The Effects of Liberalisation on Airline Passenger Traffic: An Event Study of the Enlargement of the EU and the Single European Aviation Market

Draft

Priit Vahter[1]

School of Economics
University of Nottingham

07 March 2009

Abstract

The standard problem in studies about the effects of deregulation on economic performance is how to construct a suitable proxy for the counterfactual – what would have happened if no deregulation took place? I use an event study of the enlargement of Single European Aviation Market (SEAM) in 2004 and employ difference-in-difference and synthetic control methods, together with variation in membership coverage of the SEAM and the EU, to identify its effects on volume of airline passengers. I find that, already by the end of 2004 the number of passengers travelling between UK and the eight Central and Eastern European (CEE) new member states grew by 106 per cent, relative to what it would have been in the absence of the enlargement of the EU and SEAM. The corresponding growth on routes from Norway, a member of the SEAM but not a member of the EU, to the CEE was 80 per cent, relative to a comparable synthetic control without the change in policy. The majority of these effects are concentrated on routes connecting airports outside Oslo and London with CEE countries.

[1] E-mail: lexpv@nottingham.ac.uk

1. Introduction

How large is the increase in industry output, productivity or other performance measures after a liberalisation event in a sector, relative to the counterfactual case if no liberalisation took place? The evidence presented in earlier literature[2] about the effects of liberalisation in the aviation sector and elsewhere is often limited because it is difficult to find out, how would the sector have developed in the absence of these changes.

This chapter provides an empirical assessment of the economic effects of deregulation of the aviation sector, based on an event study of the enlargement of Single European Aviation Market (SEAM) and European Union (EU) in 2004. To my best knowledge, this is the first study of the causal effects of the SEAM enlargement in 2004 on economic performance of the airline sector. It employs a recently developed extension to the difference-in-differences method (by Abadie et al. 2007). Another novelty is the use of new data from UK and Norway, previously not studied in academic literature.

I use volume of passenger traffic and revenue passenger kilometres (RPK, i.e. number of paying passengers*kilometres flown) on a country-pair or route as outcome variables to measure these economic effects. These two are standard output measures of the airline sector. The main reason why I use traffic as a proxy for economic performance of the sector is the availability of data. In the case of traffic figures I can employ a large dataset that has large number of observations and covers both pre- and post-2004 period.

I find that after the enlargement of the SEAM, already by the end of 2004, passenger flows on affected routes grew 80-106 per cent relative to what these would have been in the absence of the enlargement[3]. This gap widens rapidly further in the following years. There is also some evidence that the effects of liberalisation in 2004 on air traffic, in percentage growth terms, are larger than the immediate effects of the 1988/1992 large-scale deregulation of aviation sector in Western Europe[4].

The passenger aviation industry in Europe is a particularly suitable sector for studying the effects of the changes in the competitive environment of the firms. It has witnessed large regulatory changes—in Western Europe in 1992 and 1997 and in Central and Eastern Europe

---

[2] For example: Borenstein (1989), Dresner and Tretheway (1992), Gonenc and Nicoletti 2000, Marin (1995), Martin et al. (2005), Schipper et al. (2002), Ng and Seabright (2001).

[3] Use of RPK as an output measure shows similar large effects.

[4] The immediate effects of liberalisation in 2004 on percentage growth of number of passengers and flights are much larger than some simple estimates (found using the standard least squares regression approach) from earlier literature about the effect of 1998/1992 deregulation event in Western Europe on number of flights (e.g. in Schipper et al. 2002). However, my results (the treatment effects) and Schipper et al. (2002) coefficients from simple regression analysis are not directly comparable. So, it cannot be determined here exactly by how much the effects (in percentage terms) in CEE in 2004 were larger than in Western Europe in 1988/1992.

(CEE) in 2004. The liberalised aviation markets in the EU and US are in fact big exceptions in the world. According to Pearce and Smith (2007), only 17 per cent of international air traffic in the world is conducted in liberalised environment.

In terms of the size of the population, the eastern enlargement in 2004 has been the largest enlargement of the EU so far. The 8 new members[5] from the CEE that entered in 2004 were Poland, Czech Republic, Hungary, Slovenia, Slovakia, Estonia, Latvia, and Lithuania. For the passenger aviation sector in these countries the enlargement of the SEAM (at the same time with the overall EU enlargement) meant a significant change in the competitive environment. Entry of airlines to routes connecting the affected CEE countries with Western Europe became much easier than before.

However, identification of the effects of the enlargement of the SEAM is a difficult task. One standard approach would be to implement the before-after analysis based on the time series of only the affected country-pairs or routes. Another approach would concentrate on the analysis of cross-section of country-pairs. Both suffer from a number of (econometric) problems.

Time series analysis of affected routes would ignore the construction of a suitable control group of 'untreated' country-pairs and routes. It is also complicated by a number of other changes taking place at the same time due to the overall enlargement of the EU. The EU enlargement was also a positive demand shock for the airline industry. It meant introduction of visa-free movement of people from the CEE and potential positive effects on GDP growth and growth of trade with the EU countries. In the case of some 'old' EU countries (e.g. UK, Ireland) it meant also opening of the labour market for people from new members. All this increased the demand for passenger air transport in 2004 and the following years.

Also, new members of the EU and SEAM differed in 2004 from old members in terms of their determinants of passenger traffic growth. Therefore, a simple comparison of post-2004 dynamics of passenger traffic in the new and an average of the old members would show not only the impact of enlargement of the EU (demand shock) and SEAM, but also the effect of pre-2004 differences in determinants of passenger traffic.

My identification approach relies, firstly, on building a suitable control group to proxy the counterfactual *"By how much would have the volume of air travel to and from the CEE grown in the absence of the EU and SEAM enlargements?"* For that I use difference-in-differences and its extension—the synthetic control method (as in Abadie et al. 2007). Based on the change in regulatory regime (in May 2004) we can identify a treatment group and a

[5] In addition to these, also Malta and Cyprus entered the EU in 2004.

control group of routes. The treatment group consists of routes or country-pairs connecting the CEE-8 with Western Europe, and therefore affected by the change. The potential pool of control units can consist of routes or country-pairs within Western Europe[6]. These were not affected by the 2004 expansion of the SEAM[7].

The synthetic control method (SCM) by Abadie et al. (2008) enables us to include the possibility of non-parallel trends of the treated group and the control group of the country-pairs. It accounts for the time-varying unobservable country-pair characteristics which are ignored by the standard estimation methods. SCM provides a formal way to select a synthetic control for each treated unit. Synthetic control is a weighted average of control units that is most similar in terms of its pre-treatment trend to the treated unit.

Secondly, my identification approach relies on utilising the differences in the membership of the EU and the SEAM. I employ traffic data on routes from UK and Norway to the CEE countries. Norway is a member of the SEAM but not a member of the EU. Data of routes to Norway enable me to concentrate more specifically on the effect of the SEAM, not on the combination of the effects of the SEAM and the overall EU enlargement as in the case of the routes to UK.

2. Literature review

The difference-in-differences (DID) approach is very popular in labour economics, starting from the seminal work by Ashenfelter and Card (1985). It has also been employed before to study the effects of regulatory change. One such recent example is by Symeonidis (2008), who examines the impact of competition on wages and productivity using a 'natural experiment' created by the change in cartel laws in the UK in the 1950s. That change affected some industries but left others unaffected.

The SCM by Abadie et al. (2007) and Abadie and Gardeazabal (2003) is a new extension of the DID and has been previously applied to study the effects of: anti-tobacco laws in California on tobacco consumption (Abadie et al. 2007); terrorist conflict in Basque Country on GDP per capita (Abadie and Gardeazabal 2003); hurricane Katrina on labour market outcomes of evacuees (Groen and Polivka 2008); financial liberalisation on FDI (Campos and Kinoshita 2008); trade liberalization on GDP per capita (Billmeier and Nannicini 2008).

[6] I.e., the EU and SEAM members before the 2004 accession round. The use of the non-EU Eastern European destinations (ex-Yugoslavia, etc) as a control group is hindered here by the fact that the dynamics and scale of passenger traffic to the new EU members and to other outside-EU Eastern European countries is very different.

[7] There the deregulation of the sector had taken place already in 1992 and 1997.

The majority of earlier academic papers about the effects of liberalisation or market power in the aviation sector study the effects on (yearly) average airfares. The examples include: Morrison and Winston (1986), Dresner and Tretheway (1992), Gonenc and Nicoletti 2000, Marin (1995), Martin et al. (2005), Schipper et al. (2002). The general finding is that more competition and liberalisation are associated with lower average airfares. Ng and Seabright (2001) look also at the effect of competition on costs of airlines and labour rents. Goolsbee and Syverson (2008) study the effects of entry threat of Southwest on the airfares of incumbent airlines and provide some information about the effects on their capacity.

The vast majority of studies about the impact of liberalisation events concentrate on USA in 1970s or Western Europe in 1988/1992. A paper by Schipper et al. (2002) tries to explore the size of the welfare effects associated with bilateral airline liberalisation in Western Europe. They investigate a sample of European routes for the period 1988/92, using yearly data. Their estimated fare and frequency (number of flights) equations (estimated with 2-stage least squares) show that standard economy fares and number of departures on fully liberalised routes were 34 per cent lower and 36 per cent higher than on routes without full liberalisation. However, their results about the effect of liberalisation on traffic and its significance vary a lot depending on which type of liberalisation dummies are included in the estimated equation. Once a partial liberalisation dummy is included, no significant effect of any type of liberalisation on traffic is found. Also, the number of observations that they use in their regression analysis is small.

To the best of my knowledge there are no academic papers studying the effects of the SEAM enlargement in 2004 on air passenger traffic. The novelty of this chapter, if compared to the majority of earlier literature about deregulation in the airline sector, is concentrating on analysis of causal effects, using an event study approach. The small number of earlier studies about liberalisation and air traffic either provide the simple descriptive statistics (INTERVISTAS 2006) about the growth of traffic or rely on standard (OLS) regression analysis. Recently, also the standard gravity model estimation has been used in some papers to examine the impact of liberalisation on bilateral air traffic. These papers (Piermartini and Rousova 2008, Grosso 2008, InterVISTAS 2006) use cross-section data of a large number of country-pairs to regress the number of passengers travelling on a country-pair on a set of control variables and a proxy for the level of regulation.

The standard approach means ignoring: (i) several econometric problems, including the potential endogeneity of control variables, and (ii) the question of how to identify the most suitable control group for the units affected by the deregulation. This paper attempts to correct some of these shortcomings.

3. Background information and some descriptive statistics

In 2004 eight Central and Eastern European (CEE) countries[8] (and Malta and Cyprus) became members of the European Union (EU) and also members of the Single European Aviation Market (SEAM). For the passenger aviation sector this meant that entry of airlines to routes connecting these CEE countries with Western Europe became much easier than before. There were no more restrictive bilateral agreements that had tended to favour the national carriers and had helped to keep the airfares relatively high. Now, there was a free market and airlines could fly freely anywhere in the enlarged EU (and to Norway, Iceland and Switzerland) where they wanted[9]. The SEAM included by 2004, in addition to the EU countries, also countries like Norway and Iceland. Therefore, for example, also routes to Norway were affected by enlargement of the SEAM.

The simplification of entry to routes to the CEE resulted in a rapid entry[10] of Low Cost Carriers (LCC) and Central and Eastern Europe became a key growth area of air traffic in Europe. For example, at the end of April 2004 Easyjet started flying from Gatwick to Prague, on 1st of May from Stansted to Ljubljana and from Luton to Budapest, in October 2004 from Stansted to Tallinn, Estonia. Other LCCs like Ryanair, BMIbaby and Jet2 started providing their services on routes to the CEE as well. The airfares of these new entrants were substantially below the ones of the old full service carriers that had dominated these routes so far (Jones 2007). This entry of LCCs meant an increase[11] in number of passengers flown between Western and Eastern Europe, stronger price competition among airlines and an increase in the number of routes served (CAA 2006), i.e. increase in variety of travelling options.

Figures 1-5 confirm that there has been a very large significant and permanent increase in traffic between the UK and the new EU and SEAM members. This occurs exactly around the time of the enlargement of the EU and SEAM in May 2004. Simple before-after analysis using data series of only the new member states shows that number of flights from 10 main

---

[8] Poland, Czech Republic, Hungary, Slovenia, Slovakia, Estonia, Latvia, Lithuania.

[9] In SEAM, every airline having licence, issued by any member state, enabling it to offer air passenger transport services can fly any route within SEAM and offer his services for any price that it deems suitable.

[10] Notably, some entry of LCCs took place also 1-2 years before the enlargement of the EU and SEAM.

[11] Anecdotal evidence from Western Europe indicates (Calder 2002) that many customers of LCCs (at the beginning of this decade) were new clients who had not flown before.

UK airports to new members was by 2006 more than two times higher than before the enlargement. However, the before-after analysis may overestimate the effect as it does not account for the trend in air traffic, the fact that air traffic could have increased to some extent also without the EU enlargement.

As expected, monthly data (e.g. in Figure 1) demonstrate the seasonal nature of international air traffic.

