How New Airport Infrastructure Promotes Tourism: Evidence from a Synthetic Control Approach in German Regions

Luisa Doerr, Florian Dorn, Stefanie Gaebler, Niklas Potrafke
How New Airport Infrastructure Promotes Tourism: Evidence from a Synthetic Control Approach in German Regions

Abstract

We examine how new airport infrastructure influences regional tourism. Identification is based on the conversion of a military air base into a regional commercial airport in the German state of Bavaria. The new airport opened in 2007 and promotes travelling to the touristic region Allgäu in the Bavarian Alps. We use a synthetic control approach and show that the new commercial airport increased tourism in the Allgäu region over the period 2008-2016. The positive effect is especially pronounced in the county where the airport is located. Our results suggest that new transportation infrastructure promotes regional economic development.

JEL-Codes: O180, Z380, L930.

Keywords: airports, tourism, regional development, transportation infrastructure, synthetic control method.

Luisa Doerr
ifo Institute – Leibniz Institute for Economic Research at the University of Munich
Poschingerstrasse 5
Germany – 81679 Munich
doerr@ifo.de

Florian Dorn
ifo Institute – Leibniz Institute for Economic Research at the University of Munich
Poschingerstrasse 5
Germany – 81679 Munich
dorn@ifo.de

Stefanie Gaebler
ifo Institute – Leibniz Institute for Economic Research at the University of Munich
Poschingerstrasse 5
Germany – 81679 Munich
gaebler@ifo.de

Niklas Potrafke*
ifo Institute – Leibniz Institute for Economic Research at the University of Munich
Poschingerstrasse 5
Germany – 81679 Munich
potrafke@ifo.de

*corresponding author

December 17, 2019
This paper has been accepted for publication in Regional Studies.
1 Introduction

Transportation infrastructure connects regions and promotes regional (economic) development. Investments in roads, railroads and airports reduce transportation costs for products and people and help to attract new businesses, production plants and jobs. Moreover, infrastructure constitutes the basic determinant of (inter)national tourism flows. Tourists may well travel to rural areas when roads, railways and airports facilitate convenient and low-cost journeys. Tourists demand accommodation and amenities, cultural affairs such as theatres and exhibitions, amusement parks etc. and their expenditures in these areas often endorse regional economic development.

We examine how new airport infrastructure influences regional tourism. Empirical studies show that building or extending airports and airport services enhanced international tourism flows (Khadaroo and Seetanah 2007; Eugenio-Martín 2016; Khan et al. 2017), increased production and employment (Hakfoort et al. 2001; Klophaus 2008; Zak and Getzner 2014), endorsed regional economic development (Halpern and Bråthen 2011; Mukkala and Tervo 2013; Kazda et al. 2017), and might even generate positive spillover effects to neighboring regions (Percoco 2010). There are, however, hardly any empirical studies identifying the causal effect of airport infrastructure on tourism or economic development. Empirical studies that examine how infrastructure influences economic development have to deal with identification issues. Transportation infrastructure is built to connect economic units, hence, disentangling causality between new infrastructure projects and economic development is difficult. New empirical studies use identification strategies such as instrumental variables (IV) or synthetic control to estimate causal effects of infrastructure programs on population and employment (Duranton and Turner 2012; Möller and Zierer 2018; Gibbons et al. 2019), or economic development in individual regions (Chandra and Thompson 2000; Ahlfeldt and Feddersen 2018). Castillo et al. (2017) use a synthetic control approach for estimating the causal effect of an encompassing infrastructure program (including a new airport) on employment in the tourism sector in Argentina. The authors, however, do not isolate the effect of the airport. Scholars employing IV approaches show that airports or air passenger traffic increased local population (Blonigen and Cristea 2015), employment in service-related industries (Brueckner 2003; Green 2007), and local employment in services that directly benefit from the air connection (Sheard 2014). Koo

Tveter (2017), however, finds small positive effects of regional airports on employment and population in Norwegian municipalities.
et al. (2017), however, also use an IV and find no effect of direct air services on tourism inflow. Tsui (2017) uses IV and Difference-in-Differences approaches and shows that low-cost carriers (LCC) have a positive effect on domestic tourism demand.

We investigate how new airport infrastructure (specialized on LCC) influences additional guest arrivals in the tourism sector. Our identification is based on the conversion of the military air base “Memmingerberg” into the regional commercial airport Memmingen (Munich-West) in the German state of Bavaria. The military airfield was built by the Nazi-Regime in 1935/36 and was reused by the German Bundeswehr after World War II. In 2003, it was closed because the federal government decided to reorganize and consolidate the German Bundeswehr. We exploit the conversion of the airfield to a commercial airport specialized on low-cost carriers as exogenous positive infrastructure shock for the touristic sector in counties close to the airport. The commercial airport opened in 2007 and facilitates travelling to the touristic region Allgäu in the Bavarian Alps. We use a synthetic control approach comparing tourism inflows in counties close to the new commercial airport and their synthetic counterparts when the new commercial airport started operating. Counties from other regions in Bavaria that are not affected by the new airport constitute the donor pool to construct the synthetic counterfactuals. The results show that the new commercial airport increased incoming tourism from abroad in the Allgäu region over the 2008-2016 period. The positive effect is especially large in the county where the airport is located (Lower Allgäu): Memmingen Airport increased total arrivals of tourists and business travelers at touristic accommodations in Lower Allgäu on average by 54,000 (22%) and arrivals from abroad on average by 23,000 (69%) per year over the 2008-2016 period. Our results suggest that new transportation infrastructure may promote regional economic development.

2 Background: History, geography, airlines and passengers

The Regional Airport of Memmingen (FMM), internationally also known as Munich-West or Allgäu-Airport, was opened on the former military air base in Memmingerberg in the German state of Bavaria. The military air base was built by the Nazis in 1935/36 because of strategic military reasons and was reconstructed and reused by the German Bundeswehr and its NATO partners after World War II. In 2003, it was closed because the federal government decided to reorganize and consolidate the German
Bundeswehr. Local companies decided to start a commercial civil airport on the former NATO air base because of the high technical endowment and size of the runway. Local governments and the state government supported the civil airport with investments and subsidies for conversion and construction measures. Memmingen Airport, however, does not receive subsidies for its operating business and reports a positive operating result (earnings before interest and taxes, EBIT) since several years.\(^2\)

FMM started operating commercial air service in mid-2007. The airport already had over 450,000 passengers in 2008 and over 800,000 passengers in 2009 with scheduled flights operated by TUIfly and Air Berlin in the first years. The regional airport is specialized on services by low-cost carriers such as the Irish airline Ryanair (scheduled flights since 2010) or the Hungarian airline Wizz Air (since 2009).\(^3\) The number of passengers increased to 1.17 million by 2017, a decade after its opening (figure A1).\(^4\)

