

Regional Airport Expansion

Expansions of Regional Airports and their Effect on the Local Economy

Philipp Breidenbach
RWI, RUB

Abstract:

This paper exploits the deregulation of the European aviation market as a quasi-natural experiment to examine if the expansion of regional airports in Germany caused positive spillover effects on the surrounding economy. Such spillovers might justify the heavy subsidies which are transferred to airports annually. Standard evaluations of infrastructure investments have to face reverse causality problems since the investment decisions are based on the regional conditions of the regional economy. The deregulation act forms an exogenous incentive to invest in the expansion of existing regional airports. Furthermore, most of these airports act as military bases and their location is not economically driven. Under these circumstances a Difference in Differences approach allows to estimate causal effects of the expansion on the regional growth. Following this identification strategy, the results are sobering since airport expansions are not found to have any positive spillover effect on regional growth.

JEL Classification: R51, R42, H54

Keywords: Infrastructure investment, Regional growth, Airport effects

1. Introduction

During the past decades, German regional airports have emerged enormously from small and medium sized airfields to regional connections into the world market. In the light of a growing aviation market, regional politicians took chance to invest millions in their airport facilities to fulfill the requirements of modern airports. Despite to the ambitious expectations, today temporary intended discounts on operation fees to retain low-cost carriers (Barrett, 2000) have to be provided permanently and merely all German regional airports depend on substantial subsidies to cover their annual loss. These subsidies have been issued by the European Union who decided that they are against European competition law. After 2024 all subsidies which cover the costs of operational business are interdicted. These legal requirements will cause existential problems for a range of these airports.

Opponents of the airports welcome this announcement as they do not believe that these regional airports will be able to sustainably compete with the established airports. On the other side, proponents of the airports argue that the pure appraising of the direct losses miss out their importance for regional development. They emphasize positive spillover effects for the surrounding industry, showing that service industries and high tech branches benefit from airport proximity (Shread, 2014, Brueckner, 2003, Button and Taylor, 2000). Especially strong employment effects form a massive argument for continuing the airport operation (Robertson, 1995). Nevertheless, the counterfactual development which an airport region would have undergone without the expansion cannot be observed in such perspective. This paper examines if the expansion of regional airports holds as impulsion for prosperity growth in the airports' neighborhood.

Evaluations of infrastructure investments as growth impulse (e.g. Aschauer, 1989) are manifold and important. Nevertheless, many of them, especially in regional context, suffer from various endogeneity problems due to the non-experimental character of the decisions on location and expansion in the case of airports. The question of sustainable effects of airports on growth (Graham, Guyer, 1999) develops into the question of causality from airports to growth (Mukkala,

Tervo, 2013). Since expansion decisions of airports are closely connected to the development of the surrounding region and a reverse causality problem arise which cannot distinguish if the investment boosts regional development or a good regional development gives the reason for the investment (e.g. Mukkala and Tervo, 2013, Button et al. 2010, and Green, 2007).

Disentangling these two transmission channels in order to establish an identification strategy which focuses on the causal expansion-induced effect of airports is the major contribution of this paper. Estimations are done with a Difference in Differences (DiD) approach which minimizes endogeneity problems. Two circumstances explicitly accounting for German airports allow the application of this identification strategy. First, today's airports are closely linked to German military history since most of them converted from a military to a civil use in the past (Behnen, 2004). From a researcher's perspective this military history ensures that the localization of these airports rather stems from military strategies from economic reasons but (Cidell, 2003).

Second, deregulation of the European aviation market, implemented in Germany in 1997, lead to a substantially redesigned aviation market (Graham, 1995). Beside the enforced competition on the airline market, this reform caused an increasing demand for takeoff and landing slots. Established airports could not serve this increasing demand and more airlines headed to regional airports as operation centers. Several regional politicians took chances of this development and decided to invest millions to prepare their regional airports for the needs of modern and international airlines and passengers. Therefore, the reform marks a breaking point in the ground services (Behnen, 2004) since it forms an exogenously given investment incentive. Contrary to investments driven by positive regional developments, these incentives were set by exogenous changes in the structure of the aviation market (Graham, 2010, Barrett, 2000).

Although, US deregulation has already been exploited to analyze metropolitan development, this is the first paper shedding light on the recently discussed effect of regional airports expansions, applying an exogenous event as identification

strategy. However, the results are sobering. Although, basic approaches which ignore the endogeneity problems show a link of airport location and higher prosperity in terms of GDP, this effect disappears with the application of a sound identification strategy focusing on causality and exogenous events. The results do not give any hint that spillovers spread out from such expansions of regional airports which justify their massive subsidization. This result is confirmed by various robustness checks. Beside the overvaluing of the investor's pull factor of regional airports, opportunity costs might play a major role since cities which have to raise money for airport subsidies have fewer possibilities to invest in more rewarding projects.

The remainder of the paper is organized as follows, the following section 2 sums up existing literature, the endogeneity issues and the institutional settings of the deregulation. Section 3 describes the data set and the incorporated Diff-in Diff specification. The results and the various settings of robustness checks are presented in section 4, section 5 concludes.

2. EU aviation market reform as source of exogenous variation

2.1. Existing literature on airport effects

Proponents of the regional airports identify the existence and expansion of airports as a driving force of regional development because airports increase income and employment in the local economy (ELFAA, 2004). Following their argumentation, job opportunities for low skilled worker and unemployed as well as benefits for investors are supposed to be induced by airports (Robertson, 1995). Beside the reduced travel times (Vickerman et al., 1999), three transmission channels are in focus (see Button, 2010 for further subdivisions): Direct effects, realized through employment and investments at the airport, indirect effects – benefits for the surrounding economy in the chain of suppliers of goods and services and the induced effects which sums up the employment through spending by directly and indirectly employed people. Beside these three channels, airports are supposed to have a catalytic effect by improving productivity and attracting economic and touristic activities (e.g. EU Committee of the Regions, 2004, Cezanne Mayer, 2003).