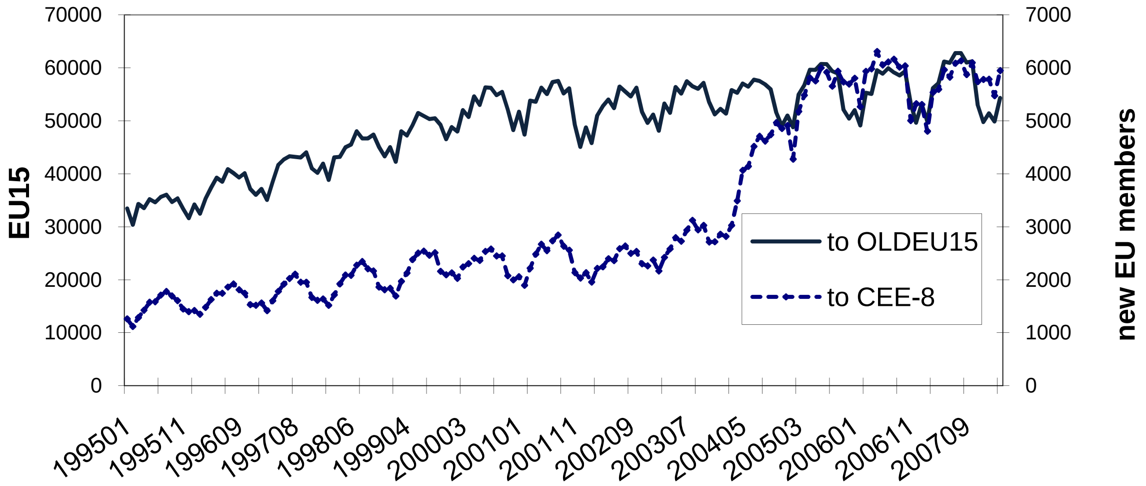

Figure 1. Number of monthly flights from UK to the 'old' 15 EU members and to the new Central and Eastern European EU member countries that acceded in May 2004.
Source: UK CAA dataset

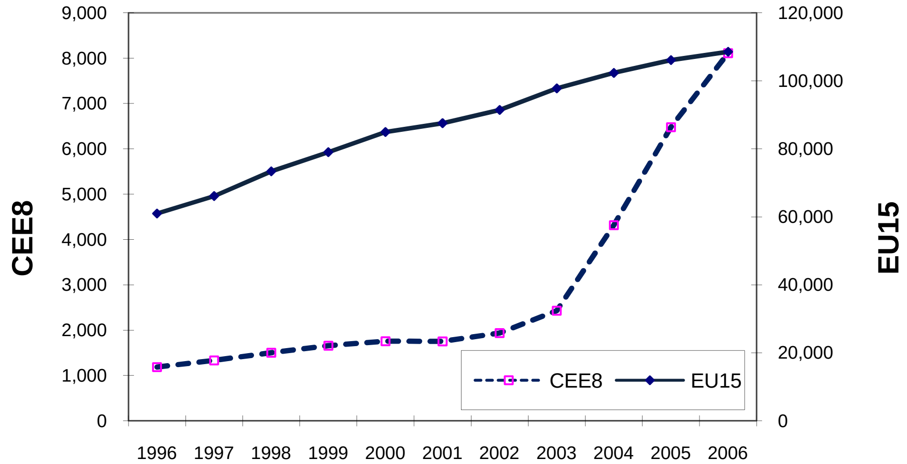

Figure 2. Number of passengers (thousands) in a year, on routes between UK and CEE-8 and between UK and EU15.
Source: UK Department for Transport.

A good example of expansion in number of routes before and after the enlargement of the EU and SEAM is Poland. According to data from the UK CAA, in 2000 there were only 5 scheduled air routes between the UK and Poland. In 2006 there were already 27 scheduled services that linked 12 UK airports with 12 Polish cities. This can be related to large migration from Poland to the UK after the EU enlargement.

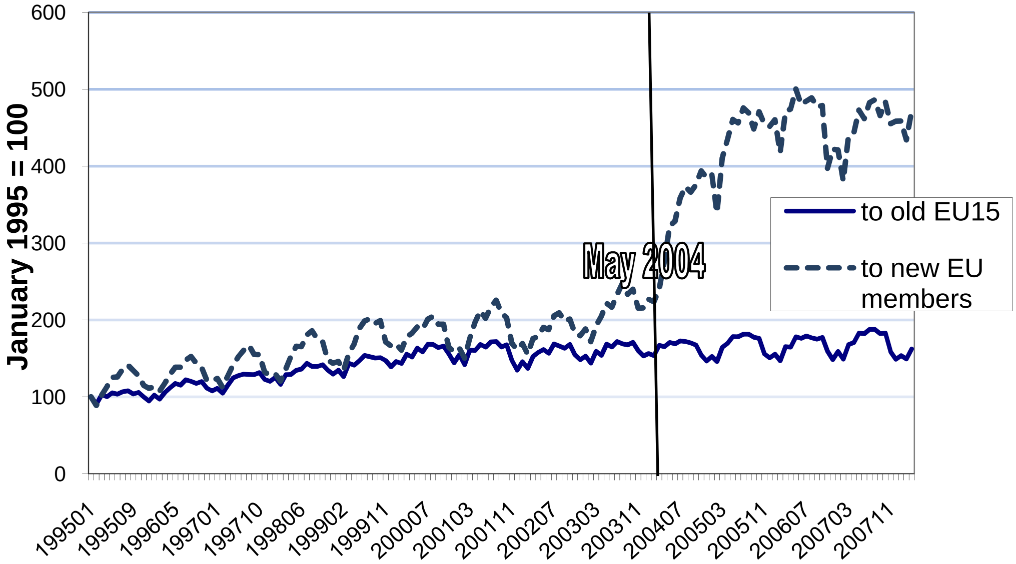

Figure 3. Number of scheduled flights from the UK (10 main airports) to the new and old EU member countries (January 1995=100 in both category).
Source: UK CAA dataset

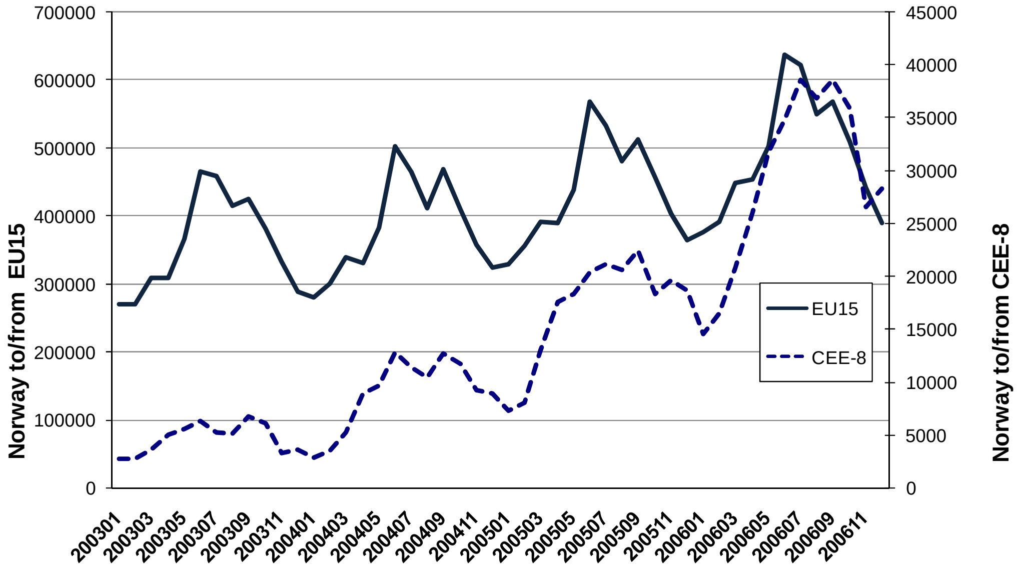

Figure 4. Number of passengers on routes from Norway to the EU.

Source: AVINOR dataset

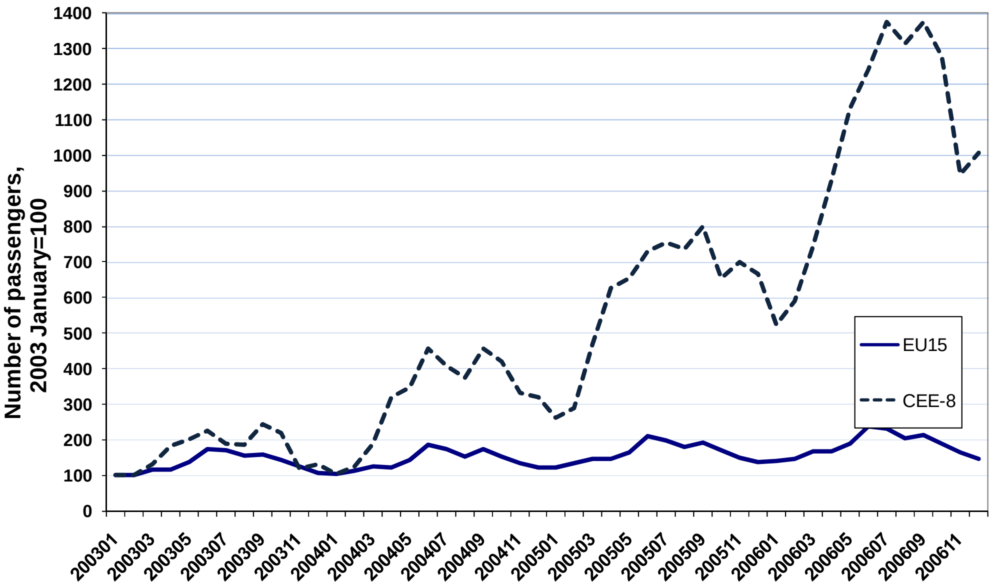

Figure 5. Index of number of passengers on routes from Norway to the EU15 and to new members of the Single Aviation Market. January 2003 is taken as 100 in both categories.
Source: AVINOR dataset

Figures 4 and 5 reveal that the number of passengers has since year 2004 grown more rapidly also on routes from Norway to the new members of the SEAM than on routes to the EU15. Interestingly, although there is an increase already in 2004, the most significant growth of traffic from Norway to the eight studied CEE countries takes place in 2006.

Note that, Figures 1 to 5 indicate some similarity of pre-enlargement trends of traffic from UK and Norway to CEE with the traffic to the EU15. One of the next steps is to perform a formal test to see whether the pre-treatment trends are indeed similar.

This chapter uses route and country-pair level panel datasets of number of passengers on routes originating from the UK and from Norway. UK monthly data of number of passengers are taken from the website of the UK Civil Aviation Authority (CAA). These cover routes from UK to the rest of the world for period June 2001 to April 2008. Norwegian monthly data of number of passengers on international routes originating from Norway are obtained from AVINOR. AVINOR is a Norwegian company that owns most airports in Norway and also collects aviation sector data. The Norwegian dataset was available for period from January 2003 to December 2006. It has monthly frequency and covers all international routes originating from Norway. This route level information of UK and Norway is then aggregated into corresponding country-pair level datasets. I use the sub-sample of routes and country-pairs from UK and Norway to countries of the EU25 (i.e. to the members of the EU after the 2004 accession round).

In addition to data on number of passengers, also some additional country-pair (or destination) level control variables are used as control variables. These include distance between origin and destination, real GDP growth rate, trade openness (ratio of export and import to GDP), size of the population of the destination country. Distances between countries are from the CEPII database of geodesic distances. This database is available from CEPII website. Real GDP and real GDP growth and population are yearly figures taken from Eurostat. Trade openness is taken from the World Bank World Development Indicators Database.

4. Methodology

4.1 Difference-in-Difference approach

The methods employed here to study how the enlargement of the European Single Aviation Market and the EU to the new members in May 2004 affected airline traffic include the difference-in-difference (DID) approach and its recent extension – synthetic control method. The latter deals with some potential shortcomings of the DID approach.

As a first exercise I use the standard version of the DID approach (see e.g. Meyer 1995, Angrist and Pischke 2009), based on monthly data of number of passengers on route or country-pair as the outcome variable. As I work with data from more than two periods, I employ the regression version of the DID estimator.

The treatment group is here defined as the routes between UK and these new CEE members of the EU that acceded to the EU and European Single Aviation Market in May 2004. The control group is routes from UK to the 'old' 15 EU members countries, as these routes did not experience any such changes in the competitive environment.

Treatment is here defined as accession of new member countries to the SEAM in 2004. However, at the same time other aspects of EU enlargement have affected the aviation sector—especially, the free movement of people within the EU and opening of labour markets for people from new members in some EU countries. These meant an increase in demand for aviation services on routes to EU countries and especially to the UK and Ireland (which were the first to open up their labour markets). Therefore, my empirical implementation includes a study of the effect of the SEAM enlargement based on Norwegian international air traffic data, as Norway is a member of the SEAM but not of the EU.