The airport connects several countries in Europe and the Mediterranean region to the Allgäu region. German domestic flights were the most important ones in the first two years after launching air services at FMM but have been discontinued since 2011. In 2018, connections to and from Spain, Portugal, Romania, Bulgaria, Ukraine and the United Kingdom had the highest passenger volume at Memmingen Airport (table A1). A passenger survey conducted in 2018 has shown that 40% of all passengers at Memmingen Airport are incoming passengers, similarly during the winter (46%) and summer season (35%) (Bauer et al., 2019).\(^5\)

Memmingen Airport is located in the touristic region Allgäu in the southwest of the German state of Bavaria (figure A2). The Allgäu is a popular touristic region in Germany. It is famous, for example, for hiking and skiing in the Alps, wellness and health hotels, and Germany’s most well-known castle Neuschwanstein. Allgäu ranks second after the state capital city Munich among the most popular touristic regions regarding arrivals and overnight stays in Bavaria. The 2018 passenger survey has shown that

\(^2\)Many regional airports do not report positive operating results and operate at inefficient levels (Adler et al., 2013). One reason for inefficiency lies in the importance of LCC (Červinka, 2017). Their market power enables LCC to negotiate favorable agreements, e.g. marketing charges (Barbot and D’Alfonso, 2014).

\(^3\)The emergence of LCC has led to an overall increase in the number of tourists (Rebollo and Baidal, 2009). Tourists choosing LCC are likely to have different preferences than tourists choosing other carriers (Eugenio-Martin and Inchausti-Sintes, 2016).

\(^4\)All tables and figures denoted with an A are shown in the Online Appendix.

\(^5\)Flight connections to the source regions Bulgaria, Poland, Romania and Russia had among the highest shares of incoming passengers (> 50%) among all air services in 2018. Air services offered to Sweden and the Mediterranean region including Croatia, Greece, Italy, Portugal or Spain are mainly used by outgoing passengers (incoming share < 30%).
Allgäu (21%) and Munich (33%) account for more than half of all overnight stays by incoming passengers via Memmingen Airport (Bauer et al., 2019). Growth rates in guest arrivals and overnight stays in the touristic region Allgäu exceeded those of Bavaria in total since 2007.

Connectivity via airport infrastructure depends on air services being offered (see Derudder and Witlox, 2005). An airport’s attractiveness for airlines is influenced by its catchment area size (Humphreys and Francis, 2002; Lieshout, 2012) and airport competition in multiple airport regions (Pels et al., 2001; Alberts et al., 2009; Derudder et al., 2010; Lian and Rønnevik, 2011; Wiltshire, 2018). Memmingen Airport is often advertised as Munich-West and Munich’s low-cost carrier airport abroad. Flights to FMM tend to be cheaper than to Munich’s International Airport (MUC). Travel times between Memmingen Airport and Munich’s city center, however, last about 1.5 hours (by car and bus/railway likewise), i.e., about 0.5-0.75 hours longer than from Munich International Airport. On the contrary, travel times to several touristic places in the Allgäu are reduced when arriving at Memmingen Airport rather than at any other airport.

3 Empirical strategy and data

Estimation strategy

We compare the development of tourism across counties in the German federal state of Bavaria. 96 Bavarian counties form 36 tourism regions (figure 1), which merchandise as Bavarian touristic destinations. Therefore, our treatment and control areas (donor...
pool) are counties belonging to different touristic regions. The Airport Memmingen is located in the touristic region Allgäu which consists of seven counties constituting our treatment group (light gray counties in figure 1). Counties in touristic regions located in the north and east of Bavaria form our control group (donor pool, dark gray counties). Counties from touristic regions bordering the Allgäu, as well as the capital Munich and its vicinity, are excluded from the analysis, i.e., they are neither in our treatment nor control groups (white counties). Touristic regions bordering the Allgäu are likely to be treated to some extent as well. Munich attracts most incoming passengers of Memmingen Airport and is by far the most populous and economically powerful area in Bavaria and therefore not comparable to other regions especially in terms of tourism inflows.

Identification relies on the main assumption that sorting into treatment was exogenous. The placement of the military air base in 1935/36 and its closure by decision of the federal government in 2003, hence, the timing of treatment, are obviously independent of touristic considerations. What is more, other former air bases in Bavaria are located relatively close to the international airports in Munich and Nuremberg or the technical equipment and size of the airfield was not as suitable for a commercial airport. They are re-used as special airfields, sport airfields, or industrial areas. Memmingen Airport, however, has proximity to the catchment and metropolitan area of Munich. Thus, it was an ideal location for establishing a specialized low-cost carrier airport close to Munich. Its geographic location combined with the circumstances of its conversion renders FMM an ideal testing ground to examine how new transport infrastructure influences tourism indicators in the (peripheral) counties around the airport.

To identify how Memmingen Airport influences tourism in the Allgäu region, we use the synthetic control approach to compare actual developments in tourism with a hypothetical situation, which would probably have arisen without the opening of the commercial airport. The synthetic control method is a powerful approach for comparative case studies when the number of treated units is small, and only aggregated outcomes are observable (see Abadie and Gardeazabal 2003; Abadie et al. 2010, 2015; Chernozhukov et al. 2018). The approach allows to construct accurate counterfactuals of the counties of interest. The identifying assumption in our context is that tourism inflows depend on travel times to the airfield, which is exogenous to the timing of the air base closure.

---

8The synthetic control approach using algorithm-derived weights is supposed to better describe the characteristics of the counties of interest than any single comparison or an equally weighted combination.
in the treated counties close to the new commercial airport would have evolved in the same manner as in their synthetic counterfactuals in a hypothetical world without opening of the commercial airport. Synthetic controls for the treated counties are constructed by using lagged values of the outcome variable as predictors (Firpo and Possebom, 2018; Kaul et al., 2018). The counterfactual outcome is determined as a weighted average of the untreated donor pool counties. Counties from other Bavarian regions that are not affected by the new airport constitute the donor pool to construct the synthetic counterfactuals (figure 1). The difference in the outcome variable between treated counties and their synthetic counterfactuals following the treatment measures the causal effect of the airport if the following assumptions hold: first, there is a sufficient match between the trends in the outcome variable for synthetic and treated counties over a long pre-treatment period. We provide evidence for this fit in the next section. Second, there are no further interventions that affected treated and untreated counties differently in the treatment period. All counties are part of touristic regions in Bavaria. General policies of the Bavarian state government and actions of the Bavarian Tourism Marketing agency to attract tourists from abroad are supposed to target all Bavarian counties in the post-intervention period. Third, the counties of the donor pool are not affected by the treatment. Counties in touristic regions bordering the Allgäu and the capital Munich are not included in our donor pool. A passenger survey conducted at Memmingen Airport in 2018 has shown that only up to 7% of all incoming passengers visit one of the 69 donor pool counties in the rest of Bavaria (Bauer et al., 2019). By estimating placebo treatment effects in our robustness tests, we show that tourism in donor pool regions is not affected by the opening of the new commercial Memmingen Airport.

