The effects of the Morocco-European Union open skies agreement: A difference-in-differences analysis

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Abstract: In this paper, we examine the effects of the open skies agreement signed between the EU and Morocco in December 2006. Specifically, we exploit the fact that Morocco was the only country in North Africa to sign such an agreement and that the pre-liberalization traffic in all North African countries presented a common trend. We use data at the route level for the period 2003-2010 to run difference-in-differences regressions and to test for heterogeneous responses. We find a 20-40% increase in the number of seats offered on pre-existing routes and a notable increase in the number of new routes offered.

Keywords: Air transportation; Open skies agreements; Differences-in-differences.

1. Introduction

Air traffic relations between countries are typically regulated by bilateral agreements. Such agreements usually regulate the number of carriers a country is allowed to designate and the number of flights and routes flown, while they place restrictions on both fares and on carriers continuing flights to third-country markets. However, air services within the European Union (EU) have been fully liberalized since 1997, following the introduction of several legislation packages promoted by the European Commission aimed at increasing competition in the EU airline market.

Additionally, various open skies agreements have been promoted by the European Commission over the last decade with several non-EU countries within the framework of the European Neighbourhood Policy (ENP). The main goal of the ENP is to increase economic integration between the EU and its southern and eastern neighbours, all of which are considered by the World Bank as middle-income developing countries (with the exception of Israel).

In this paper we use the open skies agreement (OSA) signed between the EU and Morocco in December 2006 to identify the effects of the liberalization of the air transport market in a middle-income developing country. We identify two specific aspects of the impact of the Morocco-EU OSA on Morocco's air traffic. First, we identify the effect of the agreement on the number of seats offered on pre-existing routes. Second, we identify the effect of the deregulation on the probability of new routes being opened up between the participant countries.

We use data at the route level for the period 2003-2010 between North African and European countries. We exploit the fact that Morocco was the only country in North Africa to sign such an agreement and that the pre-liberalization traffic of all North African countries presented a common trend. Our empirical assessment of the effects of the Morocco-EU OSA is made by comparing changes in traffic volume and changes in the number of routes operated between Morocco and European countries with the corresponding changes for the rest of the North African countries and the EU.

Several econometric papers have examined the liberalization of international passenger aviation services.[1] Most focus on the United States, which has signed several OSAs with countries from around the world since the early nineties. Micco and Serebrisky (2006) found that OSAs reduce air transport costs by 9% and increase the share of imports arriving by air by 7%. However, these results only hold for developed and upper middle-income developing countries. Whalen (2007) found a modest increase in fares on routes between the United States and Europe affected by the OSAs, while all the capacity expansion was undertaken by carriers on routes between their hubs. Using data from Northeast Asia to the United States, Zou et al. (2012) found that the lower airfares associated with an open-skies agreement may be counterbalanced by the mutual forbearance strategy promoted by airlines competing in multiple markets. Finally, Cristea et al. (2014) found air traffic to be 17% higher in liberalized markets than in still-regulated markets, while OSAs led to an aggregate decline of 14.4% in quality-adjusted prices.

Evidence of the impact of OSAs outside the US is scarce, given data availability restrictions, especially regarding fares.[2] Previous studies have generally used cross-sectional data and their main variable of interest has been the Air Liberalization Index (ALI) scores computed by the World Trade Organization (WTO). Piermartini and Rousová (2013) found that OSAs increased passenger traffic by 5%, using worldwide data from nearly 2,300 country-pairs for 2005. Cristea et al. (2015) performed a similar analysis with data for 2010 by combining country-pair data and city-pair data. Their results suggest that a one-unit increase in the ALI leads to a 1.8% increase in the number of air passengers and that more liberal agreements are associated with more city-pairs being served by direct flights. Ismaila et al. (2014) also found a positive and statistically significant effect of liberalization on passenger flows using a sample that included 112 country-pairs with Nigeria for 2010. Specifically, a one-unit increase in the ALI raised the level of traffic demand by 8.76%. Finally, some studies have found a substantial

[1] Some studies use analytical or computational models to examine the welfare effects of air transport liberalization policies (Adler et al., 2014; Gillen et al., 2002). Here we focus the attention on studies that follow an econometric approach as it is the one used in this paper.

[2] Various papers have examined the impact of deregulation within the European airline market. Marin (1995) investigated the impact of liberal bilateral agreements on a set of 35 European routes for the period 1982-1989 and found that bilateral agreements lead to greater competition both in terms of prices and frequencies. Schipper et al. (2002) used a sample of 34 European routes with varying degrees of liberalization for the period 1988 to 1992 and found that fares are lower and frequencies are higher on fully liberalized routes. However, the high level of economic integration between the countries of the EU mean these studies were conducted in a very different context to the one examined here.

positive impact on traffic flows in Canada due to more liberal bilateral agreements using country-pair panel data (Dresner and Oum, 1998; Clougherty et al., 2001).

We add to this literature by examining the impact of a specific multilateral OSA with a middle-income developing country. Furthermore, we employ a methodology in a treatment evaluation framework that compares changes between comparable treated and control routes. We check the robustness of our results to differences in the pre-existing characteristics of the treated and control groups by applying a matching procedure.

Previous studies of US international routes have either focused on bilateral agreements while mixing data for developed and developing countries (Micco and Serebrisky, 2006; Cristea et al., 2014) or they have focused on high-income countries or dense routes (Whalen, 2007). Studies providing wide coverage use data for just one year so that they are only able to identity traffic differences between country-pairs or city-pairs subject to different degrees of liberalization (Cristea et al., 2015; Piermartini and Rousová, 2013).

In contrast, we are able to examine the change *per se* in the regulation regime using the logic of the difference-in-differences approach as we work with data before and after the OSA was signed between Morocco and the EU, and we conduct our comparison by focusing on similar routes operated by neighbouring countries that were not affected by the liberalization agreement. Furthermore, we do not only analyse changes in existing routes but also, in line with Cristea et al. (2014, 2015), changes in the probability of new routes being opened up.

Finally, as we have access to data on the market structure at the route level, we are able to determine whether the change in the number of seats offered following the signing of the OSA is related solely to greater competition resulting from new market entrants and/or to the removal of restrictions imposed on incumbent airlines. In this regard, the impact of the OSA between the European Union and Morocco may be strongly influenced by the entry of low-cost airlines or by the shift of charter airlines to scheduled flights. In contrast to previous studies, our analysis focuses on short-haul or medium-haul routes and many of these routes have a high proportion of passengers for tourism. Some few works have analyzed the impact of low-cost airlines on traffic at the route level with contradictory results (Bettini and Oliveira, 2008; Goolsbee and Syverson, 2008; Fageda, 2014). Here, we may provide new insights about the impact of low-cost airlines on route traffic as their entry in the Morocco market was restricted in the pre-liberalization period. To this point, our econometric analysis complement the study of Dobruszkes et al. (2016)

where they use aggregate data to compare the evolution of seats and the total number of routes offered between the European Union and Morocco and Tunisia. They found a higher increase of traffic and a higher increase in the number of routes offered in Morocco after the liberalization took place due to the entry of low-cost airlines.

The rest of this paper is organized as follows. In the next section, we outline the policy context of the OSA between the European Union and Morocco and describe the sample and data used in the empirical analysis. We then explain the empirical strategy, present the results of the analysis and perform some robustness checks. The last section is devoted to the concluding remarks.

2. Policy context and data

OSAs lie at the heart of the EU's external aviation policy that seeks the creation of a Common Aviation Area with the EU's neighbours. This strategy forms part of the broader European Neighbourhood Policy (ENP), which aims at achieving the greatest possible degree of economic integration between the EU and its southern and eastern neighbours.[3]

Against this backdrop, the Moroccan government introduced a new tourist master plan known as Vision 2010, later updated and renamed Vision 2020 (Dobruszkes and Mondou, 2013). The objective of this master plan, which followed the views of the main Moroccan business association (Confédération Générale des Entreprises Marocaines (CGEM), was to attract 10 million tourists in 2010 and 20 million in 2020, growing from 4.3 million in 2000. One of the main instruments stated in the master plan to reach such volumes of tourists was to improve the international accessibility by air. As part of this plan, the Moroccan government explicitly sought to liberalize international air transport so as to obtain lower airfares and to open up new routes. This objective to promote tourism, together with the ENP driven by the EU, led Morocco and the EU to sign an OSA on 12 December 2006.

