gdp_{mt}	-0.0003**	0.0056***	-0.00003***
	(0.0001)	(0.0011)	(0.000003)
edu_{mt}	-0.2498**	-4.7226***	0.0021
	(0.1108)	(1.0051)	(0.0025)
$fuel\_cons_{jmt}$	0.1572**	-2.4450***	-0.0058***
	(0.0619)	(0.4757)	(0.0013)
$\widehat{f}_{jmt}$	0.0457***	1.2174***	-0.0030***
	(0.0041)	(0.0336)	(0.0001)
$direct\_alternative_{jmt}$	-4.9173***	-65.4392***	-0.4457***
	(1.5950)	(13.9666)	(0.0363)
$\#\_direct\_comp\_prod_{jmt}$	-4.1394***	16.7880**	-0.2507***
	(0.5747)	(6.6091)	(0.0147)
$Constant$	107.2268***	280.0894***	-0.1350
	(7.0487)	(47.8546)	(0.1601)
Observations	6,525	6,525	6,525
F test	58.31	336.42	713.00
Year dummies	✓	✓	✓
Italian region dummies	✓	✓	✓
European country dummies	✓	✓	✓
Airline/Alliance dummies	✓	✓	✓
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1			

D Calibration matrix and per-region results with decentralized regime

Table 12 shows the transfer rate of passengers landing in a given region toward the different regions of Italy after normalization. Tables 13 to 27 are the analog of Table 8 for the other regions.

Table 12: Calibration Matrix (%)

Airport region (k)	Final destination region (r)																			
	Abruzzo-Molise	Calabria	Campania	Emilia-Romagna	Friuli-Venezia Giulia	Lazio	Liguria	Lombardy	Marche	Piedmont	Puglia	Tuscany	Umbria	Veneto	Sardinia	Sicily	Basilicata	Trentino Alto Adige	Valle d'Aosta	Total
Abruzzo-Molise	94.46					1.25			2.99		1.30									100
Calabria		89.19	6.76									1.35				2.70				100
Campania			93.42			3.89					1.46	1.23								100
Emilia-Romagna				67.66		2.24		2.96	4.61			16.49		6.04						100
Friuli-Venezia Giulia					93.11			1.45						5.44						100
Lazio	1.65		4.34			81.34		1.34				5.05	1.76	2.15		2.37				100
Liguria			2.97			7.43	73.30	3.49		2.91		3.36		1.36	1.16	4.02				100
Lombardy			1.09	3.97		1.78	3.08	69.83		7.11		3.07		5.29	1.31	1.96		1.51		100
Marche	2.46			9.58		2.16			79.81			1.29	4.70							100
Piedmont							2.70	3.12		89.91									4.27	100
Puglia		1.31	3.26			1.22					87.30						6.91			100
Tuscany				1.44		2.64	3.80					89.94		2.18						100
Umbria	2.00					3.00		3.37	1.00			5.00	89.00							100
Veneto														92.25				4.38		100
Sardinia															100					100
Sicily																100				100

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Table 13: Counterfactual Analysis: Decentralized Subsidy Regime in Emilia-Romagna

Region	Total subsidy (€ year)	Pass through	Air transportation						Tourism
			Δ% pax	Δ% LCC pax	Δ% FSC pax	Δπ (€ year)	ΔCS (€ year)	Δ W air (€ year)	Δ% tourist
Emilia-Romagna	447,245	- 0.98	+5.26	+7.51	-0.04	+661,457	+421,313	+1,082,770	+1.09
Friuli-Venezia Giulia	-	-	-0.31	-0.54	-0.05	-2,141	-507	-2,648	-0.01
Liguria*	-	-	-0.13	-0.30	-0.04	-2,332	-178	-2,509	-0.02
Lombardy*	-	-	-0.21	-0.28	-0.06	-110,671	-15,076	-125,747	-0.07
Piedmont*	-	-	-0.26	-0.39	-0.06	-8,391	-1,221	-9,612	-0.06
Trentino-Alto Adige	-	-	-	-	-	-	-	-	≈0
Valle d'Aosta	-	-	-	-	-	-	-	-	-0.01
Veneto*	-	-	-0.14	-0.20	-0.05	-41,827	-1,800	-43,627	-0.01
Abruzzo-Molise	-	-	-0.33	-0.33	≈0	-4,135	-773	-4,908	-0.19
Lazio	-	-	-0.16	-0.24	-0.06	-87,512	-9,246	-96,759	-0.12
Marche*	-	-	-0.29	-0.37	-0.02	-3,014	-568	-3,581	+0.50
Tuscany*	-	-	-0.17	-0.24	-0.03	-30,777	-1,962	-32,739	+0.09
Umbria*	-	-	-0.39	-0.39	-	-2,588	-438	-3,025	-0.05
Basilicata	-	-	-	-	-	-	-	-	-0.07
Calabria	-	-	-0.14	-0.22	-0.01	-2,684	-461	-3,144	-0.05
Campania	-	-	-0.11	-0.15	-0.05	-15,514	+247	-15,267	-0.08
Puglia	-	-	-0.21	-0.29	-0.02	-17,458	-2,044	-19,502	-0.10
Sardinia	-	-	-0.11	-0.15	-0.03	-11,362	+473	-10,889	-0.04
Sicily	-	-	-0.13	-0.18	-0.05	-20,339	-748	-21,087	-0.08
Italy	447,245	-	+0.10	+0.19	-0.05	+300,713	+387,013	+687,726	+0.03

* indicate regions in proximity to Emilia-Romagna.