We provide parametric estimates from a traditional difference-in-differences model using Weighted Least Squares (WLS) to discuss the significance of our causal inference. When estimating the model with WLS, we weight all counties with the weights derived by our synthetic control approach. In our robustness tests, we also discuss results when estimating the difference-in-differences model with Ordinary Least Squares (OLS) where all counties receive an equal weight.

9The synthetic control approach is described in technical detail in the appendix.
10If at all, the airport effect might be biased towards zero if tourists travel to donor pool regions.
11The method is described in technical detail in the appendix.
Data

We use county-level data on registered guest arrivals at touristic accommodations, including business travelers and guests with touristic motives. Guests who do not stay at a touristic accommodation, for example guests staying with friends and relatives, are not registered. Our main dependent variable is guest arrivals from abroad as domestic flights are discontinued since 2011. We also use data on total guest arrivals (including domestic and foreign arrivals). Our dataset encompasses the period 1996-2016. We therefore cover 11 years before the opening of the commercial airport (pretreatment) and 9 years afterwards (post-treatment). The year 2007, when commercial flights started operating, is excluded. We use four treatment regions: East Allgäu, Lower Allgäu, Upper Allgäu and West Allgäu.

4 Results

Baseline

The results of the baseline synthetic control model are shown in figure 2 and table A2 (in the appendix). We report results for guest arrivals from abroad in the four regions East, Lower, Upper and West Allgäu. Table A2 shows that the fitting procedure yields comparable outcomes in treatment and synthetic control units over the pre-treatment period. The ratios of arrivals between the real Allgäu regions and their synthetic counterfactuals amount to almost 100% in all four regions before 2007 (table A2). Figure 2 shows the pre-treatment matching trends graphically. Table A3 shows the corresponding individual donor pool weights. The results indicate that the number of total arrivals increased in Lower, Upper and East Allgäu after FMM started operating, compared to their synthetic counterfactuals. The positive effect of Memmingen Airport on arrivals is in relative terms largest in Lower Allgäu, i.e. in the counties where Mem-
Mingen Airport is based. More precisely, Memmingen Airport increased arrivals from abroad in Lower Allgäu by 69% in the 2008-2016 period. The positive effect of the airport on guest arrivals from abroad in Upper and East Allgäu is 45% and 17% (compare the ratios in table A2, column 2). In West Allgäu, however, the results do not suggest that Memmingen Airport increased the number of arrivals from abroad.

We compare our synthetic control results to estimates from a difference-in-differences model using WLS where we weight the observations in our regression with the weights derived by our synthetic control approach (for individual weights, see table A3). Hence, we apply the difference-in-differences estimation with the synthetic control group (Roesel, 2017). Estimating the effect of the airport on arrivals from abroad using WLS yields similar results to the pre-post-treatment differences of the synthetic control approach (panel A and B of table 1). When we use the parametric WLS model the effect of the airport on guest arrivals from abroad is positive and significant in Upper and Lower Allgäu, but does not turn out to be statistically significant in East and West Allgäu (panel B in table 1). Our results suggest that the opening of the commercial airport in Memmingen increased the number of guest arrivals from abroad compared to a counterfactual development without airport by roughly 42,000 in Upper Allgäu and by roughly 23,000 in Lower Allgäu per year over the 2008-2016 period.

We also examine whether the opening of Memmingen Airport influenced total arrivals at touristic accommodations in the Allgäu region (including guests from domestic and abroad). Synthetic control results for total arrivals are very similar to those for arrivals from abroad (figure A5). Estimates using WLS, however, do not turn out to be statistically significant in East, West and Upper Allgäu. The Upper Allgäu county is by far the most popular region for domestic tourists in Bavaria (next to the capital Munich). Thus, more arrivals from abroad may not translate into more total arrivals in Upper Allgäu. Our results suggest that the positive effect of Memmingen Airport on total guest arrivals is only significant in Lower Allgäu, i.e., in the counties where FMM is based. The opening of Memmingen Airport increased total guest arrivals in touristic accommodations in Lower Allgäu by yearly 54,000 over the 2008-2016 period (table A4). The ratio of real and synthetic total arrivals is 122% for Lower Allgäu over the treatment
period 2008-2016 (table A2). Lower Allgäu had the lowest number of guest arrivals among all Allgäu regions. Hence, increasing tourism because of the airport is large in relative terms for Lower Allgäu, but, for example, not for the Upper Allgäu (figure A3). Moreover, the counties where Memmingen Airport is based may likewise benefit from incoming and outgoing passengers, for example if passengers stay in accommodations close to the airport before departure or after arrival.

**Robustness**

We submit our results to several robustness tests. First, following Abadie et al. (2015), we employ variations in the county weights by constructing leave-one-out-distributions of the synthetic control for the Allgäu regions. We re-estimate the baseline model for every treated region and iteratively omit one county from the donor pool that received a positive weight. Results for this robustness test are shown in figure 3, which reproduces the baseline results (black line) from figure 2 with the light gray lines representing the leave-one-out estimates. We focus on the gap in arrivals from abroad between each treated region and its synthetic counterfactual, i.e., we calculate the difference between the lines shown in figure 2. The estimates excluding individual donor pool counties follow the baseline estimates quite closely in all considered Allgäu regions. The leave-one-out distributions are particularly robust for the Upper Allgäu and Lower Allgäu regions. This finding is in line with our parametric WLS results that only show a significant effect of the airport on guest arrivals from abroad in the Upper and Lower Allgäu regions.

[Figure 3 about here]

Second, we estimate placebo specifications to verify the validity of the estimation design. We iteratively apply the synthetic control method on every county of the donor pool using them as a placebo-treatment group. If donor pool counties are not affected by the treatment, we should not observe any differences in the development of tourism between the placebo-treatment and control groups, i.e., we should estimate zero gaps in guest arrivals for every iteration. The results of this test are shown in figure 4, where every light gray line indicates one placebo estimate. This robustness check also corroborates our baseline findings showing that the previously estimated positive treatment effects on arrivals from abroad (black line) in the Allgäu regions are unusually large.
when compared to the bulk of placebo estimates. What is more, the large majority of placebo estimates reveals a good fit and also produces estimated zero gaps for the control counties. Thus, the selected control counties seem to be a valid comparison group for the treatment regions, since the opening of Memmingen Airport did not influence tourism or coincide with other shocks to touristic inflows in the selected donor pool counties. The positive treatment effect of Memmingen Airport on guest arrivals is indeed considerably larger in *East, Lower*, and *Upper Allgäu* than in our placebo counties. On the one hand, this validates our choice of control units, but on the other hand this also increases confidence that our significant baseline estimates for the *Upper* and *Lower Allgäu* regions are indeed attributable to the opening of Memmingen Airport.