However, finding evidence for such airport effects is likely to be a challenging task. Considering the simplest method to examine if the existence of an airport affects growth in the surrounding region – a comparison of growth between airport- and non-airport-regions – will clearly lead to bias estimates due to omitted regional heterogeneity. Even though, one can control for plenty observable variables, identification suffers from unobservable heterogeneity such as regional pre-conditions which are very likely to correlate with the existence of an airport. Though, it is not possible to distinguish whether positive growth impulses indeed hold as an airport-effect or if they merely show that airports are located in regions with favorable economic conditions. There has been a couple of innovative approaches such as the implication of instruments for the airport traffic e.g. by Brueckner (2003) or Shread (2014) may help to reduce endogeneity. However, finding proper instruments which are assumed to predict airport size but do not correlate with regional circumstances is challenging, especially in the case of infrastructure.

The common approach to overcome unobserved cross-sectional heterogeneity (Islam, 1995) is the observation of panel data which allows to apply fixed effects. Though, it does not help in this context since the airport existence is a fixed effect itself. Relying on expansion measures of airports such as flights, passengers or cargo (Florida et al., 2012) helps to impute further variation in the dataset. Nevertheless, this approach cannot when it comes to the endogeneity problem whether the expanded airport activity is the cause or the consequence of regional development. Even more, in most cases, increasing airport activity and regional prosperity act simultaneous and it is not possible to distinguish whether regional factors drive airport activity or the other way round as found by Goetz (1992) and Dobruszkes et al. (2011).

Problems can be summed up in three main endogeneity issues. First, the location of an airport is not random, so there might be higher probability for the erection of an airport in a prospering region. Second, anticipated expectations on future regional development mix up cause and correlation in the evaluation even though, the regional growth occurs in a lagged period. Beside of these two prob-

lems of unobservable drivers, the simultaneity of the airport and regional development hinders a proper identification strategy. Time series analyzes e.g. provided by Green (2007), Makkala/Tervo (2013) or Button/Yuan (2013) tackle the problem by the application of Granger causality tests. However, the existence of Granger causality does not necessarily prove economic causality and anticipation of future economic developments rest problematic (Makkala and Tervo, 2013).

The identification of reliable airport effects on the regional development - distinguishing between cause and consequence – seem not to be practicable with standard structural model approaches. Therefore, exogenous events (Shread, 2014)¹ which provide an incentive for expansions independent from contemporaneous regional development can help as a good convincing starting point for evaluation approaches. Bloningen/Cristea (2012) take advantage of the US “Aviation Deregulation act” in 1978 as an exogenous event which was endorsed to promote competition in the aviation market.

Since the pre-reform aviation market in the US did not really hold as an example for an open market but rather offered a high degree of governmental regulations, the deregulation act lead to substantial shifts in the market structure. The market situation was described by obstacles such as peripheral connections with higher governmental subsidies than attained ticket turnarounds on the one hand and other 'hot connections' where only a limited number of flights were allowed although there was a demand for much more flights on the other hand (Bloningen and Cristea, 2012). Since this setup was not sustainable for the rapid development of the aviation, US government passed a radical reform of the system for 1978.

Acting under market pressure, airlines focused their activities on the central locations. Therefore, metropolitan airports expanded massively while the more peripheral decreased. These shifts which initiated the today's hubs and spokes system provided several meaningful increases and decreases in the airports' activities (Burghouwt and Hakfoort, 2001). However, changes in the market which were

¹ Shread (2014) exploits the US 1944 National Airport Plan, which somehow exogenously decided the size of today's airports without being directly influenced by the later development of the US cities.

caused by this reform are rather assigned to be exogenous to the regional economic development. Exploring this setup, Bloningen and Cristea (2012) find positive effects of population's growth, per capita income and employment. However, profiteers of the US reform were clearly found in the cluster of rather medium and large metropolitan areas. Transfers of these results to the situation of German regional airports are problematic, as Mawson (1997) finds substantial deviations in the reform and its consequences for small and large airports as well as for peripheral and central regions (Graham, 1997).

2.2. EU aviation market reform

Encouraged from the good experiences in the deregulated market in the US, the European Commission started a deregulation initiative, the Single European market (Graham, 1997). The post-reform period in the US showed a surplus of supplier and flights with an enforced competition and decreasing price levels. The European initiative was started in 1983. However, bureaucracy of European institutions and the previously national responsibilities slowed down this process and the first two steps of deregulation were implemented in 1988 and 1990. These steps permitted bilateral intra-EU agreements (Graham, 1995) and were characterized by rather small changes such as the validity of competition rules for the aviation and implementation of three bounded fare-zones which allowed to supply tickets below the standard minimum fares (Schenk 2004: 95ff).²

Substantial changes in the structure were initiated by the third step (Graham, 1997). This included the harmonization of the airline licensing processes, entire liberalization of ticket-fares and the abolition of capacity regulations between member states. This issue opened the competition since all cabotage-restrictions, meaning international connections were only provided by a domestic airline of one of the involved countries and consequently, only domestic airlines were allowed to provide national routes (Schenk 2004: 98). Although the related European regula-

² Please see Graham (1995/1997) for detailed description of the single reform steps and Schenk (2004) for the concrete implementation in the German case. This analysis focuses on those steps which are of interest for the following identification strategy.

tion of this step passed the European Council in 1993, German took the opt-out possibility as long as possible until beginning of 1997.