[3] Of the 16 ENP countries, 12 participate as full partners in the ENP and have agreed to ENP action plans. They are Armenia, Azerbaijan, Egypt, Georgia, Israel, Jordan, Lebanon, Moldova, Morocco, Palestine, Tunisia and Ukraine. Algeria is currently negotiating an ENP action plan, while Belarus, Libya and Syria remain outside most of the structures of ENP. All these countries are classified by the World Bank as upper middle-income or lower middle-income countries with the exception of Israel which is classified as a high-income country. Other countries in North Africa, including Mauritania and Sudan, are also classified as lower middle-income countries.

To this point, the academic literature supports the views of the Moroccan government that an improvement of the air services supply could spur the number of tourist arrivals. Indeed, a large proportion of tourists arrive at their final destination by plane so it is not surprising to find that air services have a high impact on the number of tourist arrivals (Bieger and Wittmer, 2006; Donzelli, 2010; Pulina and Cortes-Jimenez, 2010; Chung and Wang, 2011; Rey et al., 2011; Albalate and Fageda, 2016). In our context, Dobruszkes and Mondou (2013) showed a substantial increase in international tourist arrivals in Morocco moving from 4.27 million in 2000 to 9.34 million in 2011. However, they also clarify that the statistics for tourists include foreign tourists and Moroccans living abroad. Finally, Dobruszkes et al. (2016) argue that liberalizing the airline market made possible to Morocco maintaining a pre-existing growth in tourist arrivals.

This agreement means that any EU or Moroccan airline can operate any route between any EU airport and any Moroccan airport and that they are free to set the flight frequencies, capacities and fares. Additionally, the Moroccan airlines are authorized to carry traffic between any EU airports if these services originate or terminate in Morocco, while the EU airlines are authorized to carry traffic between any Moroccan airport and an airport located beyond, provided that these services originate or terminate in the EU and that these points are located in the countries of the ENP. The agreement also means the adaptation of aviation legislation in Morocco to EU rules and regulations on safety, competition laws, air traffic management and consumer protection. [4]

Prior to the signing of the OSA, air services between Morocco and European countries were regulated by bilateral agreements, none of which were especially liberal. The Air Liberalization Index (ALI), the standard indicator of liberalization in the air services between country-pairs, is based on several features embodied in these agreements, including traffic rights, flexibility in the setting of prices and capacity, designation of airlines and other elements. The standard ALI runs from 0 to 50, with agreements scoring 50 being deemed the most liberal. In this regard, table 1 shows the ALI scores compiled by the World Trade Organization (WTO) for 2005 regarding the bilateral agreements between Morocco and several European countries. The ALI scores can be considered in all cases as restrictive as they range from 6 to 14 for the countries with direct services in

[4] Neighbouring countries that have benefited from an open skies agreement with the EU are Georgia (2011), Israel (2013), Jordan (2010) and Morocco (2006). As for relations with other neighbouring countries, negotiations are on-going with Lebanon, Tunisia and Azerbaijan. In a different context, the European Union has also signed OSAs with Canada (2009) and the United States (2008).

2005. In all bilateral agreements, sixth, seven and eight freedoms are not allowed. All bilateral agreements have a predetermination clause limiting capacity and dual approvals of tariffs are needed. The most liberal feature in these agreements is the multiple designation of airlines although the data provided by the WTO does not distinguish between double and multiple designation so that in some cases designation may be limited to two airlines. Only in the case of Italy and Switzerland designation is limited to one airline. Overall, these provisions imply that the market access to Morocco was restricted in the year previous to the liberalization. Hence, the OSA ushered in major changes in the level of regulation in air transport between Morocco and the EU countries.

<Insert Table 1 here>

We have worldwide data on the number of seats offered by airlines for 2002-2015 at the airport-pair level. These data are provided by RDC aviation (capstats statistics). However, we restrict our analysis to the period 2003-2010 and to routes originating in airports of North African countries (Egypt, Mauritania, Morocco, Sudan, Tunisia and Libya) and terminating in the airports of EU-15 countries plus Norway and Switzerland. This restricted sample seeks to avoid shocks other than the OSA that might distort the identification of the effects of the latter. Data after 2010 may be affected by the political conflicts associated with the Arab Spring, which has had a differential impact on the North African countries in our sample. We select 2003 to guarantee the symmetry of the periods before and after the signing of the OSA. We also exclude the European countries that have acceded to the European Union in the middle of this period, while we opt to focus on North African countries as these are the most similar to Morocco, at least in geographical terms.

Overall, our sample of pre-existing routes (routes with air services in each of the years in the period under consideration) includes 191 routes and 1,501 observations. Routes originating in Algeria, Egypt, Morocco and Tunisia represent about 95% of the total number of observations, which means the few routes originating in Mauritania, Libya and Sudan should have a very modest effect on our results. We also construct an additional sample comprising potential routes, defined as a link between all the airports in our sample of North African countries to all the airports in our sample of European countries. This expanded sample includes 3,895 routes and 31,160 observations. Again, most of the observations are for the countries identified above in the sample of pre-existing routes.

We consider the airports of the North African countries as being the origin and the airports of Europe as being the destination.

We expect an increase in the number of seats offered on pre-existing routes and an increase in the probability of new routes being opened up due to the liberalization ushered in by the OSA. In a regulated context, incumbent airlines may face capacity restrictions on the routes they operate. Furthermore, they may face restrictions in terms of fare setting, which could condition their profitability. Holding the level of competition on the route constant, the OSA may lead to an increase in the number of seats offered by incumbent airlines because of the lifting of regulations on capacities and fares. They may also adopt a pre-emption strategy, which would involve increasing the capacity on a route so as to impose entry barriers on new entrants once market access is no longer regulated.

Another expected effect of the OSA is the entry of new airlines on the routes affected, including the entry of low-cost airlines or the shift of charter airlines to scheduled flights. We expect the deregulation to be associated with greater levels of competition, which it may lead to a higher number of seats offered. Additionally, the lifting of restrictions to operate on specific routes should also lead to an increase in the number of routes operated. In the regulated context, the former flag carriers tended to monopolize the market and may have been obliged to operate specific routes. With liberalization, a number of new routes might be operated by airlines that have lower costs than those incurred by traditional carriers or the traditional carriers may face fewer restrictions when choosing their route network.

Figure 1 shows the evolution of the annual number of seats between the main North African and all European countries of our sample for the period 2003-2015. Data in this figure show the better performance of Morocco in relation to the other countries in the post-liberalization period. In 2006-2010, the increase in the seats offered is 51% in Morocco, 29% in Egypt, 16% in Tunisia and 14% in Algeria. However, these data suggest that the effects of the open skies agreement between Morocco and the European Union seem to be particularly strong in the first year that came into effect. In 2007, the total seats offered from Morocco shows a 29% increase, while such increase was 11% in Egypt and Tunisia and Algeria records a 7% decrease. In the following years after 2010, only Algeria was not clearly affected by the uncertainties associated with the Arab spring.

<Insert Figure 1 here>

Figure 2 provide details about the evolution of the seats share by different types of airlines offering flights from the main North African to European countries. In this regard, we differentiate between network carriers (former flag carriers and/or airlines involved in alliances), low-cost carriers that only provide scheduled flights and airlines that provide both charter and scheduled flights. Data in this figure show that the higher increase in the number of seats in Morocco seems to be attributable mainly to the low-cost airlines, as their share increased substantially over the period at the expense of network carriers.

In 2006, the year previous to the liberalization, network carriers concentrated 80% of seats offered from Morocco while in 2010 such numbers decreased to 50%. Note here that the numbers for network carriers are clearly dominated by the flag carrier of the corresponding North African country.