Third, we compare our baseline results to estimates from a traditional *difference-in-differences* regression using OLS with equal weights of the counties in our control group. Estimating the impact of the airport using difference-in-differences gives rise to positive effects for arrivals from abroad in all our treated regions if we consider all 69 counties of our donor pool (panel A in table A5). Compared to our baseline results, also the regions *East* and *West Allgäu* experienced a significant positive increase of arrivals from abroad. For the regions *East* and *West Allgäu* the common trend assumption of the difference-in-differences estimation is, however, not fulfilled. Figure A6 shows the development of arrivals from abroad in our treatment and control regions between 1996 and 2016. Guest arrivals in the regions *East* and *West Allgäu* experience an increase some years before the airport started operating, compared to the rest of Bavaria. For *Upper* and *Lower Allgäu*, in contrast, the common trend assumption fits quite well. Guest arrivals develop similarly compared to the rest of Bavaria before 2007 and start to diverge and increase after Airport Memmingen was opened. In addition, we restrict the counties in our control group to counties that received non-zero weights in the synthetic control approach (but contribute now with an equal weight). Our results turn out to be quite similar in economic terms and significance to the baseline estimates using WLS (table 1). When we use the restricted OLS model the effect of the airport on guest arrivals from abroad is again positive and significant in *Upper* and *Lower Allgäu*, but does not turn out to be statistically significant in *East* and *West Allgäu* (panel B in table A5).

\[\text{Figure A4 about here}\]

---

15Similar to Roesel (2017), we find that results from the difference-in-differences and synthetic control method yield similar results if pre-treatment outcomes follow a common trend. However, if pre-treatment trends are not alike, the synthetic control methods deliver more reliable results.
5 Effects on overall economic development

Our results show that new airport infrastructure increases registered arrivals at touristic accommodations. The synthetic control results suggest that every year around 95,000 additional registered guests from abroad arrived in the Allgäu region in the period of 2008 to 2016 than would have been the case if the airport had not been opened (table A2). The effect is significant and robust for the Upper and Lower Allgäu regions which amounts to 65,000 additional arrivals from abroad per year. An important question is how the increasing guest arrivals translate into higher revenues in the regional tourist industry. More guests may influence revenues in the tourist industry via numerous channels: they spend some money for food and accommodation, go shopping and demand, among others, local transport, amenities, spa and skiing, or cultural affairs. At the same time, expenditures in the regional touristic industry induce multiplier effects on other regional industries and often endorse regional economic development. A passenger survey conducted at FMM in 2018 shows that incoming passengers from abroad via Memmingen Airport spent about 131 euros on average per day, whereas each additional euro in expenditure by an incoming passenger increased purchasing power inflows by a multiplier of around 1.43 euros in counties located around the airport (Bauer et al., 2019).

Increasing revenues in the tourism industry because of guest arrivals from abroad are arguably a lower bound of regional economic benefits generated by the opening of the commercial airport. Airport infrastructure is also likely to influence business location and investment decisions, and foster regional economic development by increased production and employment; accounting for the direct effects of production and employment at the airport itself, and indirect effects because of sub-contractors benefiting

---

16 The number of 95,000 refers to the sum of the differences between the actual and synthetic arrivals from abroad of the four treatment regions in the period of 2008 to 2016.

17 The survey includes 1,002 incoming passengers at Memmingen Airport in 2018 (487 during the winter season; 515 during the summer season). Incoming passengers visiting the Allgäu region reported to stay around 6.4 days per visit. This would sum up to around 838 euros direct expenditures and additional 361 euros indirect multiplier effects in the Allgäu region per incoming passenger from abroad. Considering the total of yearly (significant) 65,000 additional guest arrivals from abroad at accommodations and employing a back-to-the-envelope-calculation, Memmingen Airport is supposed to increase direct and indirect tourism revenues by incoming guests from abroad in the Allgäu region by around 77.9 million euros per year (all in 2018 prices). The calculation must be interpreted with caution as interviewed incoming passengers at the airport and registered guest arrivals at accommodations are different concepts. On the one hand, one incoming passenger may well count twice in the guest arrivals statistics if they stay in two different accommodations within the same region. On the other hand, average expenditures refer to all surveyed passengers, staying at touristic accommodations or not. While the first could overestimate the economic effect, the latter would underestimate it.
from the new airport infrastructure (Hakfoort et al. 2001; Klophaus 2008; Zak and Getzner 2014). In any event, a commercial airport is attractive for tourists and business travelers and might influence business location decisions by helping to enhance a region’s image or facilitate the recruitment of foreign professionals. In 2018, Dorn et al. (2019) have conducted a survey asking local entrepreneurs about the extent to which their business benefits from Memmingen Airport and whether their investment decisions have been affected by the airport. The results suggest some positive effects of Memmingen Airport on business connections. 21% of the respondents believe that Memmingen Airport improved business connections and about one third reported that the new airport infrastructure helped to improve conditions regarding location and to attract specialist workers from abroad. Breidenbach (2019), however, finds no evidence for spillover effects of regional airports on the surrounding economies in Germany.

Governments and public stakeholders often argue that subsidies and investments in new airport infrastructure pay off because of its regional economic impact. New airport infrastructure has many benefits, but also external costs: “the costs are clearly localized in terms of noise, reduced property values, and degradation of health and quality of life” (Cidell 2015, 1125f, see also Boes and Nüesch 2011; Ahlfeldt and Maennig 2015). Politicians must consider the total cost-benefit ratio and sustainability of public investment decisions in infrastructure projects.

6 Conclusion

Scholars examine the extent to which new transportation infrastructure promotes economic development. Many studies describing effects of airport infrastructure on economic development employed input-output methods or show correlations. Clearly,

---

18 One may well want to investigate whether the Memmingen Airport had any effect on overall economic development in the Allgäu region. We cannot use synthetic control techniques to estimate the causal effect of the Memmingen Airport on overall economic development measures like GDP, because the military air base that operated until the year 2003 also had economic impacts on the Allgäu region. The former air base hosted some 2,200 soldiers who stimulated local consumption. They needed to be supplied with necessities including food etc. that have been provided by local enterprises.

19 Scholars examine the extent to which business travelers and tourists have similar preferences regarding airports and airlines. In the San Francisco Bay Area, preferences of business travelers and tourists were quite similar (Pels et al., 2001).

20 The survey asked participants in the monthly ifo business survey whose enterprise is located in 28 counties around Memmingen Airport. The ifo business survey is conducted every month among 7,000 German firms, and provides the basis for the ifo Business Climate Index, Germany’s leading business cycle indicator. Among a total of 7,000 German firms, 770 firms are located around Memmingen Airport and have been asked. The response rate was 30.5% (235 firms).
the input-output methods and correlations are useful in assessing benefits of new airport infrastructure, but they do not measure causal effects. Studies examining the causal effect of new airport infrastructure on regional tourism are scarce. We employ a synthetic control approach and estimate how new airport infrastructure increases arrivals of tourists in the Bavarian (peripheral) region Allgäu. Identification is based on converting a military air base into the regional commercial airport Memmingen. The results show that additional tourist inflows are particularly pronounced and robust in the county where the airport is located and are driven by guest arrivals from abroad. Our results suggest that new transportation infrastructure promotes regional economic development. The economic effects, however, might also differ among airports in their scale and direction (Allroggen and Malina 2014), and may well depend on the geographical catchment area size and airport competition in multiple airport regions (see Pels et al. 2001, Lian and Rønnevik 2011, Wiltshire 2018). Future research should employ empirical techniques to estimate causal effects of new airport infrastructure in other regions and on other economic outcome variables like employment and production.