The first estimated DID equation is the following:

$$y_{igt} = \lambda_t + \alpha_g + \beta x_{gt} + u_{igt} \,, \qquad (1)$$

where i indexes the cross-section unit (country-pair or route[12]), g indexes the group (treatment or control group), t time period (month). Outcome variable y_{igt} is the log of number of passengers[13]. The model has a full set of time effects λ_t, group effects α_g, the policy variable x_{gt} that is defined to be 1 for units and time periods subject to the policy, and cross-section unit specific error term u_{igt}. The coefficient β in Equation (1) gives us the standard difference-in-difference estimate of the treatment effect of liberalisation on the outcome variable y_{igt}. The year effects capture common period-specific shocks, group effects show permanent difference between the outcome of the treatment and control group.

Alternatively, the DID regression is specified with cross-section unit specific fixed effects:

$$y_{igt} = \lambda_t + \alpha_i + \beta x_{gt} + u_{igt}, \qquad (2)$$

where α_g is replaced by country-pair or route specific fixed effect α_i. Note that the standard errors in all estimated specifications will be clustered by the cross-section unit (i.e. either country-pair or route) to deal with concerns with serial correlation (Bertrand et al. 2004, Besley and Burgess 2004).

This DID estimator given in Eq. (1) or (2) is based on strong identifying assumptions. In particular, the standard DID estimator requires that, in the absence of the treatment the average outcomes for the treated and control group would have followed parallel trends over time. Only in that case does the simple DID approach take out the selection bias in Eq. (1). However, in practice, differences in observed or unobserved characteristics can create nonparallel outcome dynamics for the treated and untreated groups (e.g. Meyer 1995).

Based on data from the pre-treatment period one can get some idea whether the trends of these two groups could be also different in the after-treatment period. Using pre-treatment data one can apply a two-period DID estimator:

$$\Delta y_i = \mu + \alpha D_i + \varepsilon_i, \qquad (3)$$

where the dependent variable is constructed as the differences in the outcome variable for route i between two pre-treatment periods (Abadie 2008). Variable D_i indicates the membership of the treatment group (routes to the new member countries). The simple t-test of hypothesis $\alpha = 0$ in Eq. (3) is a test of the common (pre-treatment) trend assumption.

[12] Route is an airport-pair.

[13] As a robustness test I use also revenue passenger kilometres (number of passengers*kilometres flown) instead.

If there are observable variables that affect treatment and control group differently, one can account for that by including these country-pair/route specific covariates (Z_{igt})[14] into analysis as control variables:

$$y_{igt} = \lambda_t + \alpha_g + \beta x_{gt} + Z_{igt}\gamma + u_{igt} \qquad (4)$$

Then the identification assumption is that, apart from the control variables Z_{igt}, there are no other forces affecting the treatment and control groups differentially before and after treatment. The variables in vector Z_{igt} have been chosen based on earlier literature on the determinants of passenger traffic (e.g. Piermartini and Rousova 2008). These include the distance between countries in the country-pair, real GDP of the destination country (other than UK and Norway), trade openness (ratio of export and import to GDP), size of the population of the destination country.

Finally, a further robustness check on the DID approach adds, in addition to unit-fixed effects α_i and control variables Z_{igt}, also country-pair (or group) specific time trends to the controls (as e.g. in Besley and Burgess 2004). In that case I estimate:

$$y_{igt} = \lambda_t + \alpha_i + c_i t + \beta x_{gt} + Z_{igt}\gamma + u_{igt}, \qquad (5)$$

where c_i is a country-pair (or group) specific trend coefficient multiplying the time trend variable, t. This allows treatment and control units to follow different linear trends. It is important to see if the estimated effects of interest stay similar after inclusion of these trends[15].

4.2 Synthetic Control Method for Comparative Case Studies

Abadie, Diamond and Heinmueller (2007), building on the original approach of Abadie and Gardeazabal (2003), have recently developed a synthetic control method (SCM) to estimate treatment effects in comparative case studies. It is an extension to the standard DID analysis, that relaxes the strong assumptions of the traditional DID approach by allowing the effects of unobservable confounding factors to vary with time. I.e. it addresses the endogeneity problem caused by the existence of unobservable heterogeneity of studied units. It is a useful method especially at aggregate level (e.g. country) analysis when number of observations and number of treated and control units is small (or when there is just one treated unit).

[14] One can also include the interaction terms between the control variables and group identifiers.

[15] For example, in Besley and Burgess (2004) study about the effets of labour regulations on performance of firms, the inclusion of cross-section unit specific trends elimiminates the treatment effect found with standard DID approach.

Abadie et al. (2007) stress that in comparative case studies performed at aggregate level (incl. country, region, firm level) there is no sample-based estimation uncertainty. The effect of policy change is measured based on information of the entire population (country, firm) and the aggregate is measured without error. They concentrate instead on another source of uncertainty in comparative case studies—uncertainty related to the choice of the control group[16].

The SCM gives a way to select a synthetic control group based on data of a number of potential controls. Whereas often the choice of the most suitable controls is done informally, Abadie et al. (2007) provide a formal way to build a most appropriate control group, in terms of the similarity of its characteristics to the treatment group in the absence of treatment. Synthetic control is found as a weighed combination of potential control units (e.g. country-pairs not affected by the EU and the SEAM expansion) that most closely approximates the relevant pre-treatment characteristics (and trends) of unit(s) affected by the treatment.

This synthetic control can be used after the treatment to approximate the counterfactual situation of the treated unit(s)—if there had been no policy change (treatment). This can be done by comparison of differences in trends of the outcome variable after treatment between the treated unit and the synthetic control unit

Abadie et al. (2007) start with assumption that there is a panel $J+1$ of units (e.g. countries) over T periods. Only unit *i* undergoes the treatment[17] at time T_0, whereas the remaining J potential control units remain untreated. The treatment effect for this unit *i* at time *t* is:

$$\tau_{it} = Y_{it}(1) - Y_{it}(0) = Y_{it} - Y_{it}(0) \qquad (6)$$

where $Y_{it}(l)$ denotes the potential outcome: $Y_{it}(1)$ outcome if the unit *i* is treated at time T_0, $Y_{it}(0)$ if it is not treated. Our aim is to estimate the vector $(\tau_{i,T_{0+1}} ..., \tau_{i,T})$, i.e. during the after-treatment period $t > T_0$. This means that we have to estimate the missing counterfactual $Y_{it}(0)$, as only the Y_{it} is observed for the treated unit. Abadie et al. (2007) identify the treatment effects in (6) in the case of the following general model for potential outcomes:

$$Y_{it}(0) = \lambda_t + \gamma_t Z_i + \delta_t \mu_i + \varepsilon_{it} \ , \qquad (7)$$

[16] Often the standard approach is to use time series data in order to study the effects of a policy on some aggregate level variable. Using only data of the unit that was affected by the policy change has its disadvantages, as it does not use a control group. Suitable control groups would account for aggregate level changes in the outcome variable between pre- and after-treatment periods that are due to other factors than the change in policy.

[17] I.e. if there are several units undergoing the treatment, one can estimate the effects separately on all these units. Or, one can aggregate the treated units into one treated unit (e.g. CEE region) and use that in the analysis.

$$Y_{it}(1) = \lambda_t + \tau_{it} + \gamma_t Z_i + \delta_t \mu_i + \varepsilon_{it}\,, \qquad (8)$$

where λ_t is now an unknown time-specific common factor that is constant across units, Z_i is a vector of observed covariates that are not affected by the policy change[18], γ_t is a vector of unknown parameters, δ_t is a vector of unobserved common factors, μ_i is (in our case) a country-pair or route specific unobservable, and ε_{it} are unobserved transitory shocks with zero mean for all *i*. This model in Eq. (7) and (8) generalizes the standard DID model (as given, for example, in Eq. (2)). Whereas the standard DID model restricts the effect of unobserved factors to be constant over time, this more general model allows them to vary with time.

Next, Abadie et al. (2007) define a $J \times 1$ vector of weights $W = (w_1,....,w_J)'$ such that $w_j \geq 0$ and $\sum w_j = 1$. Every value of the vector *W*, i.e. a weighted average of control units, is a potential synthetic control for the treated unit (e.g. country-pair) *i*. Then they define $\overline{Y}_j^k = \sum_{s=1}^{T_0} k_s Y_{js}$ as a generic linear combination of pre-treatment outcomes. They show that, as long as we can choose *W** so that (for every $t < T_0$):

$$\sum_{j=1}^{J} w_j^* \overline{Y_j^k} = \overline{Y}_i^k \text{ and } \sum_{j=1}^{J} w_j^* Z_j = Z_i\,, \qquad (9)$$

then $\hat{\tau}_{it} = Y_{it} - \sum_{j=1}^{J} w_j^* Y_{jt}$ is an unbiased estimator of τ_{it}. In practical application of the SCM, the synthetic control *W** is selected so that the condition (9) above holds approximately: the difference between the vector of pre-treatment characteristics of the treated country and the vector of pre-treatment characteristics of the potential synthetic control is minimised with respect to *W**.

Note that the weights *W** identify these units that are used to estimate the counterfactual. So, in our case, SCM identifies which country-pairs make up the synthetic control unit.

In the case of comparative case studies the researcher observes a time series for a particular unit (treatment unit) and often has a limited number of potential control groups. Large sample inferencial techniques are often not suitable in such case. But some information about significance of the results is still needed.

[18] The fact that Z_i should be chosen so that it is not affected by intervention means that the researcher needs to use pre-treatment values of the variables (then also ruling out anticipation effects) and values of these variables from the after-treatment period that are not affected by intervention.

Abadie and Gardeabazal (2003) and Abadie et al. (2007) address this inference problem by conducting a number of placebo treatment studies. They apply SCM, similarly to the treated unit, also on every non-treated unit available in the sample. This is similar to permutation tests and it enables us to assess whether the treatment effect estimated by the SCM for the affected unit is large relative to the effect estimated for a randomly chosen unit. It answers the question: *How often would we get results of this magnitude if the researcher had chosen a unit at random for study instead of the treated unit*? If the placebo studies generate estimates of placebo 'treatment' effects of similar magnitude to our estimated actual treatment effect, then we would interpret this as lack of evidence of a significant treatment effect due to the change in policy.

Abadie et al. (2007) say that this inferencial exercise is exact, as regardless of the amount of available comparison units, time periods, or whether the data are aggregate or individual, it is possible to calculate the exact distribution of the estimated effect of the placebo interventions. The stages of the inferencial exercise of finding out the significance of the results are as follows: at first the SCM is implemented based on the true treatment unit. Then a series of placebo studies is conducted iteratively applying the SCM for all the potential comparison units. In each iteration the status of 'treatment unit' is reassigned to one of the control units. It is as if one assumed iteratively that units in the control pool would have had similar policy change as the actually treated unit at a specific period. At each iteration the estimated 'treatment' effect associated with each placebo test is computed (the gap between the values of outcome variable of the 'treated' unit and its synthetic counterpart). The iterative process provides us with a distribution of estimated placebo 'treatment' effects for units where no policy change occurred. These placebo results can then be compared to the actual treatment effect[19].

In addition to the placebo studies, the goodness of results can be assessed based on pre- and post-treatment mean square prediction error (MSPE). The mean-squared-prediction error is the average of sum of squared differences in the outcome variable (and its predictors) between the treated unit and its synthetic counterpart. The pre-treatment MSPE, and its comparison with MSPE from placebo studies, indicates how well the SCM succeeded in finding a synthetic control that is similar to the treated unit in terms of the pre-treatment outcome and its predictor variables. Sometimes, if the treated unit is very different from all control units in terms of the values of its outcome variable and its predictor variables, the

[19] An alternative is to use the time dimension of the data to produce placebo studies. In this case the dates of placebo policy changes would be set at random.

SCM will not succeed in reproducing well a similar synthetic control using the convex combination of potential control units. This will be then reflected in lack of fit in the synthetic control's dynamics of the outcome variable during the pre-treatment period, and correspondingly in high values of the MSPE.

Using information of pre- and post-treatment MSPE from the placebo runs we can additionally evaluate the significance of the (post-treatment) gap between the outcome variable of the treated unit and its synthetic counterpart relative to the placebo cases. For that we can study the distribution of the ratios of post- to pre-treatment MSPE, using MSPEs from placebo runs and the treatment run of the SCM. In the case of significant treatment effect, the placebo studies should have a lower post/pre-treatment MSPE ratio than in the case of the unit actually affected by the policy change[20].

5. Results

5.1 Difference-in-difference analysis

5.1.1 Difference-in-difference results based on UK international passenger traffic data

This section employs DID analysis to study how the enlargement of the European Union and European Single Aviation Market in May 2004 affected number of passengers travelling on scheduled flights between UK and the CEE-8. I also check whether the results are similar if revenue passenger kilometres (RPK) is used as an outcome variable instead. RPK is equal to number of paying passengers times number of kilometres flown. It accounts for differences of flight distances of different passengers.

I use monthly panel data of routes between the UK and the rest of the Europe, from June 2001 to April 2008. As passenger traffic data exhibits significant seasonality, I use in this Section seasonally adjusted time series to avoid mixing up the seasonal effects and the policy effect.