In contrast, the share of low-cost airlines moved from 3% in 2006 to 36% in 2010. The other three countries considered in figure 2 also had a reduction in the share of network airlines although less pronounced than in Morocco. Interestingly, the share of low-cost airlines increased to a 10% in Egypt and Tunisia and it remained close to zero in Algeria. In this regard, the main difference in the evolution of the air market in Morocco in relation to the other North African countries is the increasing role played by leading European low-cost airlines like Ryanair, Easyjet and Transavia. In 2010, these three airlines offered 30 percent of total seats from Moroccan airports to the European Union. While Ryanair was not offering flights in the other North African countries, it became the main rival of Royal Air Maroc in Morocco from 2008.

The third type of airline identified in this figure is airlines that offer both charter and scheduled flights so that it is not possible to classify them as low-cost or charter airlines. As suggested by Dobruszkes and Mondou (2013) and Dobruszkes et al. (2016), charter airlines were forced to change many of their flights to regular ones to be able to compete with low-cost airlines after the liberalization in Morocco took place. In this regard, low-cost airlines may be stronger competitors for charter than for network airlines (Williams, 2001). Given that our data only covers regular flights, part of the increase in the seats that we observe may be explained by the shift from charter to regular flights made by these airlines.

In this regard, Atlas Blue and Jet4you become important players in the Moroccan air Market (of regular flights) just after the liberalization came into effect.[5] In Algeria, Aigle Azur shows an important but stable proportion of flights offered while the movement that several airlines made from charter to scheduled flights seems to have taken place also in Tunisia and Egypt. In particular, in Egypt airlines like Thomson Airways, Condor and TUIfly have become the main rivals of Egyptair.

<Insert Figure 2 here>

Overall, it can be seen that low-cost carriers and charter airlines lead the increase in the supply of air services from Morocco. Given that these airlines concentrate their business in point-to-point routes, it seems likely that Moroccan airports are not used by the new entrants as a hub for the other North African countries.

While these figures show descriptive evidence in favour of the hypothesis that Morocco has benefitted from the OSA, a multivariate econometric analysis using data at the route level is needed to conclude that the agreement has had a significant and differential impact on air traffic between Morocco and Europe. Indeed, the econometric analysis controls for several explanatory variables that may have an influence on the seats offered at the route level. Furthermore, we control for the presence of differences in the pre-existing characteristics of the treated (Morocco) and control groups (the rest of North African countries). This analysis is reported in the following sections.

3. Empirical Strategy

In this section, we explain the methodology and variables used in the econometric analysis.

3.1.Methodology

We undertake a difference-in-difference (DiD) analysis to measure the impact of the OSA. Impact evaluation methodologies are increasingly used in economics and other fields to evaluate the effect of a public policy. These methodologies include the propensity score and matching, differences-in-differences and regression in discontinuities designs, which try to replicate the natural experiment methodology used in natural sciences. The basic idea of a natural experiment is to isolate the effect of the

[5] Atlas Blue flights were rebranded as Royal Air Maroc flights (the holding company) in 2010.

treatment (an external shock) over a particular outcome by comparing the outcomes of a set of individuals that randomly received treatment (treated group) with the outcomes of a similar group of individuals that were not exposed to treatment (control group). In the natural experiment, the treatment is assigned randomly within a certain population with the same characteristics and the comparison in outcomes of the two groups identifies the effect of the treatment.

What we try to identify here is the effect of a public policy that constitute an exogenous shock to individuals in some particular outcome. However, public policies are few times assigned randomly to a sub-set of a particular population and therefore impact evaluation techniques try to replicate the natural experiment environment by using a counterfactual. This is a group of individuals whose outcome evolution can be used to replicate what would have happened to the individuals exposed to the shock in absence of the shock (control group).

As mentioned above, we identify two specific aspects of the impact of the EU-Morocco OSA on Morocco's air traffic. First, we identify the effect of the agreement on the number of seats offered on pre-existing routes. Second, we identify the effect of the deregulation on the probability of new routes being opened up between participant countries.

To identify these two effects, we exploit the experimental environment created by the change in regulations between the EU and Morocco, and the fact that no changes occurred in the regulations between the EU and the other North African countries or between Morocco and the other non-EU European countries.

In this sense, if we could have proved that the release of the OSA between Europe and Morocco was signed due to only observed characteristics, we could have implemented the propensity score matching methodology directly, by looking for a control group with the exact same characteristics that influenced the agreement. The propensity score matching assumes that differences in participation are based solely on differences in observed characteristics (Cameron and Trivedi, 2005). However, as we cannot assert that in our context, we cannot rely exclusive in the propensity score-matching methodology.

DiD methodology recognizes that in absence of random assignment the treated and control groups can differ in several ways. Thus, it allows the treated and control groups to differ in unobserved characteristics. However, despite those differences, using DiD, if

we can establish that pre-treatment trends where alike between the two groups, the post-treatment trend divergence may signal the treatment effect (Angrist and Pischke, 2015). The fundamental identification assumption is the existence of parallel trends between groups in absence of treatment (Meyer, 1995; Angrist and Pische, 2009). If the assumption holds, by comparing the change in outcomes of both groups we can properly identify the effect of the shock (in our case the OSA).

Thus, we estimate the impact of the agreement on the number of seats offered on routes affected by the change in regulation, using as a counterfactual the number of seats offered on routes between the other North African countries and the EU, and, between Morocco and the other non-EU European countries. Specifically, we assess this impact by comparing the change in the number of seats offered on routes affected by the OSA with the change in the number of seats offered on routes that remained unaffected. By comparing these changes, we control for both observable and unobservable differences between routes that are invariant in time. The same analysis is made to examine an additional effect of the OSA; the increase in the probability of opening new routes.

3.2.Variables

Our treated routes are all the routes operated between Morocco and EU member countries before the agreement, while our control routes are all the routes operated between the other North African countries and EU members, and, all the routes operated between Morocco and non-EU European countries prior to the agreement. [6] In this way, we control for the evolution in the number of seats out of Morocco before the OSA and the evolution in the number of flights out of Tunisia, Algeria, Egypt, Mauritania, Sudan and Libya to the same EU countries, and the flights from Morocco to Switzerland and Norway. To do so, we estimate the following model:

$$\log(seats)_{it} = \beta_0 + \beta_1 OSA_i + \beta_2 X_{it} + \mu_t + \varepsilon_{it} \qquad \textbf{<1>}$$

where our dependent variable is the logarithm of the number of seats offered on route *i* in period *t*; *OSA* is a dummy variable that takes a value of 1 when route *i* connects Morocco with a EU member state from 2007 onwards; *X* is a vector of control variables based on

[6] We consider all routes that were served by at least one flight per week in the two years prior to the OSA.

route or endpoint features; μ_t are year dummies; and ε_{it} is the error term. We consider 2007 as the first year in which the agreement was in force, given that it was signed in mid-December 2006.

The vector of controls includes different variables that might influence the number of seats offered on a route. Here, we include the standard variables used in gravity models, assuming that the air traffic between two points depends positively on the economic and demographic size of these points and negatively on distance.

Hence, we first include the distance between the points of origin and destination of route *i* as our explanatory variable. The data for this variable are provided by RDC aviation (Innovata data). Given that most of the routes in our sample are not strongly affected by competition from other transportation modes (neither trains nor coaches), we expect a negative sign for the coefficient associated with this variable, as demand between two points is negatively related to distance.

Second, we control for the population of the cities of origin and destination. Here, bigger cities are expected to have a larger supply of seats, given that the increase in population increases the number of people wanting to fly, understood that the proportion of people who travel by plane remains constant within the total population. The data for this variable are expressed at the urban level. For cities with more than 300,000 inhabitants, information is obtained from the United Nations (World Urbanization Prospects). The data for smaller cities are obtained from the National Statistics Agency of the corresponding country.

Third, we control for the economic status of the countries of origin and destination using the Gross National Income (GNI) per capita, on the understanding that demand between richer endpoints should be higher. Furthermore, we include a variable that measures the degree of openness of the origin and destination countries which is measured as the percentage of imports and exports over GDP. The data for these variables are expressed at the country level and are obtained from the World Bank (World Development Indicators). Unfortunately, data at a more disaggregated level are only available for European countries.

We also include a variable that controls for the immigrant flows at the country-pair level. Eurostat provides data of immigrant flows between North African and European countries. However, these data is very poor because there are many missing observations.