Acknowledgments

We would like to thank the editor Ben Derudder and three anonymous referees, Gabriel Ahlfeldt, Klaus Gründler, Capucine Riom, Felix Roesel, Kaspar Wüthrich, and the participants of the 2019 meeting of the German Economic Association for helpful comments.

No conflicts of interest to disclose.
ABADIE, A., DIAMOND, A. and HAINMUELLER, J. (2010). Synthetic control methods for comparative case studies: Estimating the effect of California’s tobacco control program. *Journal of the American Statistical Association, 105* (490), 493–505.

—, — and — (2015). Comparative politics and the synthetic control method. *American Journal of Political Science, 59* (2), 495–510.

— and GARDEAZABAL, J. (2003). The economic costs of conflict: A case study of the Basque Country. *American Economic Review, 93* (1), 113–132.

ADLER, N., ÜLKÜ, T. and YAZHEMSKY, E. (2013). Small regional airport sustainability: Lessons from bench-marking. *Journal of Air Transport Management, 33*, 22–31.

AHLFELDT, G. M. and FEDDERSEN, A. (2018). From periphery to core: Measuring agglomeration effects using high-speed rail. *Journal of Economic Geography, 18* (2), 355–390.

— and MAENNIG, W. (2015). Homevoters vs. leasevoters: A spatial analysis of airport effects. *Journal of Urban Economics, 87*, 85–99.

ALBERTS, H. C., BOWEN JR, J. T. and CIDELL, J. L. (2009). Missed opportunities: The restructuring of Berlin’s airport system and the city’s position in international airline networks. *Regional Studies, 43* (5), 739–758.

ALLROGEN, F. and MALINA, R. (2014). Do the regional growth effects of air transport differ among airports? *Journal of Air Transport Management, 37*, 1–4.

BARBOT, C. and D’ALFONSO, T. (2014). Why do contracts between airlines and airports fail? *Research in Transportation Economics, 45*, 34–41.

BAUER, A., DORN, F., DOERR, L., GAEBLER, S., KRAUSE, M., MOSLER, M., NIEMEIJER, C., PENZKOFER, H. and POTRAFKE, N. (2019). Die regionalökonomischen Auswirkungen des Flughafens Memmingen auf den Tourismus. *ifo Forschungsberichte, 100*.

BLONIGEN, B. A. and CRISTEA, A. D. (2015). Air service and urban growth: Evidence from a quasi-natural policy experiment. *Journal of Urban Economics, 86*, 128–146.
BOES, S. and NÜESCH, S. (2011). Quasi-experimental evidence on the effect of aircraft noise on apartment rents. *Journal of Urban Economics, 69* (2), 196–204.

BREIDENBACH, P. (2019). Ready for take-off? The economic effects of regional airport expansions in Germany. *Regional Studies*, pp. 1–14.

BRUECKNER, J. K. (2003). Airline traffic and urban economic development. *Urban Studies, 40* (8), 1455–1469.

CASTILLO, V., GARONE, L. F., MAFFIOLI, A. and SALAZAR, L. (2017). The causal effects of regional industrial policies on employment: A synthetic control approach. *Regional Science and Urban Economics, 67*, 25–41.

ČERVINKA, M. (2017). Small regional airport performance and low cost carrier operations. *Transportation Research Procedia, 28*, 51–58.

CHANDRA, A. and THOMPSON, E. (2000). Does public infrastructure affect economic activity?: Evidence from the rural interstate highway system. *Regional Science and Urban Economics, 30* (4), 457–490.

CHERNOZHUKOV, V., WÜTHRICH, K., ZHU, Y. et al. (2018). An exact and robust conformal inference method for counterfactual and synthetic controls. *Working Paper*.

CIDELL, J. (2015). The role of major infrastructure in subregional economic development: An empirical study of airports and cities. *Journal of Economic Geography, 15* (6), 1125–1144.

DERUDDER, B., DEVRIENDT, L. and WITLOX, F. (2010). A spatial analysis of multiple airport cities. *Journal of Transport Geography, 18* (3), 345–353.

— and WITLOX, F. (2005). An appraisal of the use of airline data in assessing the world city network: A research note on data. *Urban Studies, 42* (13), 2371–2388.

DORN, F., DÖRR, L., FISCHER, K., GÄBLER, S., KRAUSE, M. and POTRAFKE, N. (2019). Der Flughafen Memmingen als Standortfaktor für die Region: Ergebnisse einer Unternehmensbefragung. *ifo Forschungsberichte, 101*.

DURANTON, G. and TURNER, M. A. (2012). Urban growth and transportation. *Review of Economic Studies, 79* (4), 1407–1440.

EUGENIO-MARTIN, J. L. (2016). Estimating the tourism demand impact of public infrastructure investment: The case of Malaga airport expansion. *Tourism Economics, 22* (2), 254–268.
— and INCHAUSTI-SINTES, F. (2016). Low-cost travel and tourism expenditures. *Annals of Tourism Research*, **57**, 140–159.

FIRPO, S. and POSSEBOM, V. (2018). Synthetic control method: Inference, sensitivity analysis and confidence sets. *Journal of Causal Inference*, **6** (2).

GIBBONS, S., LYYTIKÄINEN, T., OVERMAN, H. G. and SANCHIS-GUARNER, R. (2019). New road infrastructure: The effects on firms. *Journal of Urban Economics*, **110**, 35–50.

GREEN, R. K. (2007). Airports and economic development. *Real Estate Economics*, **35** (1), 91–112.

HAKFOORT, J., POOT, T. and RIETVELD, P. (2001). The regional economic impact of an airport: the case of Amsterdam Schiphol Airport. *Regional Studies*, **35** (7), 595–604.

HALPERN, N. and BRÅTHEN, S. (2011). Impact of airports on regional accessibility and social development. *Journal of Transport Geography*, **19** (6), 1145–1154.

HUMPHREYS, I. and FRANCIS, G. (2002). Policy issues and planning of UK regional airports. *Journal of Transport Geography*, **10** (4), 249–258.

KAUL, A., KLÖSSNER, S., PFEIFER, G. and SCHIÉLER, M. (2018). Synthetic control methods: Never use all pre-intervention outcomes together with covariates. *Working Paper*.

KAZDA, A., HROMÁDKA, M. and MREKAJ, B.-R. (2017). Small regional airports operation: Unnecessary burdens or key to regional development. *Transportation Research Procedia*, **28**, 59–68.

KHADAROO, J. and SEETANAH, B. (2007). Transport infrastructure and tourism development. *Annals of Tourism Research*, **34** (4), 1021–1032.