These trends changed the market dramatically since a substantial number of airlines entered the German market as further competitors, leading to an increased number of flights (see Thompson, 2002 for France). Nevertheless, slots (for departures and arrivals), ground operation services and booking systems were not changed and the chances for the new competitors to operate from the established airports were rather low. Grandfathering rights for national carriers without convincing “use it or lose it”-rules existed and hindered an appropriate access to the established airports for the new airlines (Schenk, 2004). Although, the missing reform of the slots etc. was anticipated by the European council, the bargaining position of the established national carriers did not allow the elimination of grandfathering rights which were hosted by these airlines.

2.3. Advantages for the evaluation

However, the enlarged number of competitors and the missing slots at established airports set incentives to regional politicians to prepare their airports for increasing air-traffic requirements in Germany after the end of the opt-out phase. Due to the quite long four years period from the approval of the law until its complete implementation there was a sufficient amount of time for regional politicians to decide for investments in the expansion of regional airports. This rise of regional airports and the newly emerging regional airlines is confirmed by various findings such as Graham (1997). By contrast to the US deregulation which provided benefits for big and drawbacks for small airports (Burghouwt, Hakfoort, 2001 and Bloningen, Cristea, 2012), the European reform (especially under the German circumstances) mainly favored such regional airports and airlines (Graham, 1997 and ELFAA, 2004). Since airlines were in the scope of the Single European market reform (Graham, 1998) and it was neither intended to promote regional airports nor the timing of investment was free to choose, these reform-induced investments do not suffer by such substantial endogeneity issues as the standard expansion deci-

sions. As Behnen (2004) point out, the reform did not only cause a revolution in the sky but, especially in Germany, also on the ground.

Germany is a special case with economically rather exogenous locations of airports than in other countries. Due to Germany's unique military background, most of the today's regional airports had military application in their history and they turned into civil use by conversion (Behnen, 2004). Therefore, their location is less driven by the economic needs of a region or favorable economic pre-conditions (Cidell, 2003) – which might be the main issue of endogeneity in standard approaches. Despite to this, the location decisions are based on military strategies and the associated distribution of the air force. Driven by these two aspects – the military shaped location of regional airports and the deregulation-driven time for expansions – the endogeneity issues are minimized and allow the examination of solid airport expansion effects.

3. Data and Identification Strategy

Since the incentives for airport expansions in the time of deregulation are regarded as exogenous, the deregulation enables to apply a DiD identification strategy which can provide an effect purely based on the supply of more airport infrastructure. Since the provision of such infrastructure is often supposed to be a crucial ingredient for sustainable development in the long run, this identification can help to verify these assumptions. Within the DiD, those regions with a regional airport are defined as treatment group and the post-1997 era is defined as treatment period. Despite to the majority of airport evaluations which exploit terms of air services (Allroggen/Malina, 2014), this paper focusses on the pure provision of infrastructure transcribed in a dummy turning 1 if the region has an airport and 0 otherwise.

The dataset³ contains annual information on German counties for the period from 1991 to 2008. The German Airport Association (ADV) members divided in international and regional airports provide the database of German airports. While counties with regional airport provide the treatment group, all remaining counties without an airport serve as control group. Reactions to the reform of international airport remain unclear. Possibly they were also positively affected by the reform and gained higher efficiency of their traffic. However, they do not hold as a control group and they were less affected by the reform than the regional airports. Therefore, all regions with such airports fulfilling the characteristics of international airports are excluded from the dataset.

The demarcation between regional and international airports is neither done by the ADV definition nor the by the legal permission of those airports since the subdivision in international airports – providing international flights – and regional airports does not seem to describe the situation adequately.⁴ The main definition relies on the terms of pre reform passengers. All those airports with less than one million passengers are defined as regional airports and included in the treatment group. This arbitrary definition is extensively tested in the robustness checks. Which contain varying threshold from 0.5 million to 5 million passengers per year. Information on passenger and airports are taken from the ADV (2015).

The variety of supposed spillovers from regional airports and the improved regional prosperity are captured best by the growth of GDP per labor force (GDPpl). Therefore, the GDPpl in nominal values is applied as left hand side variable.⁵ Since the GDPpl may also have some minor shortcomings (e.g. under the strict assumption of a fixed capital stock, the GDP pe labor force may decrease by the increase of labor force) further estimations are applied with the growth of total GDP, GDP per capita and employment as dependent variables.

³ Economic variables are taken from the Federal Institute for Research on Building, Urban Affairs and Spatial Development BBSR (2009) and Destatis (XXXX).

⁴ International flights are also provided from those airports which are legally defined as regional airports. See destinations of e.g. Dortmund-Wickede (<http://www.dortmund-airport.com/f2a0c5cf806929ea/passengers-visitors>)

⁵ GDP can only be provided on current price level since there is no information on price indices for the deflation on the chosen level of regional entities (Destatis, 2015)

Beside the constitutional terms of the DiD, the time dummy indicating post-treatment era (t_t), the cross sectional treatment (α_i) and their interaction (T_{it}), the right hand side contains a varying set of controls (x_{kit}). Over the set of estimations, the controls are included subsequently. Starting with a pure DiD, the lagged level of GDPpl is included, followed by an estimation with the lagged level employment, the population and the population density. The final setup also contains time fixed effects. Since all regressions are estimated in a fixed effect environment, α_i is skipped due to its time invariant characteristic (Augurzky et al., 2006). The included time effects in the least setup skip the post treatment effect. The subsequent model equation is

$$\Delta y_{i,t} = \mu_i + t_t + \delta T_{it} + \sum_{k=1}^K \beta_k \ln(x_{i,t-1,k}) + \varepsilon_{i,t} \quad (1)$$

where $i=1,\dots,N$ is the cross-sectional and $t=1,\dots,T$ is the time dimension, β_k and δ are regression coefficients to be estimated, and $\varepsilon_{i,t}$ is an independent and identical distributed error term (i.i.d.). All variables are taken from BBSR (2009).