Number of passengers travelling on a country-pair or route and RPK are output measures of airlines active on that route. I expect that the liberalisation of air transport sector (enlargement of the SEAM) would increase the number of passengers (and therefore also RPK) on a route or a country-pair. Liberalisation enables more competition – by making it easier for new airlines to enter the market and toughening also competition among incumbent airlines. This increase in competition should lower airfares, which would lead to increased

[20] For example, in Abadie et al. (2007) this ratio was 130 in the case of the state of California, where a change in anti-tobacco policy took place. No control state among the other 38 US states studied, where the policy was not implemented, achieved such high ratio. Therefore if one were to assign the intervention at random in their data, the probability of finding a post/pre-treatment MSPE ratio as large as that of California would have been only 1/39 = 0.026 (Abadie et al. 2007).

demand for air travel and an increase in passenger volume. Again, in the case of UK this effect of enlargement of the SEAM cannot be differentiated from the overall effect of the EU enlargement (the positive demand shock).

Equations (1), (4) and (5) from Section 4 are estimated with OLS, with group specific fixed effects. However, the results are similar if country-pair or route-specific fixed effects are used instead. Table 1 uses country-pair level data of 22 country-pairs (14 from the UK to the 'old' EU members, 8 from UK to the new Central and Eastern European EU members). Table 2 uses a much more detailed data at route level. Columns 1 and 5 in Table 1 show the results from standard DID regression, Columns 2 and 6 allow also for different group (treatment or control) specific time trends, Columns 3 and 7 include country-pair specific control variables[21] (note that this specification estimates in fact a simplistic gravity model based on bilateral passenger traffic data). Finally, Columns 4 and 8 include both country-pair specific controls and group-specific time trends.

As expected, Tables 1 and 2 show that country-pairs (Table 1) and routes (Table 2) going from UK to the new EU members have significantly lower number of passengers (see the coefficient of *NewEUmember dummy*) than these from the UK to the Western Europe.

The average treatment effect of policy change is given by the coefficient of the *Policy dummy*. The coefficient of this variable is positive and statistically significant in both tables above, indicating strong positive treatment effect of enlargement of the Single Aviation Market and the EU on number of passengers and RPK. However, the size of the estimated effect on number of passengers or RPK varies considerably depending on the specification of the DID model. Inclusion of country-pair specific controls changes the estimated treatment effect only by a limited extent (compare Column 1 and 3, or 5 and 7 in Table 1). What matters the most is inclusion of separate group-specific time trends. This allows treatment and control units to follow different trends. Notably, now the estimated positive effect of the EU and SEAM enlargement is about 40 per cent lower than otherwise. Evidently, this is due to the fact that air traffic to and from the accession countries was growing somewhat faster than elsewhere anyway. Control for this trend difference therefore drives the estimated effect down.

[21] These characteristics are the distance between countries (from CEPII database), size of population (yearly data) of the destination country, level of GDP per capita (yearly data) and trade openness (ratio of exports plus imports to GDP) of the destination country (yearly data).

Table 1. Difference-in-difference regression results based on monthly UK country-pair level data

	1	2	3	4	5	6	7	8
Dep. var.:	*ln(number of passengers)*	*ln(number of passengers)*	*ln(number of passengers)*	*ln(number of passengers)*	*ln(RPK)*	*ln(RPK)*	*ln(RPK)*	*ln(RPK)*
NewEUmember dummy	-3.005***	-3.205***	-2.065**	-2.263***	-2.435***	-2.633***	-2.192***	-2.414***
	(0.596)	(0.615)	(0.721)	(0.743)	(0.571)	(0.583)	(0.776)	(0.796)
Policy dummy (i.e. NewEUMember*Post-2004May)**[A]**	**1.153*** (0.165)**	**0.702*** (0.101)**	**1.132*** (0.173)**	**0.695*** (0.091)**	**1.142*** (0.161)**	**0.697*** (0.1)**	**1.191*** (0.177)**	**0.699*** (0.087)**
Constant	12.434***	12.497***	11.24***	11.5***	19.146***	19.208***	24.86***	24.99***
	(0.32)	(0.322)	(0.484)	(0.491)	(0.338)	(0.339)	(6.097)	(6.093)
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES
Country-pair specific controls	NO	NO	YES	YES	NO	NO	YES	YES
Group specific trends	NO	YES	NO	YES	NO	YES	NO	YES
R^2	0.485	0.487	0.843	0.845	0.36	0.362	0.794	0.796
Prob>F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
No. of Observations	1800	1800	1800	1800	1800	1800	1800	1800

Notes: 22 country-pairs. Method: OLS. *** - significant at 1 per cent level, ** - significant at 5 per cent level, * - significant at 10 per cent level. Robust standard errors, clustered at country-pair level, are in parenthesis. Seasonally adjusted monthly country-pair level data of number of passengers or RPK is used.

A. Policy dummy is equal to 1 for routes to new EU member countries for periods starting from May 2004.

Table 2. Difference-in-difference regression results based on UK route-airline level data

	1	2
Dep. var.: *ln(number of passengers)*	UK-Europe	London-Europe
NewEUmember dummy	-0.353***	-0.462***
	(0.126)	(0.111)
Policy dummy (i.e. NewEUMember*Post-2004May)[A]	**0.239*** (0.12)**	**0.157*** (0.071)**
Constant	8.668***	9.413***
	(0.69)	(0.787)
Full set of time dummies included	YES	YES
Prob>F	0.000	0.000
No. of Observations	48,529	15,723

Notes: Method: OLS. *** - significant at 1 per cent level. Robust standard errors, clustered at route level, are in parenthesis.
A. Policy dummy is equal to 1 for routes to new EU member countries for periods starting from May 2004.

Based on country-pair level results that include separate group specific trends and country-pair specific controls (the most preferred specification), we can see from Table 1 (Column 4 and 8) that on average the enlargement of the EU and European Single Aviation Market resulted in 100 per cent[22] increase in airline traffic on country-pairs between the UK and Central and Eastern Europe if compared to the counterfactual situation. As evident from Annex 1, the country-pair level result is relatively robust to inclusion or exclusion of some countries from the treatment and control group. The effect on RPK is, in the case of UK data, very similar to the effect on number of passengers (Columns 5-8 in Table 1).

The impact at a lower level of aggregation, on route level (Table 2) is much smaller than in Table 1. This is because in the case of route-level data my analysis looks at effects on already existing routes, excluding any new ones. The country-pair level analysis includes also expansion in terms of number of routes to the Eastern Europe. However, one of the most visible characteristics of post-2004 development in the aviation sector of the new member states of the EU has indeed been the increase in number of routes.

As evident from Annex 2, the treatment effect of May 2004 on number of flights on a country-pair is also positive. However, the magnitude of the effect on number of flights is smaller than the effect on number of passengers (see Table A1 in Annex 2). Note that the effect of EU and SEAM enlargement on routes from London is smaller

[22] I.e. calculated as: exp(0.695) – 1.

than based on all routes from UK (see Table2). Hence, the effect of enlargement is larger on routes originating from outside London airports.

The main results in this and the next Section are also robust to various modifications of equation (1), (4) and (5):

(i) inclusion of country-pair/route specific, not treatment/control group specific, fixed effects;

(ii) allowing γ in Equation (5) to be different for treatment and control units.

5.1.2 Difference-in-difference results based on Norwegian international passenger traffic data

Similar analysis has been implemented in the case of routes between CEE and Norway. Period of study covers in this case monthly data from January 2003 to December 2006 (as earlier monthly route level data was not available for Norway). I investigate routes from Norway to the EU25 (i.e. EU after the 2004 accession round). The treatment group consists of routes to countries that became part of the SEAM in 2004; the control group consists of routes to countries that were SEAM members already before 2004.

The results in Table 3 and Table 4 show that, generally, country-pairs/routes going from Norway to the new SEAM members have lower number of passengers and RPK than country-pairs/routes to the Western Europe (the coefficient of *NewSEAMmember dummy*).

The average treatment effect of a change in policy is again given by the coefficient of the *Policy dummy*. The coefficient of this variable is positive in Table 3 and also in Column 1 of Table 4, indicating a large positive treatment effect of SEAM enlargement on number of passengers (and RPK). However, in the case of routes originating from Oslo (Column 2 in Table 4) this coefficient is still positive but not statistically significant. Therefore, the positive effect of SEAM enlargement seems to take place on routes outside Oslo airport. This and similar result based on UK data are consistent with the standard entry strategy of the LCCs. It is well known that the LCCs tend to avoid using main large airports. That way they cut the airport charges and avoid congestion related problems (Doganis 2006).

Table 3. Difference-in-difference regression results based on monthly Norwegian country-pair level data

	1	2	3	4	5	6	7	8
Dep. var.:	*ln(number of passengers)*	*ln(number of passengers)*	*ln(number of passengers)*	*ln(number of passengers)*	*ln(RPK)*	*ln(RPK)*	*ln(RPK)*	*ln(RPK)*
NewSEAMmember dummy	-3.326***	-3.677***	-2.496*	-2.625*	-2.844***	-3.172***	-1.666	-1.699
	(0.741)	(0.787)	(1.21)	(1.233)	(0.577)	(0.608)	(1.224)	(1.148)
Policy dummy (i.e. NewSEAMmember*Post-2004May)[A]	**1.65*** **	**0.712***	**1.71*** **	**0.631***	**1.008*** **	**0.597***	**1.134*** **	**0.577***
	(0.497)	**(0.391)**	**(0.487)**	**(0.322)**	**(0.309)**	**(0.32)**	**(0.311)**	**(0.33)**
Constant	8.231***	8.245***	11.24***	11.5***	15.763***	15.788***	9.562***	9.524***
	(0.612)	(0.613)	(3.854)	(3.991)	(0.474)	(0.476)	(2.417)	(2.63)
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES
Country-pair specific controls	NO	NO	YES	YES	NO	NO	YES	YES
Group specific trends	NO	YES	NO	YES	NO	YES	NO	YES
R^2	0.4	0.424	0.673	0.687	0.406	0.424	0.58	0.607
Prob>F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
No. of Observations	1010	1010	1010	1010	1010	1010	1010	1010

Notes: Method: OLS. *** - significant at 1 per cent level, ** - significant at 5 per cent level, * - significant at 10 per cent level. Robust standard errors, clustered at country-pair level, are in parenthesis. Seasonally adjusted monthly country-pair level data of number of passengers or RPK is used.

A. Policy dummy is equal to 1 for routes to new SEAM member countries for periods starting from May 2004.

Table 4. Difference-in-difference regression results based on Norwegian route level data

Dep. var.: *ln(number of passengers)*	1 Norway-Europe	2 Oslo-Europe
NewSEAMmember dummy	-1.1***	-0.148
	(0.189)	(0.259)
Policy dummy (i.e.	**0.755*** **	**0.336**
NewSEAMMember*Post-2004May)[A]	**(0.211)**	**(0.296)**
Constant	7.078***	6.667***
	(0.197)	(0.353)
Full set of time dummies included	YES	YES
R^2	0.015	0.016
Prob>F	0.000	0.000
No. of Observations	7081	3241

Notes: Method: OLS. *** - significant at 1per cent level. Robust standard errors, clustered at route level, are in parenthesis.
A. Policy dummy is equal to 1 in the case of routes to the new SEAM member countries for periods starting from May 2004.

As in the case of UK data, the point estimate of the treatment effect is different depending of the DID identification strategy: adding group specific time trends to the list of controls lowers the estimated effect a lot. Based on Column 4 and 8 in Table 3 we can see that over the period studied the enlargement of the European Single Aviation Market resulted in a 88 per cent[23] increase in number of passengers on country-pairs between Norway and Central and Eastern European countries if compared to the control group of within-EU15 country-pairs[24]. The corresponding figure if RPK is used as dependent variable is 78 per cent. The results vary a bit depending on which countries are included or excluded from the treatment and control group (see Annex 1). An interesting finding is that the effect on RPK is smaller than the effect on number of passengers. This is because the growth on flights to the CEE has concentrated more on closer CEE countries. Such concentration on closer destinations after 2004 does not take place in UK.

As Norway is not part of the EU but is a part of the SEAM, we can argue that my findings for Norway should primarily show the effects of aviation sector's deregulation. These effects are less likely to be due to the large demand shock than in the EU15 countries, like due to the introduction of free movement of people in the EU15 or opening up of the labour market for Eastern European immigrants. However, it has to be admitted that the demand shock may still play some role, as this is the

[23] This is found as: exp(0.631)-1
[24] See Annex 3 for similar analysis based on yearly passenger volume data of country-pairs from Sweden to the rest of Europe.

period when income of people in Central and Eastern Europe grew very rapidly, thus resulting in an increase in their demand for air travel.

As outlined in methodology section, one needs to formally test whether the trends of traffic figures of these two groups differed already before the enlargement of the SEAM. I use pre-treatment data and apply two-period DID estimator to that data. The simple *t*-test of hypothesis $\alpha = 0$ in Eq. (3) is a test of the common (pre-treatment) trend assumption.