KHAN, S. A. R., QIANLI, D., SONGBO, W., ZAMAN, K. and ZHANG, Y. (2017). Travel and tourism competitiveness index: The impact of air transportation, railways transportation, travel and transport services on international inbound and outbound tourism. *Journal of Air Transport Management*, **58**, 125–134.

KLOPHAUSE, R. (2008). The impact of additional passengers on airport employment: The case of German airports. *Journal of Airport Management*, **2** (3), 265–274.

KOO, T. T., LIM, C. and DOBRUSZKES, F. (2017). Causality in direct air services and tourism demand. *Annals of Tourism Research*, **67**, 67–77.
Lian, J. I. and Rønnevik, J. (2011). Airport competition–regional airports losing ground to main airports. *Journal of Transport Geography, 19* (1), 85–92.

Lieshout, R. (2012). Measuring the size of an airport’s catchment area. *Journal of Transport Geography, 25*, 27–34.

Møller, J. and Zierer, M. (2018). Autobahns and jobs: A regional study using historical instrumental variables. *Journal of Urban Economics, 103*, 18–33.

Mukkala, K. and Tervo, H. (2013). Air transportation and regional growth: Which way does the causality run? *Environment and Planning A, 45* (6), 1508–1520.

Pels, E., NiJKamp, P. and Rietveld, P. (2001). Airport and airline choice in a multiple airport region: an empirical analysis for the San Francisco Bay Area. *Regional Studies, 35* (1), 1–9.

Percoco, M. (2010). Airport activity and local development: Evidence from Italy. *Urban Studies, 47* (11), 2427–2443.

Rebollo, J. F. V. and Baidal, J. A. I. (2009). Spread of low-cost carriers: Tourism and regional policy effects in Spain. *Regional Studies, 43* (4), 559–570.

Roezel, F. (2017). Do mergers of large local governments reduce expenditures? Evidence from Germany using the synthetic control method. *European Journal of Political Economy, 50*, 22–36.

Sheard, N. (2014). Airports and urban sectoral employment. *Journal of Urban Economics, 80*, 133–152.

Tsui, K. W. H. (2017). Does a low-cost carrier lead the domestic tourism demand and growth of New Zealand? *Tourism Management, 60*, 390–403.

Tveter, E. (2017). The effect of airports on regional development: Evidence from the construction of regional airports in Norway. *Research in Transportation Economics, 63*, 50–58.

Wiltshire, J. (2018). Airport competition: Reality or myth? *Journal of Air Transport Management, 67*, 241–248.

Zak, D. and Getzner, M. (2014). Economic effects of airports in Central Europe: A critical review of empirical studies and their methodological assumptions. *Advances in Economics and Business, 2* (2), 100–111.
Notes: The map shows the federal state of Bavaria with its touristic regions (black boundaries) and the Bavarian counties (gray boundaries). Light gray counties form our treatment region Allgäu. Dark gray counties form our donor pool. White shaded counties are not included, because they are likely to be treated to some extent as well.
Figure 2: Synthetic control method, arrivals from abroad

Notes: This figure shows arrivals from abroad in the four treated regions East Allgäu, Upper Allgäu, Lower Allgäu and West Allgäu (dark gray) and in their synthetic counterparts (light gray). The donor pool consists of counties in Bavaria that were not treated. The vertical line in each graph marks the opening of the Airport Memmingen in 2007.
Figure 3: Robustness (I): Leave-one-out

Notes: This figure shows the gap of arrivals from abroad between the treated regions and their synthetic counterfactuals. The black line represents the gap for the four treated regions East Allgäu, Upper Allgäu, Lower Allgäu and West Allgäu (baseline synthetic control estimate). The light gray lines represent estimates from repeated synthetic control analyses while iteratively leaving out one donor pool county. The vertical line in each graph marks the opening of Memmingen Airport in 2007.
Figure 4: Robustness (II): Placebo test

Notes: This figure shows the gap of arrivals from abroad between the treated regions and their synthetic counterfactuals. The black line shows the gap for our four treated regions East Allgäu, Upper Allgäu, Lower Allgäu and West Allgäu. The light gray lines show 72 placebo gaps for each county in the donor pool. Nuremberg is omitted as an outlier, since it is the upper bound in guest arrivals of the donor pool counties. The vertical line in each graph marks the opening of Memmingen Airport in 2007.
Table 1: Difference-in-differences results using WLS

|                      | Arrivals from abroad |       |       |       |
|----------------------|----------------------|-------|-------|-------|
|                      |                      | (1)   | (2)   | (3)   | (4)   |
|                      |                      | East Allgäu | Upper Allgäu | Lower Allgäu | West Allgäu |
| Panel A: Synthetic control group | Pre-Post-Treatment difference | 40,001 | 41,906 | 23,141 | -9,863 |
| Panel B: Difference-in-differences (WLS) | Allgäu · Airport | 40,001 | 41,930*** | 23,141*** | -9,911 |
|                      |                      | (44,659) | (3,422) | (4,968) | (11,059) |
| County fixed effects | Yes                  | Yes    | Yes    | Yes    | Yes    |
| Year fixed effects   | Yes                  | Yes    | Yes    | Yes    | Yes    |
| Obs.                 | 100                  | 140    | 180    | 120    |
| Within $R^2$         | 0.821                | 0.852  | 0.793  | 0.854  |

Notes: The table compares results from our synthetic control approach to difference-in-differences results. Synthetic control approach results in Panel A are calculated from Table A2 as the difference in before-after treatment differences of our treated regions and their synthetic counterparts. Panel B shows the results of difference-in-differences estimations using a WLS regression with weights derived from our synthetic control method (see Table A3 in the appendix). We use yearly data over the period of 1996 to 2016 (without 2007). Significance levels (standard errors robust to heteroskedasticity in brackets): *** 0.01, ** 0.05, * 0.10.
Appendix (for online publication only)

A Figures and tables
Figure A1: Passengers at Memmingen Airport and close-by airports

(a) Passengers at airport Memmingen

Notes: Panel (a) shows the development of passengers at national air connections (dark gray) and international air connections (light gray) at the Memmingen Airport. Panel (b) shows the development of passengers overall at Memmingen Airport and the close-by airports Friedrichshafen and Innsbruck.
Notes: The map shows the federal state of Bavaria (light gray) with its two international airports in Munich and Nuremberg and the regional airport in Memmingen (red circle). Gray lines show the motorway network, blue lines the railroad network in Bavaria. The blue region (Allgäu) is our treatment region. Passenger numbers of 2018.
Figure A3: Raw data plots

(a) Arrivals from abroad

(b) Total arrivals

Notes: This figure shows how our two dependent variables evolve over our period of investigation. Black lines represent treated counties, light gray lines control counties (see Figure 1).
Figure A4: Treatment regions

Notes: This map shows our treatment regions (italic, thick boundaries) and their counties (thin boundaries) Lower Allgäu (Memmingen and Unterallgäu), East Allgäu (Kaufbeuren and Ostallgäu), Upper Allgäu (Kempten (Allgäu) and Oberallgäu) and West Allgäu (Lindau (Bodensee)).
Figure A5: Synthetic control method, total arrivals