Some European countries do not provide the data for specific North African countries, while very few provide the data for all years. Hence, we cannot use this variable as continuous variables. To approximate the effect related with immigrant flows, we have created a dummy variable that takes the value one for those country-pairs with relevant immigrant flows and for which we have data available. We have defined as relevant immigrant flows to those European countries with more than 100.000 immigrants from the corresponding North African country. These relevant immigrant flows include Morocco with Belgium, Spain, France, Italy and Netherlands, Algeria with France, and Italy with Egypt and Tunisia. We expect a higher demand on these routes due to immigrants visiting friends and relatives. Furthermore, we include a dummy variable that takes a value of 1 for tourist destinations in North Africa where the population of the main city or town is very small. We expect demand on these routes to be higher than the control variables of population or income per capita might suggest. Note also that air traffic on these routes should be essentially from European cities to the tourist destinations.[7]

Finally, we include one variable that control for the degree of competition in the route: the Herfindahl-Hirschman concentration Index (HHI) that is measured in terms of the number of seats offered on the route. Note that the HHI variable is strongly correlated with the share of network carriers on a route so that a reduction in this index is essentially associated with the entry of low-cost or charter airlines.

We estimate two specifications of equation (1) that are differentiated by controlling or not for the competition variable. In the first specification, we consider the HHI as explanatory variable. In the second specification, we do not control for the competition variable.

These different specifications allow us to untangle whether the OSA has an effect on the number of seats offered on a route while holding the level of competition constant or whether, on the contrary, the OSA affects the number of seats offered as a result of the greater competition on the route.

Recall that the increase in the number of seats due to deregulation may be related to the lifting of the restrictions imposed on incumbent airlines so that they are free to fix capacities and fares or may reflect a pre-emption strategy whereby they seek to impede

[7] These tourist destinations are Djerba, Enfidha, Monastir, Tabarka and Tozeur in Tunisia, Hurghada, Luxor, Marsa Alam and Sharm el-Sheikh in Egypt and Essaouira in Morocco. Other major tourist destinations like Marrakech, Fez or Cairo are also big or medium-sized cities.

the entry of new airlines. If this were the case, the impact of the OSA would be relevant even when holding the degree of competition on the route constant. In contrast, the impact of the OSA could be exclusively related to the greater competition resulting from the operation of new airlines on the previously regulated routes. In this case, the effect of the OSA should only be relevant when we do not control for the competition variable.

Another potential explanatory factor for which we cannot control in our model is fares, given the lack of data. In this respect, airline behaviour can be considered as a multistage process (Marín, 1995; Schipper et al., 2002). In the first stage, airlines choose whether to enter the market or not; in the second stage, and having entered the market, they decide on the capacity they wish to offer. In the third stage, the airlines set prices, which makes them the most flexible variable. Hence, our analysis here considers the first two stages of the airlines' decision-making process. Demand and fare data would be helpful to improve the accuracy of the results as they will allow us to consider the last stage.

All (continuous) control variables are expressed in logarithms as is usual in gravity models. The year dummies allow us to control for yearly shocks, which are common to all routes. The estimate of interest here is β_1, which represents the difference-in-differences effect of the OSA on the number of seats offered. Recall that the key identification assumption of the difference-in-differences approach is that the variable of interest would have followed a parallel trend in the absence of deregulation in both the treated and control groups. Hence, the evolution in the number of seats in the control group represents a suitable estimate of the evolution of the number of seats in the treated group in the absence of deregulation.

As this assumption is not testable, we provide evidence that the treated and control groups followed parallel trends before the OSA was signed. Thus, first, we perform an equality of means test of the seats offered on the treated and control routes on a yearly basis. The results are shown in Figure 3. The null hypothesis of equality of means between control and treated groups cannot be rejected for all years of the pre-reform period.

<Insert Figure 3 here>

Second, to identify the effect of the OSA on the probability of new routes being opened up we estimate the following model:

$$P(Air\ services)_{it} = \alpha_0 + \alpha_1 OSA_i + \alpha_2 X_{it} + \delta_t + \gamma_{it} \quad \textbf{<2>}$$

where the dependent variable in this estimation is a dummy variable that takes a value of 1 when the route has air services. We consider that a route has air services when an airline offers at least one flight per week. The control variables are the same as in equation 1 and their expected signs are the same, since all these variables are demand shifters. The only variable not to be included in equation 2 is the competition variable since they cannot be computed for routes with no air services.

Recall that we estimate the effect of the OSA by comparing changes in the dependent variable in the treated and control groups. In this case, we compare the changes in the probability of the opening up of new routes between Morocco and the EU countries participating in the OSA with the changes in the probability of the opening up of new routes between the other North African countries and the EU, and, between Morocco and non-EU European countries.

Our estimate of interest in this case is α_1, which represents the difference-in-differences effect of the OSA on the probability of the opening up of new routes. The key identifying assumption in this case also holds: Figure 4 presents the equality of means test between the treated and control groups on a yearly basis. The results show that until 2006 we cannot reject the hypothesis that the probability of opening up new routes is equal on treated and on control routes. In 2006, however, the probability increases on those routes affected by the OSA. This can be attributed to the effects of the agreement itself: although it was not signed until December of that year, the airlines might have reacted to it earlier. In this respect, some informal liberalization of air travel regulations between two countries may have occurred prior to the formalisation of the OSA as it was decided some months before the signature by the corresponding authorities. Hence, the liberalization may have had effects since 2006 although the signature was at the end of that year. Thus, our estimate of the effect of the agreement might be an underestimation, as this difference in 2006 is captured for the variable *treated* but not for the OSA itself.

<Insert Figure 4 here>

3.3. Econometric issues

The results of the analysis may be affected by the presence of differences in the pre-existing characteristics of the treated and control groups. Tables 2 and 3 show the mean test differences for all the control variables. Furthermore, we also provide the mean test

differences for the previous level of liberalization (as measured by the ALI index).[8] Table 2 shows the differences in the sample of pre-existing routes, while Table 3 shows the differences in the sample of all potential routes. In the first sample, we find differences for the income per capita and openness at the point of origin, for the dummy for tourist destinations and for the ALI index. In the second sample, we find differences for all the variables considered except population and openness at the point of destination. Hence, at the end of the following section we apply a matching procedure and we re-estimate equations 1 and 2 with the observations that have common support as a robustness check.

<Insert Table 2 here>

<Insert Table 3 here>

The estimates may present heteroscedasticity and temporal and cross-sectional autocorrelation problems. We apply the Breusch-Pagan/Cook-Weisberg test for heteroscedasticity and the Wooldridge test for autocorrelation in panel data. Both tests show that we may have a problem of heteroscedasticity (in some regressions) and autocorrelation, which must be addressed. Hence, the standard errors are robust to heteroscedasticity. Following Bertrand et al. (2004), we allow for an arbitrary variance-covariance structure by computing the standard errors in clusters by route to correct for autocorrelation in the error term both at the cross-sectional and temporal levels.

The data used present a panel structure so that we need to use the techniques typically applied within the framework of panel data models. In this regard, a clear advantage of the fixed effects model is that it allows us to control for omitted variables that are correlated with the variables of interest and which do not change over time (Verbeek, 2000). Hence, the fixed effects model is more reliable than other techniques. However, the fixed effect model focuses on the within variation of data and so it cannot capture the effect of time invariant variables, such as distance or the dummies for immigrant flows

[8] We only have data available for the ALI index in the year previous to the liberalization. Hence, it is useful for the matching procedure as it allows us to control for the pre-existing differences in the regulatory status of air services between the North African and European countries. However, it is not useful to capture changes in the regulatory provisions for the following years. In fact, the main variable of our analysis is aimed to capture such change. We know that the open skies agreement between Morocco and the European Union led to a huge change in the ALI index from values in the range 6-14 to close to 50. Given that the bilateral agreements are binding for many years, it is likely that the value of the ALI remains constant for the rest of North African countries (or with very modest changes).

and tourist destinations. Hence, we also show the regressions using a pooled model that allows us to examine the influence of these time invariant variables.