Table 14: Counterfactual Analysis: Decentralized Subsidy Regime in Friuli-Venezia Giulia

Region	Total subsidy (€ year)	Pass through	Air transportation						Tourism
			Δ % pax	Δ % LCC pax	Δ % FSC pax	Δπ (€ year)	ΔCS (€ year)	Δ W air (€ year)	Δ % tourist
Emilia-Romagna	-	-	-0.02	-0.02	≈ 0	-2,024	-526	-2,550	≈ 0
Friuli-Venezia Giulia	17,861	- 0.99	+4.22	+7.96	≈ 0	+40,102	+17,038	+57,140	+0.12
Liguria	-	-	-0.03	-0.08	≈ 0	-560	-132	-692	≈ 0
Lombardy	-	-	-0.01	-0.01	≈ 0	-5,563	-1,354	-6,917	≈ 0
Piedmont	-	-	-0.02	-0.03	≈ 0	-837	-206	-1,043	≈ 0
Trentino-Alto Adige	-	-	-	-	-	-	-	-	≈ 0
Valle d'Aosta	-	-	-	-	-	-	-	-	≈ 0
Veneto*	-	-	-0.01	-0.01	≈ 0	-2,507	-577	-3,083	≈ 0
Abruzzo-Molise	-	-	-0.03	-0.03	≈ 0	-457	-106	-563	-0.01
Lazio	-	-	-0.01	-0.01	≈ 0	-4,464	-967	-5,431	-0.01
Marche	-	-	-0.07	-0.08	≈ 0	-693	-163	-855	-0.01
Tuscany	-	-	-0.01	-0.02	≈ 0	-2,441	-596	-3,037	≈ 0
Umbria	-	-	-0.09	-0.09	-	-599	-140	-739	-0.01
Basilicata	-	-	-	-	-	-	-	-	≈ 0
Calabria	-	-	-0.02	-0.02	≈ 0	-357	-84	-441	-0.01
Campania	-	-	≈ 0	-0.01	≈ 0	-624	-82	-706	≈ 0
Puglia	-	-	-0.01	-0.02	≈ 0	-1,345	-332	-1,676	-0.01
Sardinia	-	-	-0.01	-0.01	≈ 0	-586	-102	-688	≈ 0
Sicily	-	-	≈ 0	-0.01	≈ 0	-928	-215	-1,143	≈ 0
Italy	17,861	-	≈ 0	≈ 0	≈ 0	+16,117	+11,458	+27,575	≈ 0

* indicate regions in proximity to Friuli-Venezia Giulia.

Table 15: Counterfactual Analysis: Decentralized Subsidy Regime in Liguria

Region	Total subsidy (€ year)	Pass through	Air transportation						Tourism
			Δ % pax	Δ % LCC pax	Δ % FSC pax	Δπ (€ year)	ΔCS (€ year)	Δ W air (€ year)	Δ % tourist
Emilia-Romagna*	-	-	-0.01	-0.02	≈ 0	-2,070	-226	-2,296	≈ 0
Friuli-Venezia Giulia	-	-	-0.07	-0.12	≈ 0	-578	-126	-705	≈ 0
Liguria	27,889	-0.99	+2.75	+7.96	≈ 0	+54,041	+26,611	+80,651	+0.10
Lombardy*	-	-	-0.01	-0.01	≈ 0	-7,747	-796	-8,543	≈ 0
Piedmont*	-	-	-0.02	-0.04	≈ 0	-1,057	-175	-1,231	≈ 0
Trentino-Alto Adige	-	-	-	-	-	-	-	-	≈ 0
Valle d'Aosta	-	-	-	-	-	-	-	-	≈ 0
Veneto	-	-	-0.01	-0.02	≈ 0	-4,125	-717	-4,841	≈ 0
Abruzzo-Molise	-	-	-0.04	-0.04	≈ 0	-609	-122	-731	-0.02
Lazio	-	-	-0.01	-0.01	≈ 0	-6,624	-690	-7,313	≈ 0
Marche	-	-	-0.09	-0.11	≈ 0	-895	-198	-1,093	-0.01
Tuscany*	-	-	-0.02	-0.02	≈ 0	-3,494	-686	-4,179	≈ 0
Umbria	-	-	-0.11	-0.11	-	-768	-170	-938	-0.01
Basilicata	-	-	-	-	-	-	-	-	≈ 0
Calabria	-	-	-0.02	-0.03	≈ 0	-481	-102	-583	-0.01
Campania	-	-	-0.01	-0.02	≈ 0	-1,609	-113	-1,722	≈ 0
Puglia	-	-	-0.02	-0.02	≈ 0	-1,669	-350	-2,019	-0.01
Sardinia	-	-	-0.01	-0.02	≈ 0	-1,159	-216	-1,375	≈ 0
Sicily	-	-	-0.01	-0.01	≈ 0	-1,627	-357	-1,984	≈ 0
Italy	27,889	-	≈ 0	+0.01	≈ 0	+19,529	+21,569	+41,098	≈ 0

* indicate regions in proximity to Liguria.