Notes: This figure shows total arrivals in the four treated regions East Allgäu, Upper Allgäu, Lower Allgäu and West Allgäu (dark gray) and in their synthetic counterparts (light gray). The donor pool consists of counties in Bavaria that were not treated. The vertical line in each graph marks the opening of Memmingen Airport in 2007.
Figure A6: Development of arrivals in Bavarian regions (1995-2016, 2007=100)

(a) Arrivals from abroad

(b) Total arrivals

Notes: This Figure shows the development of total and abroad arrival in our four treated regions East Allgäu, Upper Allgäu, Lower Allgäu and West Allgäu (2007=100). Donor pool counties form our control group (see Figure 1). The vertical line in each graph marks the opening of Memmingen Airport in 2007. We use yearly data over the period of 1996 to 2016.
| Passengers | Incoming Share of Passengers |
|------------|------------------------------|
|            | Winter Season | Summer Season |
| Total      | 1486493       | 737908        | 745585       | 46% | 35% |
| Spain      | 241465        | 121097        | 120368       | 26% | 18% |
| Romania    | 178347        | 87041         | 91306        | 58% | 52% |
| Bulgaria   | 142208        | 70001         | 72207        | 58% | 40% |
| Portugal   | 99223         | 49767         | 49456        | 28% | 15% |
| United Kingdom | 92635   | 47241         | 45394        | 35% | 30% |
| Ukraine    | 89977         | 44056         | 45921        | 70% | 58% |
| Serbia     | 78556         | 38869         | 39687        | 74% | 45% |
| Italy      | 74007         | 37010         | 36997        | 22% | 25% |
| Macedonia  | 59575         | 29349         | 30226        | 69% | 30% |
| Greece     | 55831         | 27955         | 27876        | 25% | 15% |
| Poland     | 48659         | 24032         | 24627        | 33% | 53% |
| Ireland    | 45189         | 22604         | 22585        | 50% | 24% |
| Bosnia and Herz. | 43491 | 21309        | 22182        | 37% | 34% |
| Russia (Europe) | 43074 | 22025         | 21049        | 71% | 64% |
| Morocco    | 36586         | 18495         | 18091        | 50% | 30% |
| Montenegro | 32710         | 15803         | 16907        | 50% | 30% |
| Sweden     | 32137         | 16115         | 16022        | 19% | 25% |

Source: Bauer et al. (2019); Federal Statistical Offices (2019), Verkehr – Verkehr auf Luftverkehrsflughäfen 2018, Fachserie 8 Reihe 6.1, Wiesbaden.

Notes: This table shows passenger numbers for outbound and incoming flights in total and for selected countries as well as the share of incoming passengers in the winter and summer season at Memmingen Airport in 2018.
### Table A2: Descriptives

| Region     | Arrivals from abroad | Total arrivals |
|------------|----------------------|----------------|
|            | (1) Before 2007      | (2) After 2007 | (3) Before 2007 | (4) After 2007 |
| West Allgäu | 46,768               | 85,797         | 280,982         | 434,061        |
| Synthetic  | 46,756               | 95,647         | 280,946         | 388,835        |
| Ratio      | 100.03%              | 89.70%         | 100.01%         | 111.63%        |
| East Allgäu| 145,527              | 273,391        | 525,653         | 840,258        |
| Synthetic  | 145,405              | 233,268        | 525,031         | 730,588        |
| Ratio      | 100.08%              | 117.20%        | 100.12%         | 115.01%        |
| Upper Allgäu| 68,588               | 134,901        | 951,710         | 1,340,634      |
| Synthetic  | 68,734               | 93,141         | 948,213         | 1,385,142      |
| Ratio      | 99.79%               | 144.83%        | 100.37%         | 96.79%         |
| Lower Allgäu| 22,745               | 56,714         | 195,918         | 299,033        |
| Synthetic  | 22,699               | 33,527         | 196,173         | 245,308        |
| Ratio      | 100.20%              | 169.16%        | 99.87%          | 121.90%        |

**Notes:** This table shows the absolute numbers of arrivals from abroad and total arrivals for the four treated regions East Allgäu, Upper Allgäu, Lower Allgäu and West Allgäu and their synthetic counterparts. For the composition of the synthetic regions see Table A3 in the appendix. We use yearly data over the 1996-2016 period (without 2007).
Table A3: Synthetic control donor pool weights

| Donor pool          | Weights |                     |                     |                     |                     |                     |                     |
|---------------------|---------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|                     | West Allgäu | East Allgäu | Upper Allgäu | Lower Allgäu | West Allgäu | East Allgäu | Upper Allgäu | Lower Allgäu |
| Arrivals from abroad| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Rosenheim           | 0     | 0       | 0.057       | 0       | 0     | 0       | 0       | 0       |
| Berchtesgadener Land| 0.447 | 0       | 0           | 0       | 0.100 | 0       | 0       | 0       |
| Ebersberg           | 0     | 0       | 0           | 0.144   | 0     | 0       | 0       | 0       |
| Eichstätt           | 0     | 0.355   | 0.065       | 0.106   | 0.002 | 0.580   | 0       | 0       |
| Miesbach            | 0     | 0.054   | 0           | 0       | 0.011 | 0       | 0       | 0.160   |
| Rosenheim           | 0.369 | 0.167   | 0           | 0       | 0     | 0.020   | 0       | 0       |
| Landshut            | 0     | 0       | 0           | 0.153   | 0     | 0       | 0       | 0.095   |
| Passau (city)       | 0     | 0       | 0.133       | 0       | 0.217 | 0       | 0       | 0       |
| Freyung-Grafenau    | 0     | 0       | 0           | 0       | 0     | 0       | 0       | 0.265   |
| Passau (county)     | 0     | 0       | 0           | 0       | 0.156 | 0       | 0       | 0       |
| Dingolfing-Landau   | 0     | 0       | 0.091       | 0       | 0     | 0       | 0       | 0       |
| Regensburg          | 0.166 | 0       | 0           | 0       | 0.020 | 0       | 0       | 0       |
| Hof                 | 0     | 0       | 0           | 0       | 0     | 0       | 0       | 0.127   |
| Erlangen            | 0     | 0       | 0.168       | 0       | 0     | 0       | 0       | 0       |
| Fürth (city)        | 0     | 0       | 0           | 0.091   | 0     | 0       | 0       | 0       |
| Nuremberg           | 0.010 | 0.381   | 0           | 0       | 0.097 | 0.244   | 0.910   | 0       |
| Ansbach             | 0.007 | 0.097   | 0.082       | 0.004   | 0     | 0       | 0.090   | 0.009   |
| Fürth (county)      | 0     | 0       | 0           | 0       | 0     | 0       | 0       | 0.320   |
| Weißenburg-Gunzenhausen | 0   | 0       | 0           | 0       | 0.553 | 0       | 0       | 0       |
| Würzburg            | 0     | 0       | 0.210       | 0       | 0     | 0       | 0       | 0.024   |
| Schweinfurt         | 0     | 0       | 0           | 0.243   | 0     | 0       | 0       | 0       |