A short summary of the results of this common (pre-treatment) trend test, based on UK and Norwegian data of airline traffic is as follows:

1) Using UK data on number of passengers or RPK we can reject the hypothesis $\alpha = 0$, at 95 per cent level of confidence. Hence the common (pre-treatment) trend assumption (as assumed in Eq. (1) or (2)) does not hold. However, as a number of Figures from Section 2 indicated, these trends are in fact not very different before 2004.
2) Similarly, this common trend assumption does not hold for Norwegian data of number of passengers or RPK. We can reject the hypothesis $\alpha = 0$.
3) However, if instead of number of passenger we use number of flights as a dependent variable in Eq. (3), then based on the UK data, we cannot reject the hypothesis $\alpha = 0$. Hence, the common (pre-treatment) trend assumption holds in that case (see also Annex 2).

Due to these results, I have relied mostly on the point estimates of the treatment effect from Equation (5), i.e. the DID model with different group specific linear trends—as in Columns 4 and 8 in Table 1 and 3.

5.2 Results with the synthetic control method

5.2.1 SCM results - based on UK data of passenger numbers

We saw that the strong assumption of the DID approach does not strictly hold in the case of data of number of passengers of UK or Norway. That is, one needs to control for the possible non-parallel trends of the treated and untreated group. In order to do that in a more flexible way than in Equation (5), I use the synthetic control method (SCM). Using SCM, I demonstrate the effect of expansion of the EU and Single European Aviation Market in May 2004 on passenger traffic between UK and Poland and between UK and the aggregate region of the 8 new Central and Eastern European member states that acceded the EU in 2004 (CEE-8). Synthetic control destinations, like synthetic Poland and a synthetic CEE-8, are constructed as convex combinations of destinations (countries) from UK to the earlier members of the EU and Single European Aviation Market.

The construction of these synthetic controls is based on country-pair level data of number of passengers and some standard predictors of passenger flows. I use here UK monthly traffic data that cover the same period as in Section 4.1.1. Weighted average of Western European destinations is chosen by the SCM to resemble the values of passenger traffic and its predictors prior to May 2004 for Poland and CEE-8. My sample of potential controls includes the following ‘old’ EU destinations originating from the UK: Austria, Belgium, Denmark, Finland, France, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, and Sweden.

The country-pair level outcome variable is the monthly number of passengers of scheduled flights[25]. The predictor variables of passenger traffic in the post-treatment period are chosen based on literature on determinants of bilateral passenger traffic (e.g. Piermartini and Rousova 2008). The predictor variables used for our application, based on flights from the UK, are:

(i) number of passengers during the pre-treatment periods;

(ii) distance between the origin and destination[26];

(iii) size of population of the destination country;

(iv) trade openness (ratio of exports plus imports to GDP) of the destination country;

(v) real GDP growth rate of the destination country.

As the CEE countries have much lower GDP per capita than the Western European ones it would be impossible to find a good match based on that variable. Therefore, it has not been included in the set of air traffic predictors and the GDP growth rate of the destination country is used instead. Trade openness is additionally included as a predictor variable because of its potential effect on airline passenger traffic growth, incl. via its possible effect on GDP growth.

Table 5 shows the weights of each EU destination country in the synthetic Poland and in the aggregate synthetic CEE-8. The synthetic Poland is weighted average of Finland, Luxembourg and Greece. The synthetic CEE-8 is weighted average of

[25] Thus excluding charter flight passengers.

[26] Distances between countries are defined similarly to the studies estimating the trade gravity equation. Distances are calculated following the great circle formula, which uses latitudes and longitudes of the most important city (in terms of population).

Greece, Belgium, Finland, Germany and Luxembourg. Other countries from the pool of potential controls were assigned zero weights by the SCM.

Tables 6 and 7 compare the pre-enlargement characteristics of the actual Poland and its synthetic counterpart, and actual CEE-8 and its aggregate synthetic counterpart. The synthetic CEE-8 approximates the actual one accurately in terms of pre-enlargement passenger traffic figures, distance between countries, GDP growth rate and trade openness figures of the destination. Also in the case of Poland, the figures of actual and synthetic Poland are relatively similar, with the notable exception in terms of the size of population (see Table 6). The difference between the traffic figures of the Poland and Synthetic Poland is larger than in the case of CEE-8 as a whole and synthetic CEE-8.

Table 5. Country weights in synthetic Poland and synthetic CEE-8, estimated using UK origin-destination passenger traffic data

	Synthetic Poland	Synthetic CEE8
AUSTRIA	0	0
BELGIUM	0	0.279
DENMARK	0	0
FINLAND	0.552	0.224
FRANCE	0	0
GERMANY	0	0.122
GREECE	0.164	0.296
IRISH REPUBLIC	0	0
ITALY	0	0
LUXEMBOURG	0.283	0.078
NETHERLANDS	0	0
PORTUGAL	0	0
SPAIN	0	0
SWEDEN	0	0
Sum.	1	1

Table 6. Pre-treatment predictor and outcome means for Poland and its synthetic counterpart

	Treated	Synthetic
Monthly scheduled passengers*	41435	45051
Distance, km	1451.6	1492.9
Real GDP growth rate, %	2.5	2.53
Trade openness ((Exp+Imp)/GDP), % of GDP	50	66.6
Average population, mill.	38	4.8

*Also, pre-treatment data of each available quarter's passenger numbers, each year's GDP growth and trade openness figure was used in building the synthetic control. The averages over the whole pre-treatment period are presented here.

Table 7. Pre-treatment predictor and outcome means for CEE-8 and its synthetic counterpart

	Treated	Synthetic
Monthly scheduled passengers	181289	181605
Distance, km	1325.5	1294.1
Real GDP growth rate, %	2.39	2.31
Trade openness ((Exp+Imp)/GDP), % of GDP	85.7	81

*Also, pre-treatment data of each available quarter's passenger numbers, each year's GDP growth and trade openness figure was used in building the synthetic control. The averages over the whole pre-treatment period are presented here.

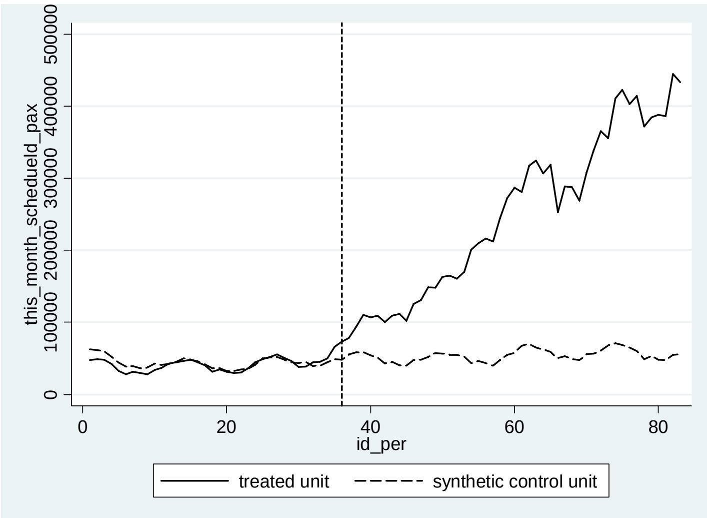

Figure 6. Trends in Scheduled Passenger numbers from UK: Destination Poland (treated unit) vs synthetic Poland.
Note: *id_per* denotes period (month). Vertical dotted line denotes May 2004.

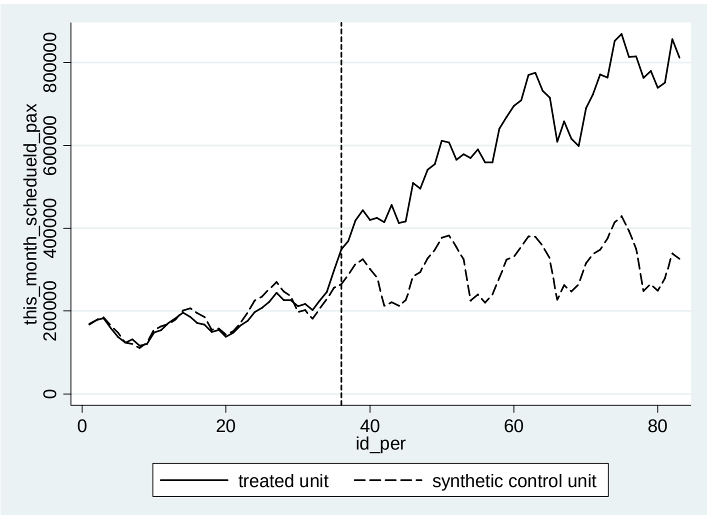

Figure 7. Trends in Scheduled Passenger numbers from UK: Destination CEE-8 vs synthetic CEE-8

Figure 6 shows the passenger traffic trajectory of UK-Poland country-pair and its synthetic counterpart for the June 2001 – April 2008 period. The synthetic Poland reproduces here a trend in pre-treatment passenger traffic that is very similar to the actual Poland. This fit in Figure 6 together with the evidence of covariate balance from Table 6 suggests that weighed average of Finland, Greece and Luxembourg may possibly serve as one relatively sensible estimate of the counterfactual passenger traffic trend that Poland may have experienced in the absence of EU enlargement.

Figure 7 shows similar results for the CEE countries as a whole. SCM succeeds here to mimic well the pre-enlargement dynamics of the CEE passenger traffic.

The estimate of the effect of enlargement of the EU and the Single European Aviation Market is given in Figure 6 and Figure 7 by, respectively, the after-treatment difference between actual Poland and synthetic Poland, and the difference between actual CEE-8 and its synthetic counterpart. In both cases the enlargement had a very large effect on the passenger traffic.

Already, a couple of months after enlargement the monthly passenger numbers between the UK and the CEE-8 countries were up by about 100,000 passengers if compared to the estimate of the counterfactual scenario. One year after the enlargement this gap had already widened to 200,000 people. In percentage terms, by December 2004 this difference between CEE-8 level of outcome variable and that of its synthetic control was already 106% of the level of synthetic CEE-8. I.e. the level volume of passengers of CEE-8 was about 2 times higher than that of the synthetic CEE-8. By December 2005 this gap had grown to 146% of the corresponding synthetic CEE-8 level[27].

This growth is remarkable, especially given that until 2003 the overall number of passengers travelling in a given month between UK and these 8 CEE countries had remained below just 200,000 people. It is also unprecedented: there was no even remotely similar growth occasion during the pre-enlargement period.

I have also implemented similar SCM study based on other CEE-8 countries. To save space I have reported here the results for Poland and CEE-8 as a whole. The results for both Hungary and Czech Republic show similar significant effects of the enlargement, these are given in Annex 4. The SCM was relatively successful in finding the synthetic controls for Poland and the CEE-8 as one aggregate unit. For very small CEE countries like Estonia, Latvia, Lithuania and Slovenia the SCM failed to find a synthetic control with good fit in the pre-treatment period (see Annex 4).

[27] Also, analysis of yearly data confirms these findings of a very large effect of the EU and the Single European Aviation Market enlargement.

However, despite the failure of implementing the SCM in these cases, UK traffic to and from these countries grew a lot after enlargement. For example, one year after enlargement monthly passenger traffic between the UK and Estonia was more than 3 times larger than before May 2004.

Statistical significance of the results

To estimate whether the effects found with SCM are statistically significant I conduct a number of placebo studies where the treatment is iteratively assigned to different old EU destination countries (as these did not face the change in regulatory framework in May 2004). The results of the placebo studies are given in next three Figures. Figure 8 and 9 show that, for example, the routes from UK to Finland and Greece did not experience any significant increase in terms of traffic around 2004 if compared to their own synthetic counterparts. In our previous section, we showed that both Finland and Greece had important shares in the synthetic controls for Poland and CEE-8.

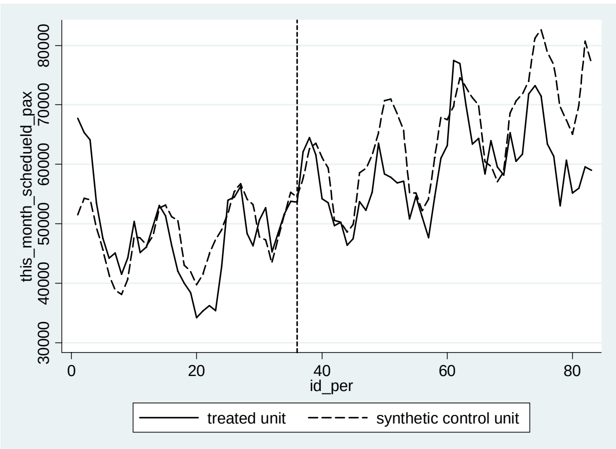

Figure 8. Placebo test – passengers travelling on the UK-Finland country-pair (solid line) and synthetic UK-Finland country-pair

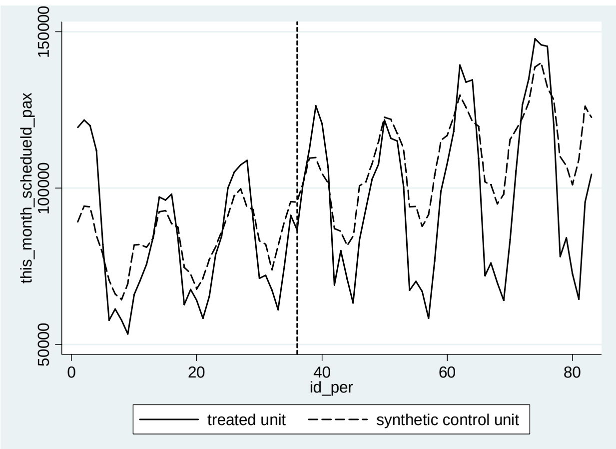

Figure 9. Placebo test – passengers travelling on the UK-Greece country-pair (solid line) and synthetic UK-Greece country-pair

The results of all placebo studies and the actual treatment study are summarised in Figure 10. It plots the gap between the outcome variable of the treated unit (CEE-8 in this case) and its synthetic control group, and shows also the similar placebo gaps[28] for 14 'old' EU destinations[29]. Note from Figure 10, that if one were to re-label the treatment status in this country(region)-pair level data of 14 control units and one treatment unit (CEE-8) at random, the probability of obtaining the results of the magnitude of those obtained for CEE-8 would be small, it is 1/15 = 0.067, i.e. 6.7 per cent. This is below the 10 per cent level typically used in standard tests of statistical significance. We can see that the gap between the treated CEE-8 and synthetic unit as a whole is far larger than the corresponding gap from placebo studies of country-pairs within the EU15. Based on lack of similar placebo gaps it can be argued that this result is statistically significant and that the deregulation on routes to the CEE-8 has resulted in a large increase of volume of passenger traffic.