Table 16: Counterfactual Analysis: Decentralized Subsidy Regime in Piedmont

Region	Total subsidy (€ year)	Pass through	Δ % pax	Δ % LCC pax	Δ % FSC pax	Δπ (€ year)	ΔCS (€ year)	Δ W air (€ year)	Tourism Δ % tourist
Emilia-Romagna*	-	-	-0.07	-0.10	-0.01	-8,491	-785	-9,277	-0.02
Friuli-Venezia Giulia	-	-	-0.12	-0.21	-0.02	-891	-198	-1,090	≈0
Liguria*	-	-	-0.06	-0.15	-0.01	-1,141	-75	-1,216	+0.01
Lombardy*	-	-	-0.04	-0.06	-0.02	-27,774	+1,342	-26,432	-0.01
Piedmont	114,364	- 0.99	+4.59	+7.82	-0.02	+168,920	+108,911	+277,831	+0.48
Trentino-Alto Adige	-	-	-	-	-	-	-	-	≈0
Valle d'Aosta*	-	-	-	-	-	-	-	-	+0.09
Veneto	-	-	-0.03	-0.05	-0.01	-11,606	+91	-11,515	-0.01
Abruzzo-Molise	-	-	-0.12	-0.13	-0.01	-1,694	-285	-1,979	-0.06
Lazio	-	-	-0.04	-0.05	-0.02	-23,756	+382	-23,374	-0.03
Marche	-	-	-0.14	-0.18	-0.01	-1,540	-276	-1,816	-0.02
Tuscany	-	-	-0.05	-0.07	-0.01	-9,612	-57	-9,668	-0.01
Umbria	-	-	-0.19	-0.19	-	-1,304	-235	-1,539	-0.02
Basilicata	-	-	-	-	-	-	-	-	-0.02
Calabria	-	-	-0.05	-0.07	-0.01	-1,043	-134	-1,177	-0.02
Campania	-	-	-0.03	-0.04	-0.02	-5,056	+1,002	-4,054	-0.02
Puglia	-	-	-0.05	-0.07	-0.01	-4,355	-665	-5,020	-0.02
Sardinia	-	-	-0.03	-0.04	-0.01	-3,295	+233	-3,061	-0.01
Sicily	-	-	-0.04	-0.05	-0.02	-6,302	+314	-5,988	-0.02
Italy	114,364	-	+0.03	+0.05	-0.02	+61,061	+109,565	+170,626	+0.01

* indicate regions in proximity to Piedmont.

Table 17: Counterfactual Analysis: Decentralized subsidy Regime in Veneto

| Region | Total subsidy (€ year) | Pass through | Air transportation | | | | | | Tourism |
			Δ % pax	Δ % LCC pax	Δ % FSC pax	Δπ (€ year)	ΔCS (€ year)	Δ W air (€ year)	Δ % tourist
Emilia-Romagna*	-	-	-0.33	-0.41	-0.14	-40,803	-1,679	-42,483	-0.09
Friuli-Venezia Giulia*	-	-	-0.37	-0.55	-0.18	-2,991	-310	-3,301	-0.01
Liguria	-	-	-0.36	-0.63	-0.21	-6,526	+356	-6,169	-0.05
Lombardy*	-	-	-0.33	-0.42	-0.13	-180,169	-11,354	-191,524	-0.10
Piedmont	-	-	-0.32	-0.42	-0.17	-12,437	-48	-12,485	-0.08
Trentino-Alto Adige*	-	-	-	-	-	-	-	-	+0.04
Valle d'Aosta	-	-	-	-	-	-	-	-	-0.01
Veneto	910,693	- 0.98	+4.06	+7.34	-0.17	+1,222,945	+865,614	+2,088,558	+0.72
Abruzzo-Molise	-	-	-0.52	-0.52	-0.39	-7,857	-658	-8,516	-0.31
Lazio	-	-	-0.30	-0.41	-0.17	-172,270	-758	-173,028	-0.26
Marche	-	-	-0.52	-0.62	-0.13	-5,687	-614	-6,301	-0.09
Tuscany	-	-	-0.41	-0.54	-0.16	-70,893	-4,827	-75,719	-0.11
Umbria	-	-	-0.69	-0.69	-	-4,655	-660	-5,315	-0.09
Basilicata	-	-	-	-	-	-	-	-	-0.13
Calabria	-	-	-0.33	-0.43	-0.18	-6,516	-311	-6,827	-0.12
Campania	-	-	-0.42	-0.55	-0.18	-53,662	-3,756	-57,418	-0.26
Puglia	-	-	-0.40	-0.49	-0.14	-32,226	-2,527	-34,753	-0.19
Sardinia	-	-	-0.43	-0.58	-0.16	-36,094	-4,345	-40,439	-0.16
Sicily	-	-	-0.35	-0.48	-0.14	-48,203	-3,870	-52,073	-0.19
Italy	910,693	-	+0.21	+0.43	-0.16	+541,957	+830,251	+1,372,209	+0.07

* indicate regions in proximity to Veneto.