The proper regional demarcation of the treated areas marks a final problem. Typically, airports are not located in the center of counties, this especially holds for those airports in bigger cities. They are rather located in the periphery of cities or in adjacent counties. Simply concerning the hosting counties of airports, is not appropriate since their economic effects spread out to adjacent regions. To this circumstance, the affected environment of the airport may not be covered very well when the counties with airports are simply defined as airport regions, while counties which are directly adjacent to the airport are specified as untreated control regions. This problem is tackled by defining airport regions with buffers around the airport's reference point (see Paloyo et al. 2010 for details).

The buffer size is chosen rather small with a radius of 15 kilometers which represents the mean radius of German counties. Although, there is an obvious advantage for all German regions due to the aviation connections from airports, the paper in specific deals with the effect for the direct environment of the airports. Since the local municipalities provide large shares of the subsidies and they justify

this by the positive spillovers, such small buffers are the right demarcation for the objective of this paper. Due to this objective, hinterland effects are intentionally disregarded in this approach. This is sharply to divide from the question whether air transport supply has a positive overall impact on Germans economy.

The characteristics of these airport buffers are defined by those administrative counties which are located in the buffer. Precisely, the buffer-variables are defined by the mean of the respective variable weighted by the spatial share the county stands for in the buffer. Therefore, those parts of the counties which are placed in a respective buffer are summed up to one region. The remaining part of the counties does not enter the estimations. Since nearly all airport buffers consist of more than one county (exemption is Hannover-Langenhagen), the number of regions shrinks dramatically. Same procedure is done for the international airports, all counties in connection with such airports are ignored in the estimations. Although Düsseldorf-Weeze and Memmingen are regional airports today, they are ignored in the estimations since they did not serve as regional airport in 1997. Weeze was opened in 2003, civil use in Memmingen started in 2004. All these limitations shrink the original sample size of 413 German counties to 261 regions.

Table 1: Descriptive Statistics for airport and non-airport regions

	Airport regions (24)		Non-Airport regions (247)	
	Mean/ Std.Dev.	Min/Max	Mean/Std.De v.	Min/Max
	0.030	-0.041	0.028	-0.260
GDP (growth)	0.039	0.218	0.039	0.252
	0.027	-0.036	0.025	-0.262
GDPpl (growth)	0.037	0.211	0.039	0.294
	0.033	-0.040	0.029	-0.241
GDPpc (growth)	0.039	0.222	0.040	0.261
	48.725	21.502	49.804	17.702
GDPpl (10 ³)	8.333	68.455	8.650	90.099
GDPpc	23.431	7.429	23.608	6.230
(x10 ³)	6.399	37.273	9.071	76.558
ln(employment)	4.258	1.807	4.100	2.915
lagged	0.884	5.739	0.540	6.861
ln(Population)	5.007	2.821	4.893	3.649
(x10 ³)	0.793	6.525	0.546	7.184
Density	0.006	0.000	0.010	0.001

(x10³) 0.009 0.066 0.033 1.027

Note: All variables are taken from BBSR (2009).

The descriptive given in Table 1 show that regions with a regional airport and those without these facilities do not differ substantially in the exploited variables of the later estimations. The mean GDPpl growth is 0.002 percentage points higher in the airport regions.⁶

4. Results

The course of the estimations is organized as follows. Before regressions with the proposed DiD approach based on the European deregulation are applied, the estimations start with a very basic estimation setup, checking whether airport regions do show up with a higher GDPpl (in terms of log-levels). These estimations give an intuition on the correlation between airports and regional prosperity and the potential bias which arises when endogeneity problems are ignored. These estimations are done for all types of airports in Germany (including internationals) and additionally for the subsample of the defined regional airports.

The existence of an airport – unconstrained on international or regional - clearly correlates with the level of regional GDPpl, as shown in column (i) and (ii) of Table 2. Depending on the inclusion of controls, the GDPpl is 2.5% (3.1% considering controls) higher than in the non-airport regions. Skipping all international airports weakens these findings: Without further control variables, the airport effect turns insignificant. Including further controls switches the effect into positive significance. However, one has to go beyond this basic analysis to achieve reliable results, focusing on the causal transmission from airport expansion to growth

Table 2: Pooled-OLS without DiD for all and regional airports
(Dependent Variable: Log of GDPpl in levels)

	(i)	(ii)	(iii)	(iv)
	All airports		Regional Airports	
Airport	0.025***	0.033***	-0.032***	0.018***

⁶ Closer examination of the minimal growth rates in non-airport regions show that these are outliers which are supposed to be artificially constructed by corrections of the official statistics.