Another problem that we must address is the potential endogeneity bias of the HHI variable (in those regressions in which it is included). As our instrument, we use the concentration index for the two airports on the route. This variable is constructed as follows: we calculate the HHI index in terms of the number of airline seats both at the origin and destination airports on the route. Then, we obtain the mean value of the HHI index for both airports on the route. Airline decisions at the airport level refer to all the routes leaving from a given airport, so we would expect this variable to be exogenous as our dependent variable refers to the supply of services in just one route. Note also that the correlation between the instrumented variable and the instrument is 0.18 which seems to be high enough. To this point, we report two tests in all tables of results that confirm the strength of the instrument.

Finally, Tables A1 and A2 in the appendix show the correlation matrix of the variables used in the empirical analysis for the sample of existing and potential routes, respectively. Overall, the correlation between the explanatory variables does not seem to be high to suggest a multicollinearity problem that could distort the individual identification of each variable. This is particularly the case for our main variable of interest.

4. Estimation and results

In this section, we discuss the results of the regressions. First of all, we report the results of a regression with data at the country-pair level that supplement the estimation with route-level data. Note here that the OSA took effect at the national level for Morocco and the EU level for the EU countries. So, to the extent that some traffic may be shifted from hub-to-hub routes to other routes made possible through the signing of the agreement, we may find some decreases in traffic (or lower growth in traffic) than would have been the case otherwise on the hub-to-hub routes. Table 4 shows the results of the estimation with country-pair data.[9] We find that the increase in the number of seats offered on the treated routes after the signing of the OSA is about 22% higher than that

[9] We only show the results with the pooled model because the estimation with fixed effects does not work well. In the fixed effects regression, any single variable is statistically significant. A possible explanation of the poor performance of the fixed effects model with country-pair data is the much more reduced number of observations that we have in relation to the regressions with route level-data.

of the control routes when we do not consider the HHI variable. Such increase is just 5% when we consider the HHI variable and it is not statistically significant. The sign of the rest of variables are in general as expected (except the variable of openness at destination and distance) but they are not all statistically significant.

<Insert Table 4 here>

Table 5 shows the results of the equation for the number of seats offered on pre-existing routes. In columns 1-2, we present the results when including the competition variable. In columns 3-4, we exclude the HHI index as explanatory variable.

We find that the Morocco-EU OSA does not have a statistically significant effect on the number of seats offered when we control for the competition variable. In contrast, the impact of the OSA is substantial when we do not control for the degree of competition on the route. This result remains the same regardless of the estimation technique used.

<Insert Table 5 here>

In terms of magnitude, the increase in the number of seats offered on the treated routes after the signing of the OSA is about 24% higher than that on the control routes when using the route fixed effects method, which is our preferred approach. Thus, we find clear evidence of the fact that the OSA has had a notable impact on the market. This impact is essentially related to stronger market competition due to the entry of non-network carriers and not to a change in the behaviour of the incumbent airlines. Note also that the magnitude of the impact of the OSA is similar when we consider country-pair or route-level data. Thus, the increase in the seats offered in some routes seems not have been made at the expenses of other routes (for example hub-to-hub routes).

The magnitude of the impact of the OSA is higher than that reported in similar studies conducted to date. Cristea et al. (2015) performed a counterfactual analysis based on their empirical results that suggests that a move to a more liberal environment in the Middle East could lead to an increase in traffic flows of between 7 and 18%, while the results of Piermartini and Rousová (2013) suggest that OSAs could increase worldwide passenger traffic by 5%.

A possible explanation for the more marked impact reported herein might be that the OSA analysed here means that Morocco, to all intents and purposes, forms part of the de-regulated European airline market with its significant presence of low-cost airlines. Indeed, the downward pricing pressure that low-cost airlines exert on the routes they

operate is well documented in the literature (e.g., Morrison, 2001; Goolsbee and Syverson, 2008; Hofer et al., 2008; Oliveira and Huse, 2009). Thus, it would appear that the OSA has had a notable impact on fares (and hence on capacity) precisely because of the entry of low-cost airlines.

Recall that an important difference between Morocco and the rest of North African countries after the liberalization took place is the increasing presence of European low-cost airlines like Ryanair or Easyjet in Morocco. Furthermore, part of the increase in the seats that we observe may be explained by the shift from charter to scheduled flights made by some airlines like Atlas Blue. Note here that the change from charter to regular flights implies an improvement for passengers as the service is not longer controlled by tour-operators

To this point, previous studies focus their analysis on longer routes and/or routes with a weaker role of tourism. Thus, the important role that charter services had in the pre-liberalization period in Morocco and the major role of low-cost airlines in the post-liberalization period may explain the stronger impact that we find in relation to previous studies.

Additionally, the potential increase in traffic may be greater when one of the countries party to the agreement is a middle-income developing country. In this regard, the results from our analysis differ from those obtained by Micco and Serebrinsky (2006). The latter failed to find a significant impact of OSAs on air transport costs when considering lower middle-income developing countries, such as Morocco. A possible explanation for this is that Micco and Serebrinsky (2006) focused on cargo markets while our analysis focuses on passenger markets. However, the higher impact that we find is not necessarily related with the differences in GDP between the two areas as results for this variable are not clear in our empirical analysis.

Recall also that previous studies use data for just one year so that they are only able to identity traffic differences according to different degrees of liberalization. In contrast, we are able to examine the change *per se* in the regulation regime as we work with data before and after the OSA was signed between Morocco and the EU. This is another possible explanation of the differences that we found in relation to previous studies.

The results for the control variables seem to work better in the pooled model than they do in the fixed effects model. Recall that the fixed effects model concentrates on the

within-variation of data and the fixed effects may already capture the impact related to bigger cities and richer countries. In any case, the results for the main variable of interest are very similar regardless of the technique used. What is notable is that we do not find a statistically significant effect of the distance variable; however, this result may be explained by the fact that the range of distances for the routes in our sample is not great.

Table 6 shows the results for the probability of the opening up of new routes. Here, we find a positive impact of the OSA. For a route affected by the OSA, the odds of having a service are about 1.5-3.5 greater than the odds for a route unaffected by the OSA. The only paper to conduct a similar analysis is that of Cristea et al. (2015). In their counterfactual analysis for the Middle East, they find that a fully liberalized environment would increase the odds of a flight between any two given cities by a factor of 1.2–1.4.

Again, the results of our analysis report an even stronger impact of the OSA between Morocco and EU. In this regard, Dobruskes and Mondou (2013) provide data in which they show that liberalization in Morocco has benefited regional airports. Note also that low-cost airlines, such as Ryanair and Easyjet, which have enjoyed a notorious presence in the Moroccan market since liberalization, do not necessarily operate at the largest airports.

As in the previous regression, the control variables work better in the pooled regression than in the fixed effects regression. The estimated effect for the main variable of interest is higher when we use the fixed effects model but it is high in both cases.

<Insert Table 6 here>

We check the robustness of our results to potential differences in the pre-existing characteristics of the treated and control groups. Essentially, we wish to eliminate any concerns that the evolution in the respective number of seats offered and the respective probabilities of the opening up of a new route might have differed because of pre-existing differences. For example, it might be that the number of seats offered on a route or the probability of a new route being opened is influenced by the income per capita of the countries involved or pre-existing levels of liberalization of air traffic in the two countries.

To overcome this concern we apply matching procedures and re-estimate equations 1 and 2 with the observations that have common support. Matching procedures eliminate the possible bias by pairing observations in the treated and control groups with similar characteristics. That is, following Rosenbaum and Rubin (1983), we first estimate the

probability of being treated conditional on the pre-existing characteristics that differ between groups with a logistic model, obtaining the propensity score for each observation. In a second step, we match the observations in the treated and control groups with respect to the propensity score using the first nearest neighbour algorithm. This algorithm matches treated observations with the control that has the closest propensity score. Then, we drop all the observations without common support and re-estimate equations 1 and 2.

Recall that for our first question (that is, the effect of the OSA on the number of seats offered) the treated and control groups differed in terms of the income per capita and openness of the point of origin, the number of routes where immigration is significant, the percentage of tourist routes, and, the degree of liberalization between the countries of origin and destination. Hence, to maintain only those observations with common support, we estimated the probability of being treated conditional on these features, with exception of the immigrant variable. As many of the relevant immigrant flows refer to Morocco, this dummy variable predicts almost perfectly the probability of being treated (which are the routes from Morocco) so that the estimation with the matching procedure excludes automatically the variable.