Table 18: Counterfactual Analysis: Decentralized Subsidy Regime in Abruzzo-Molise

Region	Total subsidy (€ year)	Pass through	Air transportation						Tourism
			Δ % pax	Δ % LCC pax	Δ % FSC pax	Δπ (€ year)	ΔCS (€ year)	Δ W air (€ year)	Δ % tourist
Emilia-Romagna	-	-	-0.03	-0.04	-0.01	-4,296	-760	-5,056	-0.01
Friuli-Venezia Giulia	-	-	-0.06	-0.10	-0.01	-475	-103	-579	≈0
Liguria	-	-	-0.03	-0.08	≈0	-620	-124	-744	≈0
Lombardy	-	-	-0.02	-0.02	≈0	-11,559	-1,445	-13,004	-0.01
Piedmont	-	-	-0.04	-0.07	≈0	-1,712	-303	-2,014	-0.01
Trentino-Alto Adige	-	-	-	-	-	-	-	-	≈0
Valle d'Aosta	-	-	-	-	-	-	-	-	≈0
Veneto	-	-	-0.02	-0.03	≈0	-8,089	-908	-8,998	≈0
Abruzzo-Molise	59,124	-0.99	+7.77	+7.81	≈0	+116,766	+56,476	+173,243	+2.87
Lazio*	-	-	-0.02	-0.03	≈0	-11,568	-1,346	-12,915	-0.01
Marche*	-	-	-0.15	-0.19	-0.01	-1,463	-271	-1,734	+0.03
Tuscany	-	-	-0.03	-0.05	≈0	-8,021	-960	-8,981	-0.01
Umbria*	-	-	-0.17	-0.17	-	-1,137	-203	-1,341	-0.01
Basilicata	-	-	-	-	-	-	-	-	-0.02
Calabria	-	-	-0.10	-0.16	≈0	-2,141	-252	-2,394	-0.03
Campania*	-	-	-0.02	-0.02	≈0	-2,419	-138	-2,558	-0.01
Puglia*	-	-	-0.05	-0.07	≈0	-5,021	-587	-5,608	-0.02
Sardinia	-	-	-0.04	-0.06	-0.01	-4,561	-307	-4,868	-0.01
Sicily	-	-	-0.03	-0.05	-0.01	-5,757	-503	-6,259	-0.02
Italy	59,124	-	+0.01	+0.02	≈0	+47,926	+48,265	+96,191	≈0

* indicate regions in proximity to Abruzzo-Molise.

Table 19: Counterfactual Analysis: Decentralized Subsidy Regime in Lazio

| Region | Air transportation | | | | | | | | Tourism |
	Total subsidy (€ year)	Pass through	Δ % pax	Δ % LCC pax	Δ % FSC pax	Δπ (€ year)	ΔCS (€ year)	Δ W air (€ year)	Δ % tourist
Emilia-Romagna	-	-	-0.79	-0.97	-0.36	-87,369	-5,593	-92,962	-0.21
Friuli-Venezia Giulia	-	-	-0.72	-0.99	-0.40	-5,488	-398	-5,886	-0.02
Liguria	-	-	-0.53	-0.93	-0.33	-9,334	+208	-9,126	-0.08
Lombardy	-	-	-0.66	-0.82	-0.35	-371,301	-6,409	-377,709	-0.26
Piedmont	-	-	-0.66	-0.90	-0.31	-22,310	-485	-22,796	-0.17
Trentino-Alto Adige	-	-	-	-	-	-	-	-	-0.01
Valle d'Aosta	-	-	-	-	-	-	-	-	-0.01
Veneto	-	-	-0.62	-0.81	-0.37	-180,331	+4,050	-176,281	-0.10
Abruzzo-Molise*	-	-	-0.82	-0.83	-0.37	-10,665	-1,418	-12,083	+0.99
Lazio	1,826,031	- 0.96	+3.55	+6.81	-0.40	+2,142,056	+1,720,879	+3,862,935	+2.86
Marche*	-	-	-0.70	-0.80	-0.28	-6,793	-1,216	-8,009	-0.16
Tuscany*	-	-	-0.68	-0.88	-0.32	-113,821	-6,640	-120,462	-0.03
Umbria*	-	-	-0.85	-0.85	-	-5,579	-1,023	-6,602	+0.48
Basilicata	-	-	-	-	-	-	-	-	-0.24
Calabria	-	-	-0.62	-0.81	-0.32	-11,451	-740	-12,191	-0.23
Campania*	-	-	-0.60	-0.74	-0.34	-82,286	+2,654	-79,632	+0.02
Puglia	-	-	-0.71	-0.86	-0.29	-55,485	-3,193	-58,678	-0.34
Sardinia	-	-	-0.62	-0.78	-0.33	-55,189	-1,767	-56,956	-0.23
Sicily	-	-	-0.64	-0.83	-0.33	-89,293	-3,270	-92,562	-0.17
Italy	1,826,031	-	+0.43	+0.92	-0.36	+1,035,361	+1,695,639	+2,731,000	+0.14

* indicate regions in proximity to Lazio.