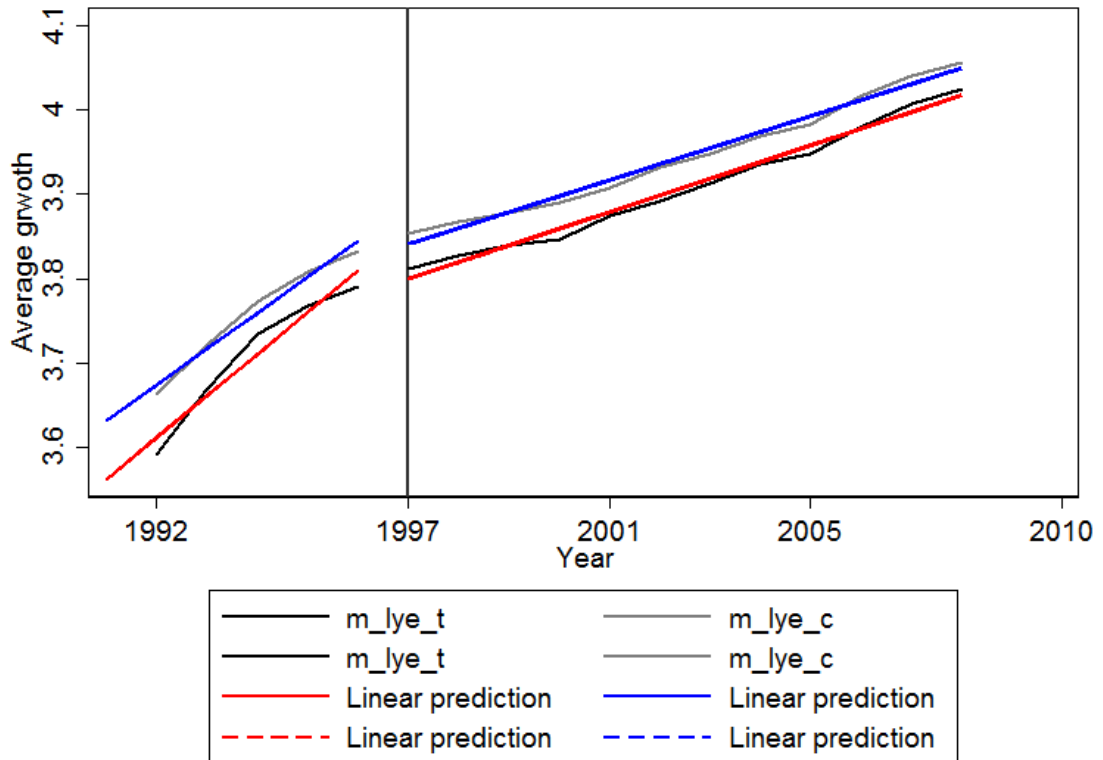
	(0.009)	(0.004)	(0.009)	(0.004)
West Germany		0.216***		0.276***
		(0.012)		(0.014)
ln(Population)		0.005***		0.003*
		(0.001)		(0.001)
ln(Population-Density)		0.037***		0.033***
		(0.003)		(0.003)
State-Dummies	N	Y	N	Y
County-type	N	Y	N	Y
Time Dummies	N	Y	N	Y
No. of Regions	287	287	274	274
No. of Obs.	4879	4527	4658	4320

Note: ***, **, * = denote significance at the 1%-, 5%-, and 10%-level. Robust standard errors clustered on county-level in parentheses.

Before equation (1) based on the DiD is estimated, the Common Trend Assumption is shown in Figure 1. DiD specifications lose their convincing identification setup if the treatment- and control-group do not show a common trend in the pre-treatment period which could be assumed as a counterfactual development in the absent of the treatment. After main results are estimated, some crucial assumptions (e.g. the demarcation in regional and international airports, pre-treatment adjustment to the treatment, spatial demarcation of treatment regions, etc.) are tested in a various set of robustness checks.

Figure 1 provides the development of the main dependent variable, the annual growth of GDPpl divided into pre- and post-treatment period and treatment and control group. The Common Trend Assumption (CTA), comparing the development of the left hand side variable in the pre-treatment period, seems not to be violated. Therefore, the DiD seems to be a suitable method for this analysis.

**Figure 1: CTA, Treatment and non-Treatment growth rate
(GDPpl growth rate)**



Main estimation results, given in Table 3 include a progressively growing set of control variables. A growing number of controls included in the regression can account for varying regional conditions and minimize regional heterogeneity. On the other hand, especially in the context of regional economics, the development of such controls might be driven by the variable of interest – the airport expansion in this case (Becker et al. 2011). For example, airports may attract more firms from abroad in the airport environment. Therefore, foreign direct investments (FDI) might increase due to the airport. Controlling for the effect of FDI on the regional growth may reduce the coefficient of the treatment variable than. Although the included controls – lags of GDPpl level, employment, population and population density seem not to be very vulnerable for this problem, they are included step-wise, starting with a pure DiD. The problem of unobserved heterogeneity is reduced by the estimation in a fixed effect environment.

The main results, irrespective of the inclusion of controls, do not show an expansion effect of the regional airports on growth. As the graphical description already suggested, the post-treatment growth is weaker than in period before (col-

umn (1)). However, this does not differ among airport- and non-airport-regions since the DiD-estimator, the variable of interest stays insignificant. By the inclusion of controls, the Post-Treat-estimator turns into positive significance and – with the consideration of population characteristics – into insignificance. Nevertheless, any result hints on a growth benefit of airport regions by the expansion of their airports. The respective DiD estimator stays insignificant over all estimations.