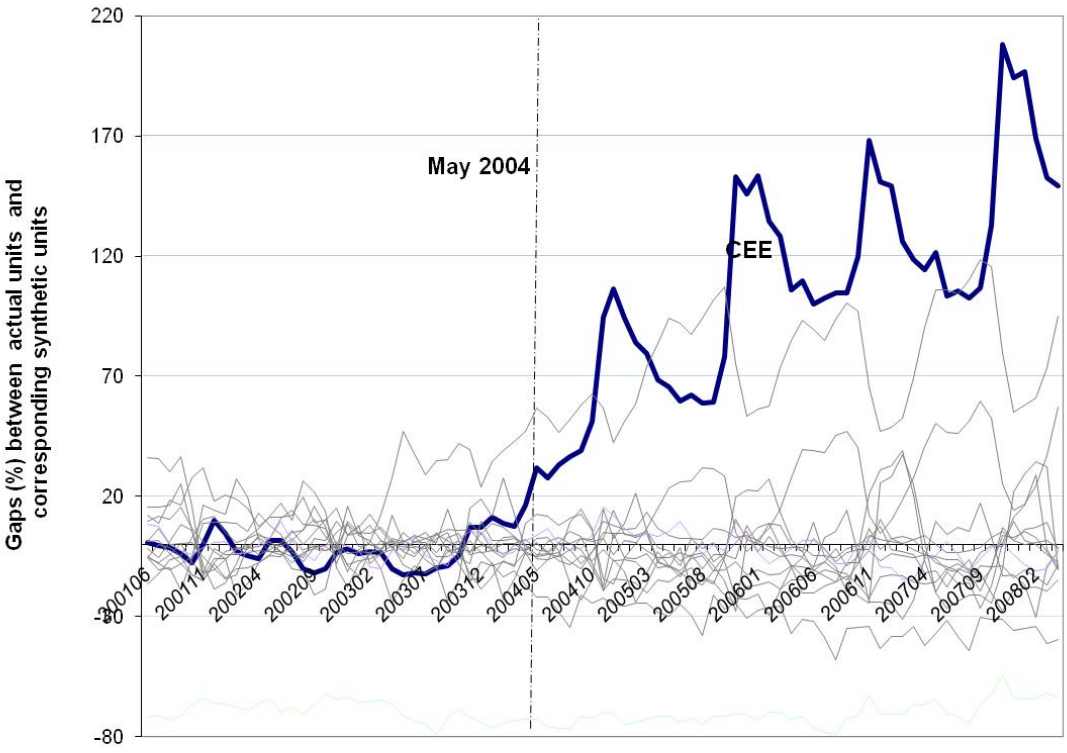

Figure 10. Difference (as per cent of the synthetic control) between actual number of passengers travelling on a country-pair and the corresponding synthetic control of the country-pair. UK-CEE8 region-pair vs placebo studies of 14 control country-pairs.

[28] For example: between actual Finland and its synthetic control, between Spain and its synthetic counterpart.
[29] It is 14 destinations as flights from UK to UK itself are excluded from analysis.

Using information of pre- and post-treatment MSPE from the placebo runs we can additionally evaluate the significance of the (post-treatment) gap between the outcome variable of the treated unit and its synthetic counterpart relative to the placebo cases. For that I study the distribution of the ratios of post- to pre-treatment MSPE, using MSPEs from placebo runs and the treatment run of the SCM. In the case of significant treatment effect, the placebo studies should have a lower post/pre treatment MSPE ratio than in the case of the unit actually affected by the policy change (Abadie et al. 2007). This is indeed the case here (see Annex 6). Based on UK data, the ratio of Post-SEAM enlargement MSPE and Pre-SEAM enlargement MSPE in the treated region pair (CEE-8 to/from the UK) is more than 70 times higher than in the case of placebo studies based on control country-pairs. As no control country-pair achieved such high ratio, if one were to assign the intervention at random in the data, the probability of finding a post/pre-treatment MSPE ratio as large as that of UK-CEE region pair would have been only 0.067 (i.e. 1/15).

5.2.2 SCM results - based on Norwegian data of passenger numbers

I show the effects of the expansion of the Single European Aviation Market with SCM based on data of international flights from Norway. In this case the synthetic CEE destinations are constructed based on data of routes between Norway and the EU15 countries. That is, the potential pool of controls is considered to be the ‘old‘ EU destinations. Data used in my analysis is passenger traffic data aggregated to country-pair level, where one end in the country-pair is always Norway. The time-frame studied here is the same as in Section 4.1.2. The predictor variables of passenger traffic are exactly the same as in previous section.

Table 8 shows the weights of each EU destination country in the synthetic CEE-8 and synthetic Poland. Now, the synthetic destination of Poland is a weighted average of Finland, Ireland and Italy. The corresponding weights were 0.035, 0.811, and 0.154. All other destinations have zero weights. The synthetic CEE-8 turned out to be a weighted average of Finland (0.1), France (0.234) and Ireland (0.666).

Tables 9 and 10 compare the pre-enlargement characteristics of the actual Poland (Table 9) or the aggregate CEE-8 (Table 10) with their synthetic counterparts. Note that this time the fit of pre-treatment characteristics is not as similar as in the case of UK data. However, the synthetic control group is still more similar to the treated group than the population-weighted average of all EU15 destinations would be.

Table 8. Country weights in synthetic Poland and synthetic CEE8, estimated using Norwegian origin-destination passenger traffic data

	Synthetic Poland	Synthetic CEE8
AUSTRIA	0	0
BELGIUM	0	0
DENMARK	0	0
FINLAND	0.035	0.1
FRANCE	0	0.234
GERMANY	0	0
GREECE	0	0
IRISH REPUBLIC	0.811	0.666
ITALY	0.154	0
LUXEMBOURG	0	0
NETHERLANDS	0	0
PORTUGAL	0	0
SPAIN	0	0
SWEDEN	0	0
Sum	1	1

Table 9. Pre-treatment predictor and outcome means for Poland and its synthetic counterpart, estimated using Norwegian origin-destination passenger traffic data

	Treated	Synthetic
Monthly scheduled passengers*	1455.4	1703.8
Distance to Norway, km	1062.1	1364.9
Real GDP growth rate, %	3.9	3.7
Trade openness ((Exp+Imp)/GDP), % of GDP	58.3	83.9
Average population, mill.	38.2	12.3

*Also, pre-treatment data of each available quarter's passenger numbers, each year's GDP growth and trade openness figure was used in building the synthetic control. The averages over the whole pre-treatment period are presented here.

Table 10. Pre-treatment predictor and outcome means for CEE8 and its synthetic counterpart, estimated using Norwegian origin-destination passenger traffic data

	Treated	Synthetic
Monthly scheduled passengers*	5374.6	5389.4
Distance to Norway, km	1056.9	1237
Real GDP growth rate, %	6.03	4.03
Trade openness ((Exp+Imp)/GDP), % of GDP	97.1	87.9

*Also, pre-treatment data of each available quarter's passenger numbers, each year's GDP growth and trade openness figure was used in building the synthetic control. The averages over the whole pre-treatment period are presented here.

Figure 11 and 12 show, respectively, the dynamics of passenger volume to/from the destinations CEE-8 and Poland, compared in both cases to their synthetic control group. The synthetic CEE-8 and synthetic Poland have quite similar pre-treatment passenger traffic dynamics if compared, correspondingly, with the actual CEE-8 and actual destination Poland. In the case of CEE-8 as an aggregate region we, again, find a large effect of the enlargement of the European Single Aviation Market in year 2004 (see Figure 11 and 13). In percentage terms, by December 2004 the difference between CEE-8 level of outcome variable and that of its synthetic control was already 80 per cent of the level of the synthetic CEE-8.

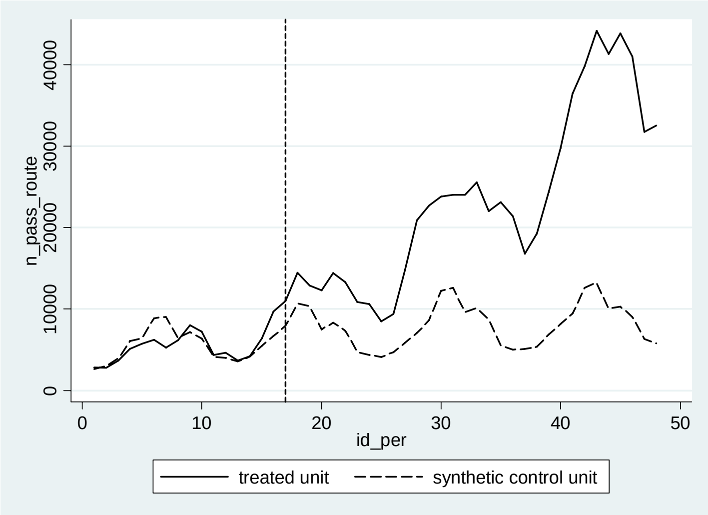

Figure 11. Trends in Passenger numbers from Norway: Destination CEE-8 (treated unit) vs synthetic CEE-8

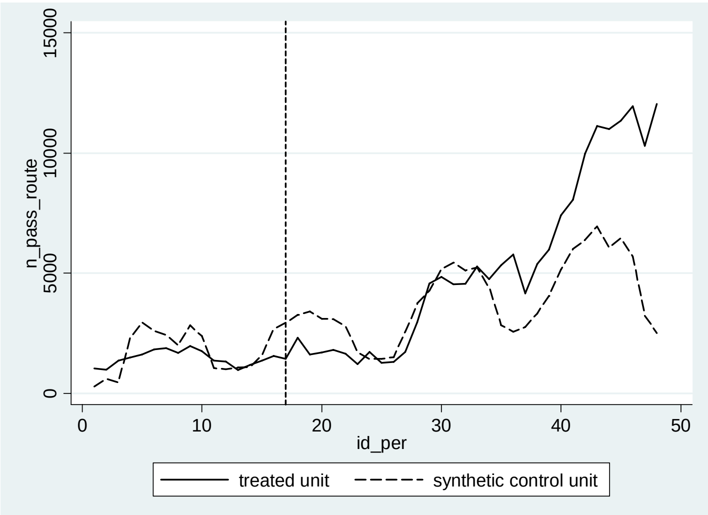

Figure 12. Trends in Passenger numbers from Norway: Destination Poland (treated unit) vs synthetic Poland

Notably, in the case of the Norway – Poland country-pair (see Figure 12), the increase in number of passengers starts one and two years after the enlargement of the Single Aviation Market. No significant treatment effect of the enlargement was found immediately after the enlargement. The results based on Norway-Poland country-pair are consistent with previous experience from liberalisation of air services in Western

Europe (in 1992 and 1997) where it took at first some years after the liberalisation before the spread of low cost airlines started (Civil Aviation Authority 2006). The volume of traffic to the CEE reacted at first more quickly in the case of the UK (see previous section). Similarly, the effects of previous large air traffic liberalisation from 1992 and 1997 were at first evident in routes to/from UK and only gradually appeared elsewhere in Europe (Civil Aviation Authority 2007, IATA 2007).

To evaluate the statistical significance of my results, I conduct a placebo study in a similar way to the last section. Figure 13 plots the gap between the outcome variable of the treated unit (CEE-8) and its control group, and also the similar placebo gaps for ‘old’ EU destinations. Again, we can see that the gap between the treated CEE-8 and synthetic unit as a whole is far larger than based on placebo studies of country-pairs from elsewhere in the EU. Based on lack of any similar placebo gaps it can be argued that this result is statistically significant and that the deregulation on routes to the CEE-8 has resulted in large increase of volume of passenger traffic.