After applying the first nearest neighbour algorithm we obtained a smaller sample comprising the treated and control groups that are closest with respect to the three pre-existing characteristics. Overall, the matching sample contains 53 routes from the treated group and 53 from the control group.[10]

For our second question, (that is, the effect of the OSA on the probability of a new route being opened up), the treated and control groups differ in several characteristics, namely, the distance between the points of origin and destination, the level of population at origin, the income per capita at origin and destination, the openness at origin, the number of routes where immigration is significant, the percentage of routes considered as being tourist routes, and the pre-existing level of air liberalization between the countries. Here again, we estimated a logistic regression of the probability of being treated conditional on all quoted characteristics but immigrants, and include observations on

[10] The results for the logistic regression and the mean difference between groups in the full and the matching samples (both for the sample of existing and potential routes) are available upon request from the authors.

common support using the first nearest neighbour algorithm. This sample contains 918 treated and 918 control routes.

Tables 7 and 8 show the results of the regressions using the matching sample. Our results for these additional regressions confirm our previous findings. In fact, we find a stronger effect of the OSA between Morocco and the EU. The results for the fixed effects model indicate an increase of about 34% in the number of seats offered on the treated routes after the signing of the OSA. For a route affected by the OSA, the odds of having a service are about four times greater than the odds for a route unaffected by the OSA. Thus, the previous regressions that did not take into account the differences in pre-existing characteristics of treated and control groups underestimate the impact of the OSA between Morocco and EU.

<Insert Table 7 here>

<Insert Table 8 here>

Finally, we perform a falsification test to check that the effects reported with regard to the number of seats and the probability of new routes being opened up could only be found when the OSA was in place. To do so, we first discard all treated routes from both samples and assign treatment randomly to the control routes. We assign treatment to randomly selected routes maintaining the same proportion between control and treated routes as in the original samples. Thus, we have 37 treated routes from the 139 in the first estimation and 60 from the 193 in the second sample. As observed in Table 9, the results show that the OSA effect is not significant when applied to random routes that have not actually been affected by the agreement.

<Insert Table 9 here>

5. **Concluding remarks**

In this paper, we have shown that the OSA signed between Morocco and EU has had a very marked impact on the air traffic services between the participant countries. We have found that the increase in the number of seats offered is about 20-35% on pre-existing routes, while there has been a notable increase in the number of new routes offered, after controlling for the characteristics that might explain the probability of having air services.

Given that the link between economic development and air traffic is well established in the literature, our results shed light on the importance of promoting policies that liberalize airline markets. In this regard, we provide evidence of the benefits that a liberalized environment may have for middle-income developing countries.

Most previous studies likewise report positive effects of the liberalization of the airline market; however, our estimated magnitudes appear to be higher. It could be the case that the potential benefits of liberalization are stronger when one of the countries party to the agreement is not a high-income country. In addition, Morocco is geographically close to many European countries and it counts with several important tourist destinations. This may have facilitated the entry of European low-cost airlines and charter airlines into this market. Indeed, our analysis suggests that the implementation of an OSA between the EU and other neighbouring countries may have strong positive effects in terms of generating more traffic on pre-existing routes and opening up more routes for operation.

While we provide complementary evidence of the potential benefits of the liberalization of international air transport services, the practical advances in the policy arena are still somewhat limited. Significant progress towards a liberalized environment has been achieved in some parts of the world, for example, among the countries belonging to the Association of Southeast Asian Nations. However, the EU has signed OSAs with relatively few countries, while legacy airlines in the US (the most active country in terms of its involvement in OSAs) are bringing considerable pressure to bear on the government to cancel such agreements with countries in the Middle East.[11] From a more general perspective, restrictive bilateral agreements continue to regulate the air services between most countries around the globe. Hence, the results of this study should be informative in guiding policies that seek to eliminate such regulations and which distort airline decisions concerning their route network, capacity and fares.

Finally, this paper has focused on the effect of the liberalization on air transport services but it may be of interest to explore the link between the liberalization (and the associated increase in air traffic) and the increase in the economic links between the cities/countries implied in the liberalization like tourism, trade or foreign direct investments. In our context, given that the liberalization of the air traffic includes a middle-income developing country and developed countries, it would be also of interest

[11] "Open-Skies Agreements Challenged", *New York Times*, February 6, 2015.

to examine whether the richer or poorer countries take more benefit from the liberalization.

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TABLES

Table 1. Bilateral agreements between Morocco and European countries in 2005

Country	ALI index	Type	Freedoms	Withholding/ownership	Designation	Tariffs	Capacity
United Kingdom	14	E	3rd,4th,5th	Substantive ownership and effective control	Multidesignation	Double approval	Pre-determination
Germany	12	i	N.A	N.A	N.A	N.A	N.A
France	11	E	3rd,4th,5th	Substantive ownership and effective control	Multidesignation	Double approval	Pre-determination
Portugal	11	E	3rd,4th,5th	Substantive ownership and effective control	Multidesignation	Double approval	Pre-determination
Belgium	10	E	3rd,4th,5th	Substantive ownership and effective control	Multidesignation	Double approval	Pre-determination
Netherlands	10	E	3rd,4th,5th	Substantive ownership and effective control	Multidesignation	Double approval	Pre-determination
Luxembourg	10	E	3rd,4th,5th	Substantive ownership and effective control	Multidesignation	Double approval	Pre-determination
Spain	8	O	N.A	N.A	N.A	N.A	N.A
Italy	6	C	3rd,4th,5th	Substantive ownership and effective control	Single designation	Double approval	Pre-determination
Austria	4	B	3rd and 4th	Substantive ownership and effective control	Multidesignation	Double approval	Pre-determination
Sweden	0	A	3rd and 4th	Substantive ownership and effective control	Single designation	Double approval	Pre-determination
Switzerland	6	C	3rd,4th,5th	Substantive ownership and effective control	Single designation	Double approval	Pre-determination

Note: Bilateral agreements with Denmark, Finland, Greece, Ireland, Luxembourg and Norway are not covered by WTO. In 2005, any of these countries had direct services to Morocco so that we assume they have the same regulatory status as Sweden, the only country in the table for which WTO cover a bilateral agreement and do not had direct services to Morocco in 2005.

Table 2. Mean test differences in characteristics of treated and control groups, offered seats sample. Year 2006

Characteristic	Treated	Control	Difference
Distance	1787 (78)	1942 (82)	156 (141)
Pop at origin	1758 (187)	2534 (395)	775 (649)
Pop at destination	4045 (542)	3525 (306)	-519 (597)
GNI at origin	5130 (0)	9768 (377)	4638*** (609)
GNI at destination	33907 (453)	34471 (309)	563 (573)
HHI	0.765 (0.034)	0.731 (0.021)	-0.0336 (0.0398)
$D^{immigrants}$	0.77 (0.058)	0.245 (0.037)	-0.529 ***(0.069)
$D^{Tourist}$	0.019 (0.019)	0.35 (0.04)	0.32*** (0.066)
ALI	10.45 (0.26)	7.31 (0.44)	-3.14*** (0.735)
Openness at origin	73.9 (0)	77.3 (1.24)	3.43* (2)
Open. at destination	72.6 (4.26)	71.9 (2.77)	-0.65 (5.19)

Notes: Standard errors in parenthesis. Statistical significance at 1% (***), 5% (**), 10% (*).

Table 3. Mean differences in characteristics of treated and control groups, probability of new routes sample. Year 2006

Characteristic	Treated	Control	Difference
Distance	1960 (20)	2278 (21)	317*** (17)
Pop at origin	814 (29)	1167 (49)	354*** (89)
Pop at destination	1625 (76)	1559 (41)	-66 (85)
GNI at origin	5130 (0)	8981 (91)	3851*** (163)
GNI at destination	34305 (125)	35271 (93)	965*** (181)
$D^{immigrants}$	0.522 (0.016)	0.122 (0.006)	-0.4*** (0.014)
$D^{Tourist}$	0.09 (0.009)	0.27 (0.008)	0.18*** (0.015)
ALI	9.65 (0.11)	5.05 (0.087)	-4.6*** (0.17)
Openness at origin	73.88 (0)	75.9 (0.265)	2.04*** (0.46)
Open. at destination	71.69 (1.13)	73.55 (0.62)	1.86 (1.28)

Notes: Standard errors in parenthesis. Statistical significance at 1% (***), 5% (**), 10% (*).