Table 3: DiD-Fixed effects for regional airports

Dep. Variable:	(i)	(ii)	(iii)	(iv)
GDPpl growth				
DiD-estimator	-0.007 (0.008)	-0.006 (0.005)	-0.004 (0.005)	-0.003 (0.003)
Post-Treat ⁷	-0.024*** (0.002)	0.004*** (0.001)	0.003 (0.002)	0.003 (0.002)
ln(GDPpl) lagged		-0.162*** (0.008)	-0.151*** (0.009)	-0.297*** (0.012)
ln(employment) lagged		0.090*** (0.017)	0.049** (0.023)	-0.083*** (0.022)
ln(Population) lagged			0.090*** (0.026)	0.132*** (0.031)
ln(Density) lagged			-0.000 (0.001)	-0.001** (0.001)
Constant	0.043*** (0.002)	0.276*** (0.077)	-0.038 (0.105)	0.840*** (0.133)
Time Dummies	N	N	N	Y
No. of Regions	264	264	264	264
No. of Obs.	4384	4384	4320	4320

Note: ***, **, * = denote significance at the 1%-, 5%- and 10%-level. Robust standard errors clustered on county-level in parentheses.

However, these findings might depend on the chosen definition of the threshold between regional and international airports. Since the assumption that all airports, listed by the ADV with less than one million passengers per year might be crucial, this threshold is varied from 0.5 million to 5 million. The estimations in Table 4 cover the same controls as column (iv) in Table 3. Since those regions hosting an airport with passenger terms above the threshold are excluded from the estimations, the number of groups and observations rises with an increasing threshold level. However, results are very robust for the varying specifications. The DiD es-

⁷ Under the consideration of time fixed effects the coefficient of the “Post-Treatment” variable should not be interpreted. This also accounts for the following tables.

timator does not turn into significance in any column and the remaining coefficients stay robust.

Table 4: DiD-Fixed effects for regional airports

Dep. Variable:	Threshold: Passengers per year				
	0.5 million	1 million	2 million	2.5 million	5 million
GDPpl growth					
DiD-estimator	-0.002 (0.003)	-0.003 (0.003)	-0.003 (0.003)	-0.004 (0.003)	-0.004 (0.003)
Post-Treat	0.009*** (0.003)	0.003 (0.002)	0.009*** (0.003)	0.003 (0.002)	0.003 (0.002)
ln(GDPpl) lagged	-0.296*** (0.012)	-0.296*** (0.012)	-0.294*** (0.012)	-0.296*** (0.012)	-0.296*** (0.012)
ln(employment) lagged	-0.082*** (0.022)	-0.082*** (0.022)	-0.080*** (0.022)	-0.082*** (0.022)	-0.082*** (0.022)
ln(Population) lagged	0.131*** (0.031)	0.131*** (0.031)	0.129*** (0.031)	0.131*** (0.031)	0.131*** (0.031)
ln(Density) lagged	-0.001** (0.001)	-0.001** (0.001)	-0.001** (0.001)	-0.001** (0.001)	-0.001** (0.001)
Constant	0.829*** (0.132)	0.839*** (0.133)	0.826*** (0.131)	0.832*** (0.132)	0.833*** (0.132)
Time Dummies	Y	Y	Y	Y	Y
No. of Regions	271	274	276	278	279
No. of Obs.	4272	4320	4352	4384	4400

Note: ***, **, * = denote significance at the 1%-, 5%- and 10%-level. Robust standard errors clustered on county-level in parentheses.

Another crucial issue is the construction of the control group. As discussed in chapter 2, airports might be located in regions with specific economic characteristics. Hence, if these characteristics determine the probability for having an airport on the one hand and the growth expectations over the treatment period on the other hand, results may suffer from the broadly chosen group of control regions. In econometric terms, the overlapping assumption would be violated in this case. This problem is central in the application of matching methods where the assumption of linear functional forms is specifically relaxed. Although, this problem is not in the focus of DiD and OLS estimations, the broad control group-definition in this specific approach gives an argument to put special attention on the overlapping assumption.

The aim of this approach is to exclude those control regions from the estimation, which differ substantially from the airport regions in their regional characteristics. Hence, a propensity score is applied for the region's probability of having an

airport estimated with the airport dummy (turning 1 if region i has an airport and 0 otherwise) as dependent variable and a very broad set of regional controls on the right hand side. Standard approach for this situation is the application of a probit model. Since time variance does not offer further information, the model

$$p_i = \mu_i + \sum_{k=1}^K \beta_k z_{ik} + v_i \quad (2)$$

is estimated for 1996, the last pre-reform observation. The range of the estimated probabilities of the airport regions decides which regions enter the control group.⁸ Only those control-regions with a (\hat{p}) which lie within the range of (\hat{p}) of airport regions are considered.

**Table 5: Probit for the Airport probability
(Dependent Variable: Airport Dummy)**

Probit estimation	(i)
ln(GDP)	3.595*** (0.922)
ln(GDPpl)	-0.435 (1.784)
ln(Population)	-0.577** (0.235)
ln(Density)	-2.812*** (0.889)
West Germany	-0.453 (1.061)
Constant	-16.706*** (5.971)
County Types	Y
Federal State Dummies	Y
Lowest \hat{p} of apt. region	0.015
Highest \hat{p} of apt. region	0.975
No. of Obs	264

Note: ***, **, * = denote significance at the 1%-, 5%- and 10%-level. Robust standard errors in parentheses.

⁸ To give an example, if the lowest predicted airport probability of an airport region is 50%, all those control regions with a probability below 50% are excluded from the following DiD estimation.

However, as the information in Table 4 show, the range of (\hat{p}) for airport regions covers the spectrum from 1.5% to 99.7 % airport probability. Since this result suggests that there is no region which has no probability for an airport based on the applied controls, the associated DiD without the **XXXNUMBERXX** regions with a probability below 2% is not shown here. The military background of the airports might be the driving factor behind these results. As assumed in chapter 2, the airports are not located in the respective regions due to economic background but for military strategy and planning. Summing up the result of Table 4 means that the broad set of control groups does not shrink the reliability of the results.