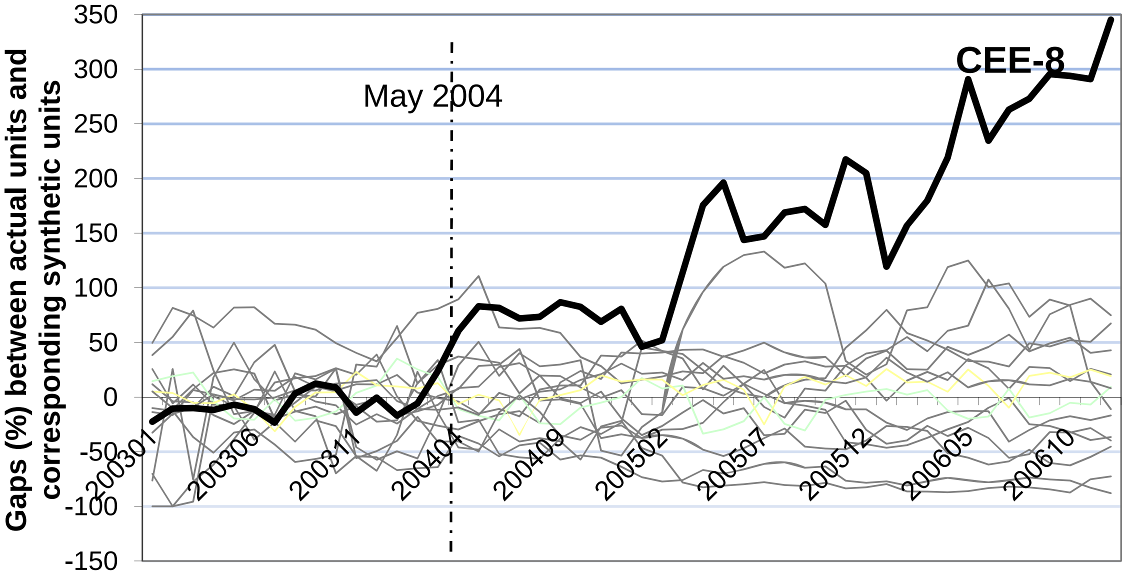

Figure 13. Difference (as per cent of the synthetic control) between actual number of passengers travelling on a country-pair and the corresponding synthetic control of the country-pair. Norway-CEE region-pair vs placebo studies of 14 control country-pairs.

Conclusions

This chapter employed an event study of the enlargement of Single European Aviation Market in 2004 and used difference-in-difference and synthetic control methods to identify its causal effect on volume of airline passengers. I demonstrate that this liberalisation event in 2004 resulted in substantial increase in number of passengers travelling between Norway and the CEE-8. Also, the SEAM and the EU enlargement together resulted in very large increase in number of passengers travelling between UK and the CEE-8.

Based on implementation of the synthetic control method we can conclude that this sizeable effect is still evident even after construction and analysis of the proxy of the counterfactual—if the liberalisation of air traffic had not taken place in 2004.

I find that after the enlargement of the SEAM, already by the end of 2004, passenger flows on affected routes grew 80-106 per cent relative to what these would have been in the absence of the enlargement. In the case of flights to/from the UK the increase in traffic materialised immediately after the enlargement of the SEAM and EU. In the case of flights to/from Norway (a member of Single European Aviation Market but not a member of the EU) the largest increases in passenger numbers started a year after May 2004.

The majority of the effects take place on routes connecting airports outside London and Oslo with CEE countries. Also, my findings about the immediate effects of the SEAM enlargement in 2004 are much larger, in percentage growth terms, than some estimates about the immediate effects of 1988/1992 deregulation (e.g. in Schipper et al. 2002).

Based on a number of placebo studies I show that the effect of actual liberalisation (on routes to the CEE-8) on passenger numbers is much bigger than the estimated corresponding placebo ‘effects’ in old EU countries. If one were to re-label the treatment status in a country(region)-pair level data of 14 control units and one treatment unit (CEE-8) at random, the probability of getting the results of the magnitude of those obtained for the CEE-8 would be small—it is 0.067, both if the UK or Norwegian passenger volume data is used.

References

Abadie, A., Diamond, A. and J. Hainmüller, 2007. "Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program," NBER Working Papers 12831.

Abadie, A., Gardeazabal, J. 2003. Economic Costs of Conflict: A Case Study of the Basque Country. *American Economic Review* 93(1): 113-132.

Angrist, J., Pischke, J. 2009. Mostly Harmless Econometrics. An Empiricist's Companion. Princeton University Press, 373 p.

Ashenfelter, O., Card, D. 1985. "Using the Longitudinal Structure of Earnings to Estimate the Effects of Training Programs", *Review of Economics and Statistics*, 67, 648–660.

Besley, T., Burgess, R. 2004. "Can Labor Regulation Hinder Economic Performance? Evidence from India," *The Quarterly Journal of Economics*, vol. 119(1), 91-134.

Billmeier, A., Nannicini, T. 2008. Do Open Transition Economies Grow Faster? Mimeo, IMF and Bocconi University.

Borenstein, S. 1989. "Hubs and high fares: dominance and market power in the US airline industry", The *RAND Journal of Economics*, vol. 20, no. 2 pp. 344-65.

Campos, N., Kinoshita, Y. 2008. Financial Liberalization, Structural Reforms and Foreign Direct Investment: An Empirical Investigation. Mimeo, August 2008,

Doganis, R., 2001. *The airline business in the 21st century*. Routledge, London.
Evidence from the Airline Industry." *The Economic Journal*, 111(473), pp. 591-619.

Dresner, M. and M. W. Tretheway 1992. "Modelling and Testing the Effect of Market Structure on Price: The Case of International Air Transport'". *Journal of Transport Economics and Policy*, 26, 171-84.

Gönenc, R.. Nicoletti, G., 2000. "Regulation, Market Structure and Performance in Air Passenger Transportation", OECD Economics Department Working Papers No. 254.

Goolsbee, A., Syverson, C., 2008. "How do Incumbents Respond to the Threat of Entry? Evidence from the Major Airlines," *Quarterly Journal of Economics*.

Groen, J. A., Polivka, A. E. 2008. "The Effect of Hurricane Katrina on the Labor Market Outcomes of Evacuees." *American Economic Review*, 98(2): 43–48.

Imbens, G., Wooldridge, J., 2007. Difference-in-Differences Estimation. NBER lecture notes: http://www.nber.org/WNE/lect_10_diffindiffs.pdf

Inter-VISTAS (2006) "The Economic Impact of Air Service Liberalization" available at http://www.intervistas.com/4/reports/2006-06-07_EconomicImpactOfAirServiceLiberalization_FinalReport.pdf

Jones, L. 2007. EasyJet: The Story of Britain's Biggest Low-cost Airline. Aurum Press Ltd.

Marin, P. 1995. "Competition in European Aviation: Pricing Policy and Market Structure." *The Journal of Industrial Economics*, XLIII(2), pp. 141-160.

Martin, R., Roma, M. and I. Vansteenkiste, 2005. "Regulatory Reforms in Selected EU Network Industries." ECB 2005 Occasional Paper no 28.

Meyer, B. D. 1995. "Natural and Quasi-Experiments in Economics", *Journal of Business & Economic Statistics*, 13, 151–161.

Morrison, S. and C. Winston, 1986. The Economic Effects of Airline Deregulation. Brookings Institution, Washington, DC.

Ng, C., Seabright, P. 2001. "Competition, Privatisation and Productive Efficiency: Evidence from the Airline Industry." *The Economic Journal*, 111(473), pp. 591-619

No-Frills Carriers: Revolution or Evolution? A Study by the Civil Aviation Authority.

2006, Civil Aviation Authority, 26 p.
Pearce, M., Smyth, M. 2007. “Airline Liberalization.” 2007, IATA Economics Briefing No 7, 43 p.
Piermartini, R., Rousova, L., 2008. Liberalisation of Air Transport Services and Passenger Traffic. ETSG conference paper, 2008 August.
Schipper, Y., P. Nijkamp, and P. Rietveld, 2002. ‘European Airline Reform: An Empirical Welfare. Analysis’, *Journal of Transport Economics and Policy*, 36, 2, 189-209.
Schipper, Y., P. Nijkamp and P. Rietveld, 2007. “Frequency competition and environmental costs: An application to European air transport liberalization.” *Socio-economic Planning Sciences,* 41, 208-23.
Symeonidis, G. 2008. "The Effect of Competition on Wages and Productivity: Evidence from the UK", *Review of Economics and Statistics,* vol. 90 (2008), pp. 134-146.

Annex 1. Robustness tests of the DID results, based on passenger volume data of UK and Norway

Here I describe the robustness of the results of my DID analysis, based on passenger volume data from UK and Norway to European Union. The estimated DID equation is Eq. (1) from Section 4. In these robustness tests here I have tried how the exclusion of some countries from the control group affects the results. Tables A1 and A2 give a short summary of these results, correspondingly, for UK and Norway. The coefficient of the policy dummy in Tables A1 and A2 shows the average treatment effect of the enlargement of the European Single Aviation Market (in the case of UK it includes the general effect of enlargement of the EU).

In the tables below, Column 1 includes all 'old' EU destination countries as a control group, Column 2 excludes Spain and Greece from the control group, Column 3 excludes also additionally Italy, France and Portugal. In the case of Norway (Table A2), Column 4 excludes additionally also UK from the control group.

Table A1. DID regression results based on country-pair level data, UK **monthly** data, June 2001- April 2008

Dep. var.: *ln(number of passengers)*	(1)	(2)	(3)
NewEUmember dummy	-3.005*** (0.596)	-2.978*** (0.289)	-2.762*** (0.297)
Policy dummy (i.e. NewEUMember*Post-2004May)[A]	**1.153***** **(0.165)**	**1.186***** **(0.148)**	**1.24***** **(0.189)**
R^2	0.485	0.465	0.414
Prob>F	0.000	0.000	0.000
No. of Observations	1,800	1,634	1,385

Notes: All regressions include also a constant term and full set of time dummies. Robust standard errors, clustered by country-pair, are in parenthesis. Method: OLS. *** - significant at 1% level.
A. Policy dummy is equal to 1 for country-pairs to new Single European Aviation market member countries for periods starting from May 2004.

The results in Table 1 show that, although the size of estimated treatment effect varies only little depending on which destination countries are included in the analysis, it is still always found to be positive and significant. Although no additional control variables are included here, the estimated model explains a large share of variation in the dependent variable based on UK data (between 41 and 48 per cent of its variation).

Table A2. DID regression results based on monthly Norwegian country-pair level data, January 2003 – December 2006

Dep. var.: *ln(number of passengers)*	(1)	(2)	(3)	(4)
NewEUmember dummy	-3.326*** (0.741)	-2.647*** (0.187)	-2.893*** (0.197)	-2.718*** (0.197)
Policy dummy (i.e. NewEUMember*Post-2004May)[A]	**1.65***** **(0.497)**	**0.978***** **(0.322)**	**1.095***** **(0.334)**	**1.096***** **(0.334)**
R^2	0.4	0.352	0.358	0.336
Prob>F	0.000	0.000	0.000	0.000
No. of Observations	1010	899	756	708

Notes: All regressions include also a constant term and full set of time dummies. Robust standard errors, clustered by country-pair, are in parenthesis. Method: OLS. *** - significant at 1% level. ** - significant at 5% level.

A. Policy dummy is equal to 1 for country-pairs to new Single European Aviation market member countries for periods starting from May 2004.

In Norwegian dataset the inclusion or exclusion of destination countries from the control group affects the size of the estimated effect—in fact, more than in the case of UK data. Still, the coefficient of the policy dummy is statistically significant in all the columns of Table 2.

Annex 2. DID regression results: effects of Single Aviation Market and EU enlargement on number of flights to/from the UK

In addition to the effects on number of passengers I check whether similar effects of SEAM and EU enlargement can be found based on data of number of flights. Monthly data of number of number of flights on a country-pair or route are taken from the UK Civil Aviation Authority (CAA). My dataset of number of flights covers routes between the UK and the rest of the Europe, from January 1995 to March 2008. Time of policy change is again May 2004.

I estimate the Equation (1) using data of number of flights. Table 1 uses country-pair level data of 24 country pairs (14 from the UK to the 'old' EU members, 8 from UK to the 8 new EU members). Table 2 uses much more detailed data of traffic at route and airline level for the same analysis.

Table A1. DID regression results based on country-pair level data

Dep. var.: *ln(number of flights)*	Coeff.	Std. Error
NewEUmember dummy	-2.127***	(0.053)
Policy dummy (i.e. NewEUMember*Post-2004May)[A]	**0.509*** **	**(0.095)**
Constant	6.884***	(0.275)
Full set of time dummies included	Yes	
R^2	0.362	
Prob>F	0.000	
No. of Observations	3996	

Notes: 24 country-pairs. Method: OLS. *** - significant at 1% level.
A. Policy dummy is equal to 1 for routes to new EU member countries for periods starting from May 2004.

Table A2. DID regression results based on route-airline level data

Dep. var.: *ln(number of flights)*	Coeff.	Std. Error
NewEUmember dummy	-1.031***	(0.015)
Policy dummy (i.e. NewEUMember*Post-2004May)[A]	**0.526*** **	**(0.022)**
Constant	4.447***	(0.057)
Full set of time dummies included	Yes	
R^2	0.084	
Prob>F	0.000	
No. of Observations	70,757	

Notes: Method: OLS. *** - significant at 1% level.
A. Policy dummy is equal to 1 for routes to new EU member countries for periods starting from May 2004.