Table 4. Results of the estimates – Seats offered (country-pair sample)

Method	**IV –Pooled**	**Pooled**
Competition variables	**HHI**	**None**
D^{Open_skies}	0.050 (0.31)	0.223*** (0.09)
Controls		
Log(distance)	0.07 (0.27)	0.06 (0.11)
Log(population at origin)	0.57** (0.29)	0.56*** (0.11)
Log(population at destination)	0.44*** (0.18)	0.27*** (0.11)
Log(GNI at origin)	0.09 (0.13)	0.24 (0.16)
Log(GNI at destination)	2.16 (0.9)***	1.75 (0.48)***
Tourist_resorts	0.01 (0.01)	0.04*** (0.01)
Immigrants	1.25 (0.34)***	1.57 (0.17)***
Log(HHI)	-1.23 (1.9)	-
Log(Op at origin)	0.78 (0.77)	0.0007 (0.27)
Log(Op at destination)	-0.67 (0.63)	-1.07 (0.29)***
Intercept	-23.97 (10.6)**	-13.67 (4.9)***
Year fixed effects	YES	YES
Joint sig. test	15.25***	717.15***
R^2	0.66	0.99
Wooldridge test	48.62***	45.10***
Breusch-Pagan / Cook-Weisberg test	2.36	6.75***
F test (partial R2 of excluded instruments)	5.58**	-
Underidentification tests (Kleibergen-Paap LM statistic)	5.41**	-
Number of ids	44	44
Number observations	350	350

Notes: We apply an instrumental variables procedure (IV) when HHI is included as explanatory variable. Standard errors are in parenthesis. In the IV regression, standard errors are clustered at the route level. In the pooled regression, we assume an AR-1 process in the error term and standard errors are robust to heterocedasticity. Statistical significance at 1% (***), 5% (**), 10% (*).

Table 5. Results of the estimates – Seats offered in pre-existing routes

Method	**IV (Pooled)**	**IV (Fixed effects)**	**Pooled**	**Fixed effects**
Competition variables	**HHI**	**HHI**	**None**	**None**
D^{Open_skies}	-0.03 (0.12)	0.03 (0.10)	0.19*** (0.07)	0.24*** (0.09)
Controls				
Log(distance)	0.06 (0.09)	-	-0.08 (0.09)	-
Log(population at origin)	0.37*** (0.04)	0.82 (1.23)	0.37*** (0.02)	1.38 (1.51)
Log(population at destination)	0.27*** (0.04)	6.15*** (2.17)	0.34*** (0.03)	6.30*** (2.4)
Log(GNI at origin)	0.08 (0.11)	-1.65** (0.71)	0.14 (0.08)*	-1.63* (0.84)
Log(GNI at destination)	1.31** (0.45)	0.43 (0.72)	0.40 (0.56)	-0.17 (0.9)
$D^{Tourist}$	0.56** (0.22)	-	0.73*** (0.09)	-
$D^{inmigrants}$	0.31*** (0.12)	-	0.16 (0.10)	-
Log(HHI)	-0.92 (0.57)	-1.20*** (0.37)	-	-
Log(Op at origin)	0.44 (0.27)	-0.27 (0.26)	-0.05 (0.14)	-0.19 (0.28)
Log(Op at destination)	-0.30 (0.15)**	0.85 (0.61)	-0.19 (0.10)*	0.4 (0.72)
Intercept	-10.34** (4.33)	-	1.41 (5.04)	-31.14 (23.36)
Year fixed effects	YES	YES	YES	YES
Joint sig. test	26.03***	13.85***	926.62***	10.58***
R^2	0.53	0.25	0.98	0.22
Wooldridge test	22.93***	17.94***	19.62***	19.62***
Breusch-Pagan / Cook-Weisberg test	4.99***	0.05	4.4**	10.93**
F test (partial R2 of excluded instruments)	10.42***	29.06***	-	-
Underidentification tests (Kleibergen-Paap LM statistic)	8.42***	24.31***	-	-
Number of ids	191	191	191	191
Number observations	1501	1501	1501	1501

Notes: We apply an instrumental variables procedure (IV) when HHI is included as explanatory variable. Standard errors are in parenthesis. They are robust to heterocedasticity, and they are also clustered at the route level except in the pooled model where we assume an AR-1 process in the error term. Statistical significance at 1% (***), 5% (**), 10% (*).

Table 6. Results of the estimates –Probability of new routes openings

Dependent variable	$D^{air\_services}$	
Method	**Logit (pooled)**	**Logit (Fixed Effects)**
D^{Open_skies}	0.46 (0.13)***	1.24 (0.39)***
Odds Ratio	1.59*** (0.20)	3.45*** (1.37)
Controls		
Log (Distance)	-0.97 (0.14)***	-
Log (Population at origin)	0.84 (0.06)***	5.06 (4.53)
Log (Population at destination)	0.78 (0.05) ***	-15.87 (8.14)*
Log (GNI at origin)	0.29 (0.16)*	9.16 (4.36)**
Log (GNI at destination)	1.53 (0.46)***	-9.25 (2.88)***
$D^{Tourist}$	2.74 (0.22)***	-
$D^{Immigrants}$	0.90 (0.15)***	-
Log (openness at origin)	0.97 (0.37)***	2.96 (0.90)***
Log (openness at destination)	0.87 (0.18)***	1.06 (1.88)
Intercept	-33.40 (4.81)***	-
Year fixed effects	YES	YES
Joint significance test	513.26***	165.87***
R^2	0.20	-
Wooldridge test	78.87***	81.08***
Breusch-Pagan / Cook-Weisberg test	16624.90***	10378.35***
Number of ids	3895	299
Number observations	31160	2392

Notes: Standard errors are in parenthesis. They are robust to heterocedasticity and clustered at the route level in the pooled regression and applying bootstrap standard errors in the fixed effects regression. Statistical significance at 1% (***), 5% (**), 10% (*). In the fixed effects regression, 3596 groups (28768 observations) are dropped by Stata because the dependent variable has all positive or all negative outcomes.

Table 7. Results of the estimates – Seats offered: Matching sample

Dependent variable	**Log(seats)**			
Method	**IV (Pooled)**	**IV (Fixed effects)**	**Pooled**	**Fixed effects**
D^{Open_skies}	-0.028 (0.16)	0.0393 (0.19)	0.166* (0.09)	0.341*** (0.11)
Controls				
Log(HHI)	YES	YES	-	-
Intercept	-5.4 (7.7)	-	3.41 (8.71)	-109.1*** (38.58)
Other controls	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES
Joint sig. test	13.54***	5.49***	358.91***	4.75***
R^2	0.49	0.2	0.98	0.20
Number of ids	106	106	106	106
Number observations	836	836	836	836

Notes: We apply an instrumental variables procedure (IV) when HHI is included as explanatory variable. Standard errors are in parenthesis. They are robust to heterocedasticity, and they are also clustered at the route level except in the pooled model where we assume an AR-1 process in the error term. Statistical significance at 1% (***), 5% (**), 10%

Table 8. Results of the estimates – Probability of new route openings: Matching sample

Dependent variable	$\mathbf{D^{air\_services}}$	
Method	**Logit (pooled model)**	**Logit (Fixed Effects)**
D^{Open_skies}	0.35*** (0.14)	1.35** (0.69)
Odds Ratio	1.42*** (0.21)	3.84** (2.4)
Controls		
Intercept	-47.7*** (10.6)	-
Other controls	YES	YES
Year fixed effects	YES	YES
Joint significance test	246.9***	76.44***
R^2	0.19	-
Number of ids	1836	156
Number observations	14688	1248

Notes: Standard errors are in parenthesis. They are robust to heterocedasticity and clustered at the route level in the pooled regression and applying bootstrap standard errors in the fixed effects regression. Statistical significance at 1% (***), 5% (**), 10% (*). In the fixed effects regression, 1629 routes (13032 observations) are dropped because the dependent variable has all positive or all negative outcomes.