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Table 20: Counterfactual Analysis: Decentralized Subsidy Regime in Marche

Region	Total subsidy (€ year)	Pass through	Air transportation						Tourism
			Δ % pax	Δ % LCC pax	Δ % FSC pax	Δπ (€ year)	ΔCS (€ year)	Δ W air (€ year)	Δ % tourist
Emilia-Romagna*	-	-	-0.02	-0.03	≈0	-3,120	-529	-3,649	+0.01
Friuli-Venezia Giulia	-	-	-0.08	-0.15	≈0	-717	-155	-872	≈0
Liguria	-	-	-0.04	-0.12	≈0	-903	-197	-1,100	≈0
Lombardy	-	-	-0.01	-0.01	≈0	-9,208	-1,352	-10,561	≈0
Piedmont	-	-	-0.03	-0.05	≈0	-1,553	-274	-1,827	≈0
Trentino-Alto Adige	-	-	-	-	-	-	-	-	≈0
Valle d'Aosta	-	-	-	-	-	-	-	-	≈0
Veneto	-	-	-0.01	-0.02	≈0	-5,620	-827	-6,448	≈0
Abruzzo-Molise*	-	-	-0.10	-0.10	≈0	-1,469	-267	-1,736	≈0
Lazio*	-	-	-0.01	-0.01	≈0	-6,811	-1,170	-7,981	-0.01
Marche	31,576	- 0.99	+6.25	+7.90	-0.01	+72,759	+30,073	+102,832	+0.68
Tuscany*	-	-	-0.02	-0.03	≈0	-5,074	-863	-5,937	≈0
Umbria*	-	-	-0.19	-0.19	-	-1,304	-243	-1,546	+0.02
Basilicata	-	-	-	-	-	-	-	-	-0.01
Calabria	-	-	-0.05	-0.08	≈0	-1,029	-183	-1,211	-0.02
Campania	-	-	-0.01	-0.01	≈0	-1,238	-58	-1,295	-0.01
Puglia	-	-	-0.03	-0.04	≈0	-3,112	-536	-3,648	-0.01
Sardinia	-	-	-0.02	-0.03	≈0	-2,097	-174	-2,271	-0.01
Sicily	-	-	-0.02	-0.02	≈0	-2,819	-436	-3,255	-0.01
Italy	31,576	-	+0.01	+0.01	≈0	+26,685	+22,810	+49,495	≈0

* indicate regions in proximity to Marche.

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Table 21: Counterfactual Analysis: Decentralized subsidy Regime in Tuscany

Region	Total subsidy (€ year)	Pass through	Air transportation						Tourism
			Δ % pax	Δ % LCC pax	Δ % FSC pax	Δπ (€ year)	ΔCS (€ year)	Δ W air (€ year)	Δ % tourist
Emilia-Romagna*	-	-	-0.27	-0.35	-0.09	-31,613	-3,995	-35,609	-0.04
Friuli-Venezia Giulia	-	-	-0.35	-0.58	-0.10	-2,674	-547	-3,220	-0.01
Liguria*	-	-	-0.26	-0.53	-0.12	-4,884	-110	-4,994	+0.09
Lombardy	-	-	-0.22	-0.29	-0.09	-127,615	-10,216	-137,830	-0.10
Piedmont	-	-	-0.27	-0.39	-0.10	-9,948	-833	-10,781	-0.06
Trentino-Alto Adige	-	-	-	-	-	-	-	-	≈0
Valle d'Aosta	-	-	-	-	-	-	-	-	-0.01
Veneto	-	-	-0.25	-0.37	-0.11	-74,812	-4,690	-79,503	-0.04
Abruzzo-Molise	-	-	-0.53	-0.53	-0.16	-7,837	-976	-8,813	-0.28
Lazio*	-	-	-0.21	-0.30	-0.10	-118,576	-9,401	-127,977	-0.14
Marche*	-	-	-0.48	-0.59	-0.07	-4,974	-889	-5,863	-0.08
Tuscany	610,389	- 0.98	+4.83	+7.50	-0.09	+897,514	+576,784	+1,474,298	+0.97
Umbria*	-	-	-0.60	-0.60	-	-4,044	-755	-4,799	-0.07
Basilicata	-	-	-	-	-	-	-	-	-0.10
Calabria	-	-	-0.24	-0.35	-0.07	-5,014	-590	-5,605	-0.09
Campania	-	-	-0.22	-0.29	-0.11	-31,500	-281	-31,781	-0.15
Puglia	-	-	-0.29	-0.37	-0.06	-24,110	-2,654	-26,765	-0.14
Sardinia	-	-	-0.25	-0.35	-0.08	-23,416	-2,515	-25,931	-0.09
Sicily	-	-	-0.23	-0.32	-0.08	-33,882	-3,445	-37,326	-0.13
Italy	610,389	-	+0.13	+0.28	-0.10	+392,613	+534,887	+927,500	+0.04

* indicate regions in proximity to Tuscany.