Both tables show that country-pairs (Table 1) and routes (Table2) going from UK to the new EU members have significantly lower level of traffic than these to the Western Europe (see the coefficient of *NewEUmember dummy*).

The average treatment effect of change in policy is given by the coefficient of the *Policy dummy* in Table 1 and 2. The coefficient of this variable is positive in both tables, indicating strong positive treatment effect of EU enlargement on number of flights. In quantitative terms, it occurs from Table 1 that the enlargement of the

European Single Aviation Market (and EU enlargement in general) resulted in 66 per cent [30] increase in number of flights on country-pairs between the UK and Central and Eastern European new member countries.

The analysis in Table 1 and 2 is based data of scheduled flights. When I used similar approach to look at the effects of EU enlargement on number of charter flights, then in that case no significant effect on traffic was found.

[30] I.e. calculated as: exp(0.509) – 1.

Annex 3. Difference-in-difference analysis based on yearly Swedish passenger traffic data

Hypothesis to be tested based on Swedish passenger traffic data: Deregulation of passenger aviation sector in Europe in 2004, by the extension of European Single Aviation Market to the new EU members, caused an increase in number of passengers on routes to these Central and Eastern European countries.
Data: Swedish data of number of passengers on international flights on country-pairs originating from Sweden.
Level of aggregation: country-pair level
Period: 1999-2007
Coverage: European destination countries from Sweden
Frequency of data: yearly
Source: SIKA-Institute, Sweden

As in the case of the UK and Norway I estimate a standard DID equation as given in Section 2 in Equation (1). Table 1 below uses Swedish country-pair level data for that.

Table A1. D-I-D regression results based on Swedish country-pair level data (1999-2007)

	1	2
Dep. var.: *ln(number of passengers)*	Sweden to the rest of the EU25 (including Malta and Cyprus)	Sweden to the rest of the EU but excluding destinations Malta and Cyprus
NewSEAMmember dummy	-2.285***	-2.266***
	(0.185)	(0.203)
Policy dummy (i.e.	**0.468**	**0.551***
NewSEAMmember*Post-2004May)[A]	**(0.291)**	**(0.305)**
Constant	12.325***	12.413***
	(0.224)	(0.221)
Full set of time dummies included	Yes	Yes
R^2	0.554	0.547
Prob>F	0.000	0.000
No. of Observations	189	171

Notes: OLS results. *** - significant at 1% level, * - significant at 10% level.
A. Policy dummy is equal to 1 in the case of routes to the new member countries of the European Single Aviation Market (SEAM) for periods starting from May 2004.

Similarly to the previous results from UK and Norway, Column 1 and 2 in Table 1 show that routes going from Sweden to the new member countries of the European Single Aviation Market have significantly lower number of passengers than routes to the Western Europe (the coefficient of *NewSEAMmember dummy*).

The average treatment effect of change in policy is given by the coefficient of the *Policy dummy*. We find significant treatment effect of enlargement of the Single Aviation Market and the EU on passenger numbers in Column 2, i.e. when both Malta and Cyprus are excluded from the sample. Both of these countries became members of the European Single Aviation Market in 2004. However, unlike the new members from the Central and Eastern Europe (CEE), they had large traffic numbers already before 2004. These 2 countries have been important holiday destinations with traditionally large number of (charter) flights from Western Europe.

Annex 4. Synthetic control method—effects of enlargement of the Single Aviation Market and EU on number of passengers flying between the CEE countries and the UK

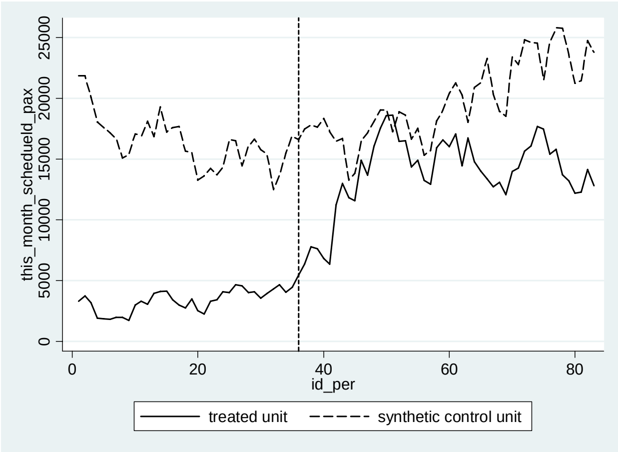

Figure A1. Number of passengers from Estonia and synthetic Estonia. Note that in the case of Estonia the SCM fails to find a suitable synthetic control (due to size differences with control units). The synthetic control found does not follow the pre-treatment trend of number of passengers from Estonia.

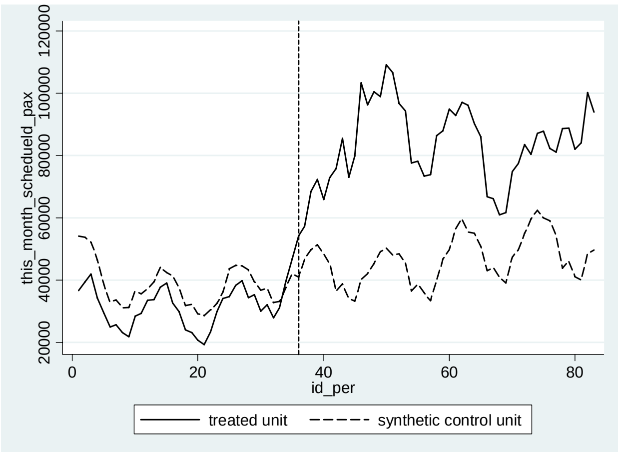

Figure A2. Number of passengers from Hungary and synthetic Hungary.

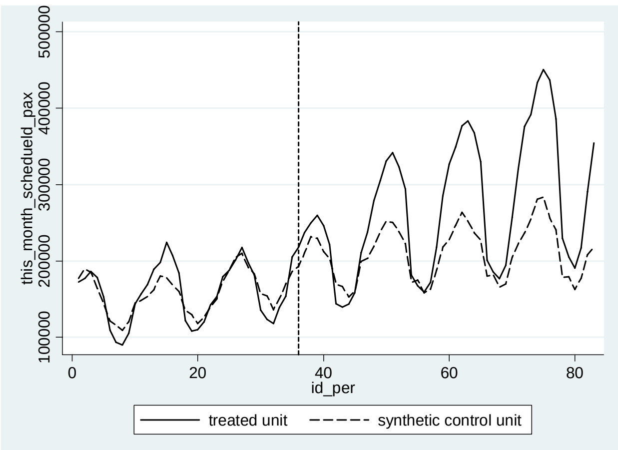

Figure A3. Number of passengers from Czech Republic and synthetic Czech Republic.

Annex 5. Some results of the SCM method based on Swedish yearly data of number of passengers

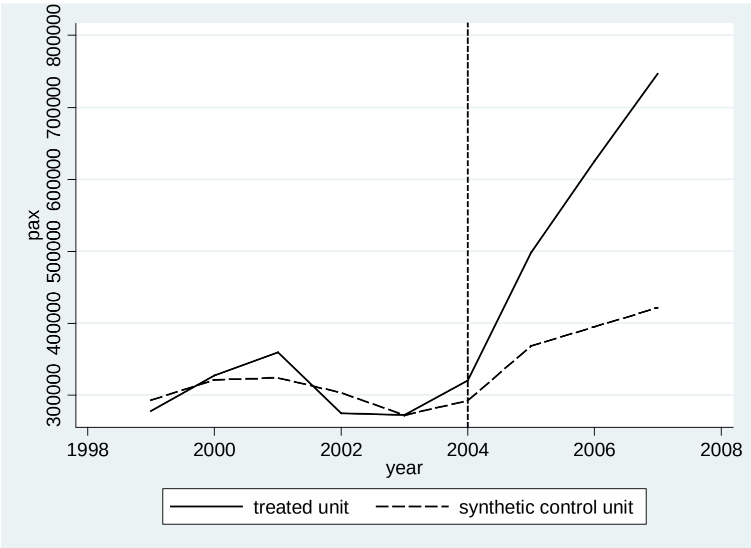

Figure A1. Trends in passenger traffic from/to Sweden: destination CEE-8 (treated unit) vs synthetic CEE-8.

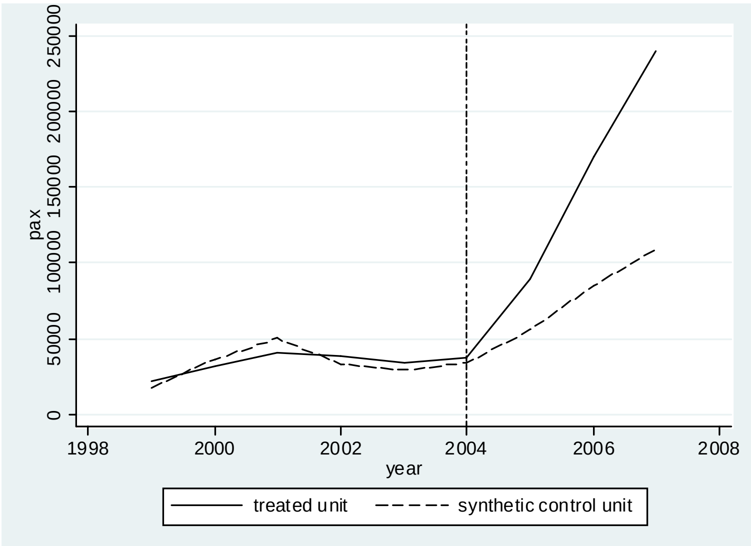

Figure A2. Trends in passenger traffic from/to Sweden: destination Poland (treated unit) vs synthetic Poland

Annex 6. Ratio of Post-treatment and Pre-treatment MSPE (mean square prediction error), SCM analysis

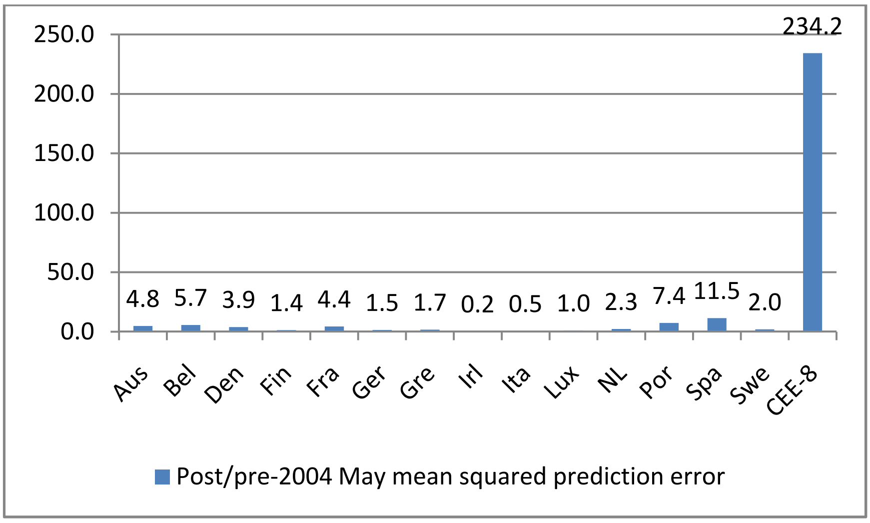

Figure A1. Ratio of Post-EU enlargement MSPE and Pre-EU enlargement MSPE. CEE to/from UK vs. 14 control country-pairs from/to UK.

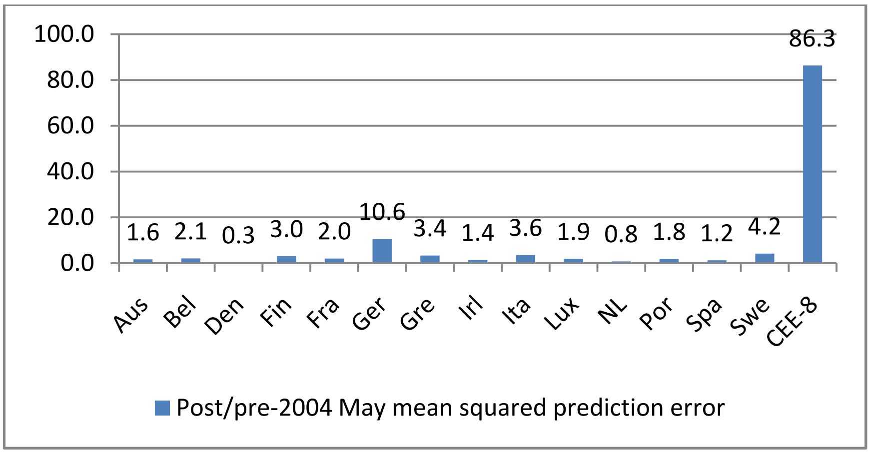

Figure A2. Ratio of Post-SEAM enlargement MSPE and Pre-SEAM enlargement MSPE. CEE to/from Norway vs. 14 control country-pairs from/to Norway.