A standard problem of DiD estimations is the anticipation of reforms and associated pre-reform adjustments to the new scenery (Ashenfelter's Dip, 1978). Although airport planner did anticipate the reform and its implementation (opt-out ended in 1997), the market situation could not change notably before this date due to the existing regulations. Therefore, an earlier investment did not lead to advantages in the pre-reform period. However, construction measures to provide the infrastructure until the appointed date had to start before the reform and this may bias the results. This bias may be twofold, on the one hand reform induced constructions may have caused pre-reform growth and bias the DiD estimator downwards therefore. On the other hand, airport operations may have been shrink due to such constructions in pre-reform-years leading to an upward bias of the DiD estimator. By the exclusion of critical years around the reform date, the sensitivity of the results can be tested. Table 6 show that the estimated DiD coefficient do not turn into any significance by the exclusion of those years which are supposed to be crucial.

Table 6: DiD-Fixed effects with excluded years
(Dependent Variable: Growth of GDPper labor force)

Exclusion of...	1996	1995&1996	1997	1997&1998
DiD-estimator	-0.006 (0.004)	-0.008 (0.005)	-0.003 (0.003)	-0.003 (0.003)
Post-Treat	0.009*** (0.003)	0.009*** (0.003)	0.016*** (0.003)	0.016*** (0.003)
ln(GDPpl) lagged	-0.298*** (0.013)	-0.307*** (0.013)	-0.295*** (0.012)	-0.292*** (0.012)

ln(employment)	-0.086***	-0.081***	-0.084***	-0.078***
lagged	(0.023)	(0.026)	(0.024)	(0.024)
ln(Population)	0.137***	0.139***	0.134***	0.140***
lagged	(0.032)	(0.034)	(0.032)	(0.032)
ln(Density)	-0.001**	-0.001*	-0.002***	-0.002***
lagged	(0.001)	(0.001)	(0.001)	(0.001)
Constant	0.823***	0.836***	0.817***	0.756***
	(0.135)	(0.139)	(0.133)	(0.132)
Time Dummies	Y	Y	Y	Y
No. of Groups	274	274	274	274
No. of Obs.	4054	3788	4051	3782

Note: ***, **, * = denote significance at the 1%-, 5%- and 10%-level. Robust standard errors clustered on county-level in parentheses.

The remaining crucial assumption of the identification strategy is the size of the buffer which marks the treated regions. Since only the directly adjacent regions of airports are in the scope of this paper, it is not the aim to quantify additional hinterland effects with a varied buffer size. However, growth of adjacent counties may be affected by the airport. This may be positive due to spillovers from the airport or negative due to decisions of investors in favor of the airport proximity and against their neighbors. Independent from the direction of this effect, it means that regions belonging to the control group are affected by the treatment. This is a violation of the stable unit treatment assumption (SUTVA) and irrespectively from the direction, it forms a bias of the DiD estimator.

To overcome this problem, a second buffer with a radius of 30 kilometer around the respective airport is constructed. In combination with the original 15 km buffer it forms a belt. To avoid the direct transition from treated to untreated regions, this belt is ignored in the estimations in Table 7 assuming that those regions above the 30 km demarcation do not have a direct effect from the airport. This assumption gets even more plausible since every county which touch on this belt are excluded completely even if their larger share is more than 30 km away. Due to this restrictive exclusion, the number of controls shrinks dramatically. However, the relevant coefficient of the DiD does not change systematically.

Table 7: DiD-Fixed effects with excluded 30km belt
(Dependent Variable: Growth of GDPper labor force)

	(i)	(ii)	(iii)	(iv)
DiD-estimator	-0.008 (0.008)	-0.007 (0.005)	-0.006 (0.005)	-0.006* (0.003)
Post-Treat	-0.023*** (0.003)	0.006*** (0.002)	0.004* (0.002)	0.018*** (0.005)
ln(GDPpl) lagged		-0.162*** (0.011)	-0.152*** (0.013)	-0.297*** (0.018)
ln(employment) lagged		0.091*** (0.026)	0.047 (0.033)	-0.075** (0.031)
ln(Population) lagged			0.098*** (0.035)	0.136*** (0.043)
ln(Density) lagged			0.000 (0.001)	-0.001 (0.001)
Constant	0.043*** (0.002)	0.281*** (0.106)	-0.050 (0.135)	0.796*** (0.192)
Time Dummies	N	N	N	Y
No. of Groups	157	157	157	157
No. of Obs.	2512	2512	2474	2474

Note: ***, **, * = denote significance at the 1%-, 5%-, and 10%-level. Robust standard errors clustered on county-level in parentheses.

Further robustness checks are provided in the appendix. To ensure, that these results are not based on the lower productivity of new jobs in the spirit of the airport expansion, regressions with the growth of total GDP growth, GDP per capita growth and growth of the employment are applied and reported in Table A.1 (column (i)-(iii)). None of these variables leads to diverging findings. To avoid the heavy deterioration of the aviation market after 9/11 in the observation, the observation period is cut after 2001 in column (iv). This does not change the results as well as the change to the legal definition of regional airports. Considering only those airports which are authorized as regional airports in the treatment group does not change the results.

Constraining the treatment group on the ten airports with the biggest passenger surplus from 1996 to 2000⁹ even turns the DiD coefficient into negative significance. Effects stemming from such a small treatment group should not be stressed too much. Nevertheless, it can be assumed that those regions with the biggest sur-

⁹ The considered airports are: Augsburg, Dortmund, Erfurt, Frankfurt-Hahn, Karlsruhe-Baden, Lübeck, Münster/Osnabrück, Paderborn, Rostock and Neubrandenburg. The surpluses are measured in relative terms. Note that rather small absolute changes on small airports might cause high relative changes.

plus highly invested into their airport facilities. Probably the opportunity costs, meaning that these regions or cities were not able to invest in other projects play a role for this result.