Notes: This table shows the weights derived from the synthetic control approach for the four treated regions East Allgäu, Upper Allgäu, Lower Allgäu and West Allgäu, and the two dependent variables total arrivals and arrivals from abroad. We omit counties that have never received a positive weight in any specification.
Table A4: Difference-in-differences using WLS

|                      | (1)       | (2)       | (3)       | (4)       |
|----------------------|-----------|-----------|-----------|-----------|
|                      | East Allgäu | Upper Allgäu | Lower Allgäu | West Allgäu |
| **Panel A: Synthetic control group** |           |           |           |           |
| Pre-Post-Treatment difference | 109,048   | -48,006   | 53,979    | 45,194    |
| **Panel B: Difference-in-differences (WLS)** |           |           |           |           |
| Allgäu · Airport     |           |           |           |           |
| (106,094)            | (69,229)  | (27,25)   | (49,923)  |
| County fixed effects | Yes       | Yes       | Yes       | Yes       |
| Year fixed effects   | Yes       | Yes       | Yes       | Yes       |
| Obs.                 | 100       | 60        | 160       | 160       |
| Within $R^2$         | 0.826     | 0.960     | 0.761     | 0.675     |

Notes: The table compares results from our synthetic control approach to difference-in-differences results. Synthetic control approach results in Panel A are calculated from Table 1 as the difference in before-after treatment differences of our treated regions and their synthetic counterparts. Panel B shows the results of four difference-in-differences estimations using a WLS regression with weights derived from our synthetic control method (see Table A3 in the appendix). We use yearly data over the 1996-2016 period (without 2007). Significance levels (standard errors robust to heteroskedasticity in brackets): *** 0.01, ** 0.05, * 0.10.
Table A5: Robustness (III): Difference-in-differences using OLS

|                  | (1)          | (2)          | (3)          | (4)          |
|------------------|--------------|--------------|--------------|--------------|
|                  | East Allgäu | Upper Allgäu | Lower Allgäu | West Allgäu  |
| Panel A: All counties from donor pool |              |              |              |              |
| Allgäu · Airport | 116,015***   | 54,465***    | 22,121***    | 27,180***    |
|                  | (2,632)      | (2,632)      | (2,632)      | (2,632)      |
| County fixed effects | Yes         | Yes         | Yes         | Yes         |
| Year fixed effects | Yes         | Yes         | Yes         | Yes         |
| Obs.              | 1,460        | 1,460        | 1,460        | 1,460        |
| Within $R^2$     | 0.348        | 0.25         | 0.217        | 0.222        |

|               | (1)          | (2)          | (3)          | (4)          |
|----------------|--------------|--------------|--------------|--------------|
|                  | Allgäu · Airport |              |              |              |
| Panel B: Only synthetic counterpart counties |              |              |              |              |
| Allgäu · Airport | 57,268       | 44,058***    | 19,873***    | -22,589      |
|                  | (34,967)     | (5,147)      | (4,721)      | (30,018)     |
| County fixed effects | Yes         | Yes         | Yes         | Yes         |
| Year fixed effects | Yes         | Yes         | Yes         | Yes         |
| Obs.              | 100          | 140          | 180          | 120          |
| Within $R^2$     | 0.688        | 0.683        | 0.501        | 0.531        |

Notes: The table reports difference-in-differences results using OLS. In Panel A all counties from our donor pool form the control group (see Figure 1). In Panel B only the counties that received a weight in our synthetic control approach form the control group (see Table A3 in the appendix) but each receive a weight of 1. We use yearly data over the 1996-2016 period (without 2007). Significance levels (standard errors robust to heteroskedasticity in brackets): *** 0.01, ** 0.05, * 0.10.
B Synthetic control approach

The synthetic counterfactual is calculated as a weighted average of the untreated control counties from the donor pool such that the fit in the variable of interest in the pre-treatment period is maximized. The counterfactual outcome $\hat{Y}_{it}$ of county $i$ in period $t$ is determined by a weighted average of the untreated donor pool counties $j$:

$$\hat{Y}_{it} = \sum_{i \neq j} w_j Y_{jt}, \quad \sum w_j = 1 \quad (1)$$

The counterfactual weights $w$ across all donor pool counties $j$ sum up to unity and are selected to minimize the pre-treatment Root Mean Square Prediction Error (RMSPE) of the observed pre-treatment outcome of the treated county $Y_{it}$ and the counterfactual pre-treatment outcome of its synthetic county $\hat{Y}_{it}$

$$\min RMSPE_i = \min \sqrt{\sum_{t=1}^{T_0} \frac{(Y_{it} - \hat{Y}_{it})^2}{T_0}} \quad (2)$$

The synthetic control estimator is given by the comparison between the outcome for the treated county and the outcome for the synthetic control county at the post-treatment period $t$ (with $t \geq T_0$):

$$Y_{it} - \hat{Y}_{it} \quad (3)$$

The difference in the outcome variable between treated counties and their synthetic counterfactuals following the treatment measures the causal effect of the airport if the following assumptions hold: first, there is a sufficient match between the trends in the outcome variable for synthetic and treated counties over a long pre-treatment period. That is, the RMSPE in equation (2) is sufficiently minimized.
C Difference-in-differences approach

Our difference-in-difference model takes the following form:

$$ Y_{it} = \alpha_i + \theta_t + \gamma (\text{Allg}äu_i \cdot \text{Airport}_t) + \epsilon_{it} $$

where $Y_{it}$ describes our dependent variables arrivals in county $i$ and year $t$ (1996-2016). $\text{Allg}äu_i$ is a dummy variable that takes on the value one for our treatment counties in the touristic region Allgäu and zero otherwise, while $\text{Airport}_t$ is a dummy variable denoting the years after the Memmingen Airport was opened (2008-2016) with one, and zero otherwise. $\text{Allg}äu_i \cdot \text{Airport}_t$ measures the interaction of the two dummies and $\gamma$ thus estimates our treatment effect. We include county and year fixed effects ($\alpha_i$ and $\theta_t$). The coefficient $\gamma$ can be interpreted as a causal effect of the airport if the common pre-trend assumption between the treated counties and the control group holds.

We estimate equation (4) with Weighted Least Squares (WLS) and Ordinary Least Squares (OLS) and use three different control groups. WLS and OLS regressions differ in their regression weights. First, we estimate WLS where we combine the synthetic control approach with the difference-in-differences estimation. We use the donor pool weights derived from the synthetic control approach as regression weights (the counties in the control group are weighted according to Table A3 in the appendix). Second, we estimate a difference-in-differences model using OLS where all counties from our donor pool are included (dark gray counties, see Figure 1) and contribute with equal weights to the control group. Third, we estimate a difference-in-differences model using OLS where only the counties that received a weight in our synthetic control approach are included in our control group, but all with an equal weight.