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Table 22: Counterfactual Analysis: Decentralized Subsidy Regime in Umbria

Region	Total subsidy (€ year)	Pass through	Air transportation						Tourism
			Δ % pax	Δ % LCC pax	Δ % FSC pax	$\Delta\pi$ (€ year)	ΔCS (€ year)	Δ W air (€ year)	Δ % tourist
Emilia-Romagna*	-	-	-0.02	-0.02	≈ 0	-2,642	-422	-3,063	≈ 0
Friuli-Venezia Giulia	-	-	-0.07	-0.13	≈ 0	-616	-133	-749	≈ 0
Liguria	-	-	-0.04	-0.11	≈ 0	-786	-160	-946	≈ 0
Lombardy	-	-	-0.01	-0.01	≈ 0	-7,610	-1,253	-8,862	≈ 0
Piedmont	-	-	-0.03	-0.04	≈ 0	-1,341	-216	-1,557	≈ 0
Trentino-Alto Adige	-	-	-	-	-	-	-	-	≈ 0
Valle d'Aosta	-	-	-	-	-	-	-	-	≈ 0
Veneto	-	-	-0.01	-0.02	≈ 0	-4,761	-807	-5,568	≈ 0
Abruzzo-Molise*	-	-	-0.07	-0.07	≈ 0	-1,148	-199	-1,347	≈ 0
Lazio*	-	-	-0.01	-0.01	≈ 0	-5,873	-957	-6,830	≈ 0
Marche*	-	-	-0.12	-0.15	≈ 0	-1,307	-241	-1,548	-0.01
Tuscany*	-	-	-0.02	-0.03	≈ 0	-4,153	-719	-4,872	≈ 0
Umbria	25,851	- 0.99	+7.94	+7.94	-	+60,336	+24,660	+84,996	+0.46
Basilicata	-	-	-	-	-	-	-	-	-0.01
Calabria	-	-	-0.03	-0.05	-0.01	-788	-140	-928	-0.01
Campania	-	-	-0.01	-0.01	≈ 0	-1,049	-56	-1,106	≈ 0
Puglia	-	-	-0.03	-0.04	≈ 0	-2,569	-474	-3,043	-0.01
Sardinia	-	-	-0.01	-0.02	≈ 0	-1,521	-183	-1,704	≈ 0
Sicily	-	-	-0.01	-0.02	≈ 0	-2,183	-306	-2,489	-0.01
Italy	25,851	-	≈ 0	+0.01	≈ 0	+21,988	+18,397	+40,385	≈ 0

* indicate regions in proximity to Umbria.

Table 23: Counterfactual Analysis: Decentralized Subsidy Regime in Calabria

Region	Total subsidy (€ year)	Pass through	Air transportation						Tourism
			Δ % pax	Δ % LCC pax	Δ % FSC pax	Δπ (€ year)	ΔCS (€ year)	Δ W air (€ year)	Δ % tourist
Emilia-Romagna	-	-	-0.02	-0.03	-0.01	-2,866	-420	-3,286	-0.01
Friuli-Venezia Giulia	-	-	-0.05	-0.08	-0.02	-399	-76	-474	≈ 0
Liguria	-	-	-0.03	-0.07	-0.01	-513	-98	-611	≈ 0
Lombardy	-	-	-0.02	-0.02	-0.01	-10,490	-1,192	-11,683	-0.01
Piedmont	-	-	-0.02	-0.03	-0.01	-1,067	-147	-1,214	≈ 0
Trentino-Alto Adige	-	-	-	-	-	-	-	-	≈ 0
Valle d'Aosta	-	-	-	-	-	-	-	-	≈ 0
Veneto	-	-	-0.02	-0.03	-0.01	-6,247	-544	-6,791	≈ 0
Abruzzo-Molise	-	-	-0.15	-0.15	≈ 0	-2,133	-264	-2,398	-0.06
Lazio	-	-	-0.02	-0.03	-0.01	-11,277	-715	-11,992	-0.01
Marche	-	-	-0.11	-0.14	-0.02	-1,035	-192	-1,227	-0.02
Tuscany	-	-	-0.02	-0.03	-0.01	-5,102	-520	-5,622	-0.01
Umbria	-	-	-0.11	-0.11	-	-752	-147	-898	-0.01
Basilicata*	-	-	-	-	-	-	-	-	-0.02
Calabria	56,002	- 0.99	+4.84	+7.85	-0.01	+99,552	+53,571	+153,123	+1.65
Campania*	-	-	-0.02	-0.02	-0.01	-2,393	-36	-2,429	+0.01
Puglia	-	-	-0.05	-0.07	-0.01	-4,674	-484	-5,157	-0.02
Sardinia	-	-	-0.04	-0.05	-0.01	-3,531	-308	-3,839	-0.01
Sicily	-	-	-0.03	-0.05	-0.01	-5,677	-432	-6,109	-0.01
Italy	56,002	-	+0.01	+0.02	-0.01	+41,397	+47,996	+89,393	≈ 0

* indicate regions in proximity to Calabria.