5. Conclusion

The EU commission has recently announced that subsidization of airports which merely survive due to substantial public support will be permitted after 2024. Since most of the smaller rather regional airports in Germany are subsidized at the moment, they are facing lethal problems for the future. Proponents of the regional airports emphasize the positive spillovers on employment and economy which are spread throughout the region. This paper shed light on the question if German regions with a regional airport outline other regions in terms of growth of GDP and employment.

Since investments in infrastructure such as airports are endogenous to the regional conditions and the expectations on regional future performance, estimated airport effects in standard model are supposed to be biased. The deregulation of the European aviation market marks an exogenous event which can be seen as a quasi-natural experiment for the expansion of regional airports. An increasing number of airlines had the need for further operation slots in Germany and shifted to the regional airports which invested in their infrastructure independent from the contemporaneous regional performance. Furthermore, the military background of most regional airports makes them less dependent on the economic conditions in their environment.

The circumstances allow to apply a DiD where the first year of deregulation, 1997, is employed as moment of treatment. For the spatial definition of the treatment, buffers with a radius of 15km are constructed by the share of counties they consist of. The DiD can help to overcome the endogeneity issues. Ignoring these problems leads to a positive impact of airports on the GDPpl level which is shown in a basic estimation. These positive effect neglects when the preferred DiD identi-

fication is applied. A positive effect of the expansion of regional airports cannot be quantified in the estimations irrespective to the chosen set of control variables.

A broad set of robustness checks strengthens these findings. The results are robust to a change of the definition of regional airports, various definitions of the control group, avoidance of an Ashenfelter's dip by the exclusion of years around the deregulation and changes of the dependent variable. Focusing an approach which restricts the analyses on the channel from airports to regional prosperity does not give any hint for airport induced growth stimulus. A reason for these sobering results might be the overwhelming opportunity costs of the airport operation. Since a numerous amount of capital is bounded to the airport other possibly better investments are prevented.

However, one has to keep in mind the limitations of this approach, hinterland effects of airports are excluded by definition in this approach. Furthermore, no evidence can be given for the international airports. It may be the case that airports need to exceed a certain threshold to fade out spillovers. Since the estimations has be done for German airports, the circumstances in Germany has to be considered. Germany has a high density, in terms of population as well in terms of airports. The distance from one airport to the next is often far below 50 kilometers. Beside the advanced identification strategy and the specific scope of this paper, this might be a further explanation for the differing findings in this paper compared to existing literature. Regarding recent results of Mukkala, Tervo (2013), who find Granger causality from airports to growth in peripheral European regions might strengthen the problem that these results are merely transferable to other countries.

As Nijkamp, Geenhuizen (1997) and Graham, Guyer (1999) point out, the social context of airports, especially in peripheral areas have to be taken into account since they improve mobility, communication and connectivity of regions. On the other side, negative effects on the general well-being caused by noise and health cumulated are found in the literature (e.g. Cidell, 2013 and van Praag Baarsma, 2005). Furthermore, the gained connectivity seems not to be that important in the

dense airport network in Germany. Based on these results, the concerns of regional politicians that regions suffer from absence of airport subsidies are not confirmed. A downscaling of regional airports towards sustainable airports without subsidies is not supposed to have major effects on the surrounding municipalities.

Table 7: DiD-Fixed effects with excluded 30km belt
(Dependent Variable: Growth of GDPper labor force)

Dep. Variable: GDPpl growth or see headline	(i)	(ii)	(iii)	(iv)	(v)	(vi)
	Dep. Var. GDP growth	Dep. Var. GDPpc growth	Dep. Var. Employment growth	Skipped after 2001	Regional Airports legally defined	Biggest Passen- ger surplus (10 Apt)
DiD-estimator	-0.006 (0.005)	-0.007 (0.005)	-0.003 (0.003)	-0.002 (0.003)	-0.005 (0.004)	-0.011*** (0.003)
Post-Treat	0.008*** (0.002)	0.008*** (0.002)	0.005*** (0.001)	0.020*** (0.004)	0.009*** (0.003)	0.003 (0.003)
ln(GDPpl) lagged	-0.296*** (0.014)	-0.292*** (0.014)	0.001 (0.006)	-0.378*** (0.016)	-0.294*** (0.012)	-0.293*** (0.013)
ln(employment) lagged	-0.207*** (0.025)	-0.227*** (0.025)	-0.125*** (0.010)	-0.107*** (0.032)	-0.079*** (0.023)	-0.079*** (0.023)
ln(Population) lagged	0.229*** (0.039)	0.294*** (0.037)	0.097*** (0.016)	0.233*** (0.050)	0.131*** (0.031)	0.128*** (0.032)
ln(Density) lagged	-0.001* (0.001)	-0.001** (0.001)	0.000 (0.000)	-0.003 (0.001)	-0.001** (0.001)	-0.002*** (0.001)
Constant	0.866*** (0.151)	0.610*** (0.147)	0.027 (0.066)	0.728*** (0.233)	0.813*** (0.131)	0.826*** (0.135)
Time Dummies	Y	Y	Y	Y	Y	Y
No. of Groups	264	264	264	274	263	257
No. of Obs.	4320	4320	4320	2402	4144	4056

Note: ***, **, * = denote significance at the 1%-, 5%- and 10%-level. Robust standard errors clustered on county-level in parentheses.

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