Table 24: Counterfactual Analysis: Decentralized Subsidy Regime in Campania

	Air transportation								Tourism
Region	Total subsidy (€ year)	Pass through	Δ % pax	Δ % LCC pax	Δ % FSC pax	Δπ (€ year)	ΔCS (€ year)	Δ W air (€ year)	Δ % tourist
Emilia-Romagna	-	-	-0.14	-0.18	-0.02	-17,805	-2,297	-20,103	-0.04
Friuli-Venezia Giulia	-	-	-0.18	-0.32	-0.03	-1,436	-313	-1,749	-0.01
Liguria	-	-	-0.10	-0.23	-0.03	-2,129	-58	-2,187	-0.01
Lombardy	-	-	-0.09	-0.12	-0.03	-56,170	-4,450	-60,620	-0.04
Piedmont	-	-	-0.11	-0.17	-0.03	-4,687	-580	-5,268	-0.03
Trentino-Alto Adige	-	-	-	-	-	-	-	-	≈0
Valle d'Aosta	-	-	-	-	-	-	-	-	≈0
Veneto	-	-	-0.10	-0.16	-0.03	-33,076	-2,905	-35,981	-0.02
Abruzzo-Molise*	-	-	-0.33	-0.33	≈0	-4,999	-595	-5,594	-0.16
Lazio	-	-	-0.09	-0.14	-0.03	-57,132	-4,400	-61,532	-0.07
Marche	-	-	-0.30	-0.38	-0.02	-3,106	-548	-3,654	-0.05
Tuscany	-	-	-0.12	-0.17	-0.03	-24,868	-2,143	-27,011	-0.03
Umbria	-	-	-0.39	-0.39	-	-2,522	-491	-3,013	-0.04
Basilicata*	-	-	-	-	-	-	-	-	+1.86
Calabria	-	-	-0.23	-0.35	-0.04	-4,676	-557	-5,234	+0.04
Campania*	-	-	-0.10	-0.14	-0.03	-14,641	-684	-15,325	-0.02
Puglia	282,665	- 0.98	+5.47	+7.58	-0.03	+468,884	+267,880	+736,763	+2.56
Sardinia	-	-	-0.16	-0.23	-0.05	-15,925	-1,687	-17,612	-0.06
Sicily	-	-	-0.15	-0.21	-0.05	-22,947	-2,459	-25,406	-0.08
Italy	282,665	-	+0.06	+0.12	-0.03	+202,765	+243,712	+446,476	+0.02

* indicate regions in proximity to Puglia.

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Table 25: Counterfactual Analysis: Decentralized Subsidy Regime in Puglia

Region	Total subsidy (€ year)	Pass through	Air transportation						Tourism
			Δ % pax	Δ % LCC pax	Δ % FSC pax	Δπ (€ year)	ΔCS (€ year)	Δ W air (€ year)	Δ % tourist
Emilia-Romagna	-	-	-0.14	-0.18	-0.02	-17,805	-2,297	-20,103	-0.04
Friuli-Venezia Giulia	-	-	-0.18	-0.32	-0.03	-1,436	-313	-1,749	-0.01
Liguria	-	-	-0.10	-0.23	-0.03	-2,129	-58	-2,187	-0.01
Lombardy	-	-	-0.09	-0.12	-0.03	-56,170	-4,450	-60,620	-0.04
Piedmont	-	-	-0.11	-0.17	-0.03	-4,687	-580	-5,268	-0.03
Trentino-Alto Adige	-	-	-	-	-	-	-	-	≈0
Valle d'Aosta	-	-	-	-	-	-	-	-	≈0
Veneto	-	-	-0.10	-0.16	-0.03	-33,076	-2,905	-35,981	-0.02
Abruzzo-Molise*	-	-	-0.33	-0.33	≈0	-4,999	-595	-5,594	-0.16
Lazio	-	-	-0.09	-0.14	-0.03	-57,132	-4,400	-61,532	-0.07
Marche	-	-	-0.30	-0.38	-0.02	-3,106	-548	-3,654	-0.05
Tuscany	-	-	-0.12	-0.17	-0.03	-24,868	-2,143	-27,011	-0.03
Umbria	-	-	-0.39	-0.39	-	-2,522	-491	-3,013	-0.04
Basilicata*	-	-	-	-	-	-	-	-	+1.86
Calabria	-	-	-0.23	-0.35	-0.04	-4,676	-557	-5,234	+0.04
Campania*	-	-	-0.10	-0.14	-0.03	-14,641	-684	-15,325	-0.02
Puglia	282,665	- 0.98	+5.47	+7.58	-0.03	+468,884	+267,880	+736,763	+2.56
Sardinia	-	-	-0.16	-0.23	-0.05	-15,925	-1,687	-17,612	-0.06
Sicily	-	-	-0.15	-0.21	-0.05	-22,947	-2,459	-25,406	-0.08
Italy	282,665	-	+0.06	+0.12	-0.03	+202,765	+243,712	+446,476	+0.02

* indicate regions in proximity to Puglia.

Table 26: Counterfactual Analysis: Decentralized Dubsidy Regime in Sardinia

Region	Total subsidy (€ year)	Pass through	Air transportation						Tourism
			Δ % pax	Δ % LCC pax	Δ % FSC pax	Δπ (€ year)	ΔCS (€ year)	Δ W air (€ year)	Δ % tourist
Emilia-Romagna	-	-	-0.08	-0.10	-0.04	-12,584	+1,662	-10,921	-0.02
Friuli-Venezia Giulia	-	-	-0.07	-0.07	-0.06	-1,078	+573	-505	≈ 0
Liguria	-	-	-0.09	-0.15	-0.06	-2,226	+814	-1,412	-0.01
Lombardy	-	-	-0.08	-0.10	-0.04	-50,418	+1,781	-48,637	-0.04
Piedmont	-	-	-0.08	-0.10	-0.05	-3,944	+888	-3,055	-0.02
Trentino-Alto Adige	-	-	-	-	-	-	-	-	≈ 0
Valle d'Aosta	-	-	-	-	-	-	-	-	≈ 0
Veneto	-	-	-0.13	-0.19	-0.05	-39,166	-390	-39,556	-0.03
Abruzzo-Molise	-	-	-0.28	-0.28	-0.08	-4,729	+269	-4,460	-0.14
Lazio	-	-	-0.09	-0.13	-0.04	-58,144	+2,325	-55,819	-0.08
Marche	-	-	-0.17	-0.20	-0.06	-2,566	+772	-1,793	-0.03
Tuscany	-	-	-0.13	-0.17	-0.06	-25,604	+536	-25,068	-0.04
Umbria	-	-	-0.16	-0.16	-	-1,909	+658	-1,251	-0.02
Basilicata	-	-	-	-	-	-	-	-	-0.06
Calabria	-	-	-0.17	-0.25	-0.05	-3,697	+175	-3,522	-0.06
Campania	-	-	-0.17	-0.23	-0.04	-21,854	-2,475	-24,329	-0.10
Puglia	-	-	-0.18	-0.24	-0.04	-16,251	+135	-16,117	-0.09
Sardinia	315,774	- 0.99	+4.82	+7.58	-0.06	+470,069	+301,006	+771,075	+1.67
Sicily	-	-	-0.18	-0.26	-0.05	-28,584	-1,294	-29,879	-0.09
Italy	315,774	-	+0.08	+0.15	-0.04	+197,316	+307,435	+504,751	+0.02

Table 27: Counterfactual Analysis: Decentralized Subsidy Regime in Sicily

Region	Air transportation								Tourism
	Total subsidy (€ year)	Pass through	Δ % pax	Δ % LCC pax	Δ % FSC pax	Δπ (€ year)	ΔCS (€ year)	Δ W air (€ year)	Δ % tourist
Emilia-Romagna	-	-	-0.18	-0.22	-0.10	-20,757	-1,796	-22,553	-0.05
Friuli-Venezia Giulia	-	-	-0.17	-0.21	-0.13	-1,274	-121	-1,395	≈0
Liguria	-	-	-0.17	-0.27	-0.11	-2,930	+116	-2,814	-0.02
Lombardy	-	-	-0.15	-0.19	-0.08	-84,462	-5,362	-89,824	-0.07
Piedmont	-	-	-0.18	-0.23	-0.12	-6,797	-38	-6,836	-0.04
Trentino-Alto Adige	-	-	-	-	-	-	-	-	≈0
Valle d'Aosta	-	-	-	-	-	-	-	-	≈0
Veneto	-	-	-0.19	-0.26	-0.10	-54,842	-1,644	-56,486	-0.04
Abruzzo-Molise	-	-	-0.38	-0.38	-0.21	-5,332	-611	-5,943	-0.21
Lazio	-	-	-0.17	-0.23	-0.10	-96,305	-2,905	-99,210	-0.15
Marche	-	-	-0.31	-0.36	-0.11	-2,789	-457	-3,247	-0.05
Tuscany	-	-	-0.21	-0.26	-0.11	-35,723	-3,090	-38,813	-0.06
Umbria	-	-	-0.32	-0.32	-	-2,024	-359	-2,383	-0.05
Basilicata	-	-	-	-	-	-	-	-	-0.10
Calabria	-	-	-0.31	-0.43	-0.12	-5,826	-420	-6,246	-0.11
Campania	-	-	-0.20	-0.25	-0.10	-26,781	-823	-27,604	-0.13
Puglia	-	-	-0.29	-0.37	-0.10	-21,868	-2,872	-24,740	-0.14
Sardinia	-	-	-0.31	-0.42	-0.12	-29,258	-1,746	-31,003	-0.11
Sicily	502,036	- 0.98	+4.66	+7.58	-0.12	+703,103	+477,418	+1,180,522	+2.21
Italy	502,036	-	+0.12	+0.25	-0.10	+306,135	+455,290	+761,425	+0.04