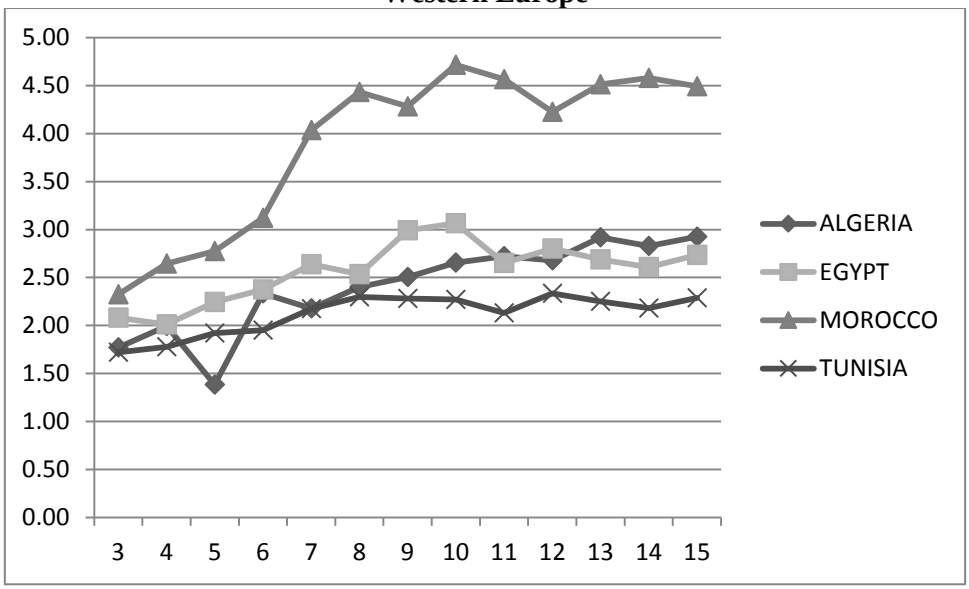
Table 9. Robustness checks: Falsification tests

Dependent variable	**Log (seats)**		**Probability of new route openings**	
Method	**Pooled**	**Fixed Effects**	**Logit (pooled model)**	**Logit (Fixed Effects)**
D^{Open_skies}	-0.032 (0.062)	-0.015 (0.08)	-0.24 (0.35)	-0.017 (0.88)
Controls	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES
Joint significance test	653.76***	12.23***	380.1***	79.23***
R^2	0.99	0.17	0.21	-
Number of ids	138	138	2905	193
Number observations	1085	1085	23240	1544

Notes: Standard errors are in parenthesis. Statistical significance at 1% (***), 5% (**), 10% (*).

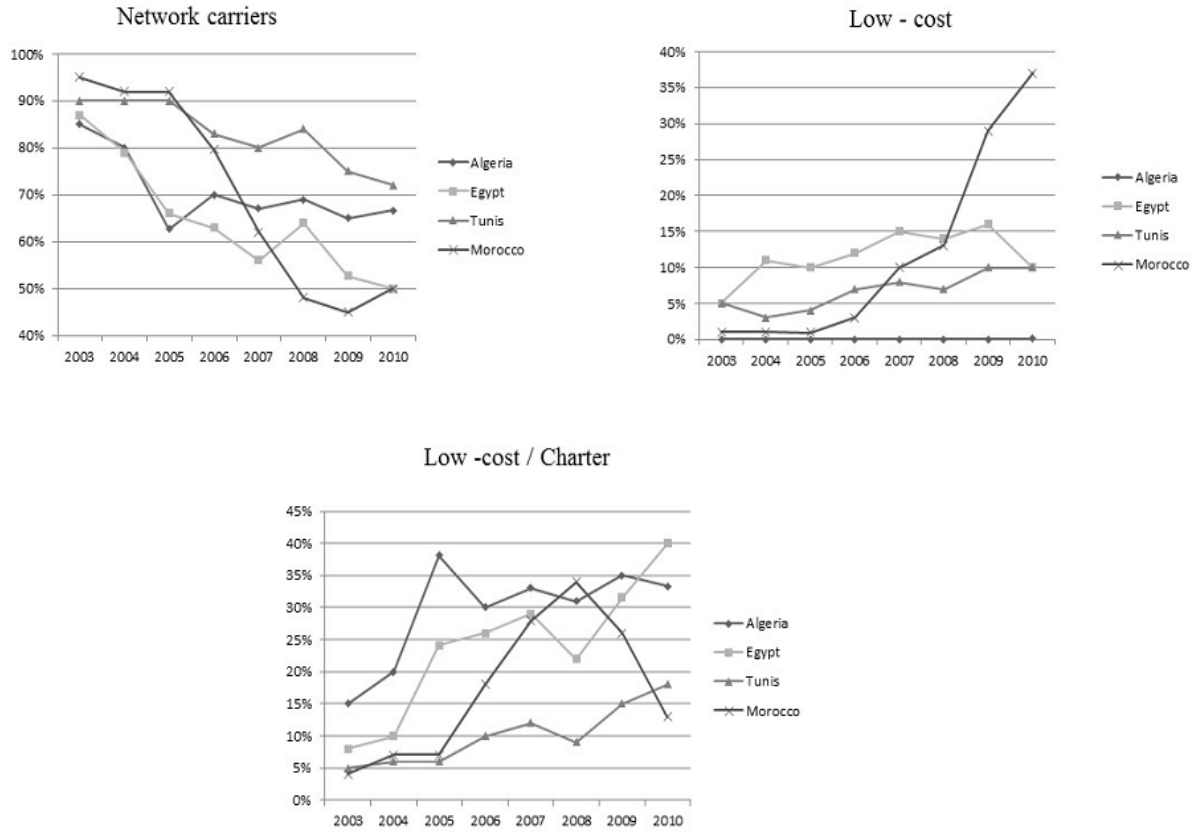
FIGURES

Figure 1. Evolution of the number of seats offered from North-African countries to Western Europe



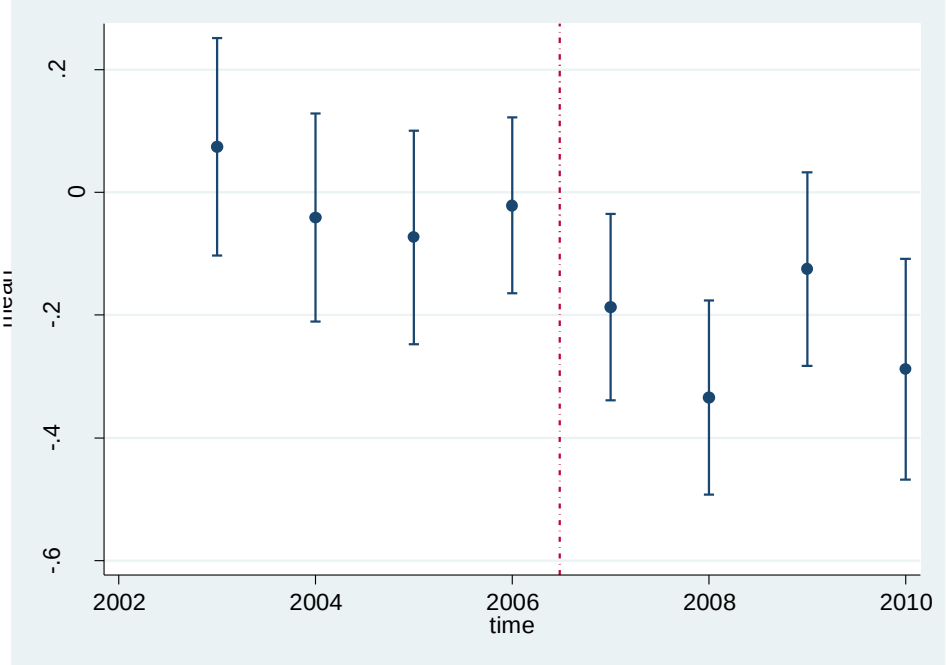
Note: Data is for the sample of routes considered in the empirical analysis. On the horizontal axis we refer to years (ie; 3 is 2003).

Figure 2. Evolution of the seats share by type of airline



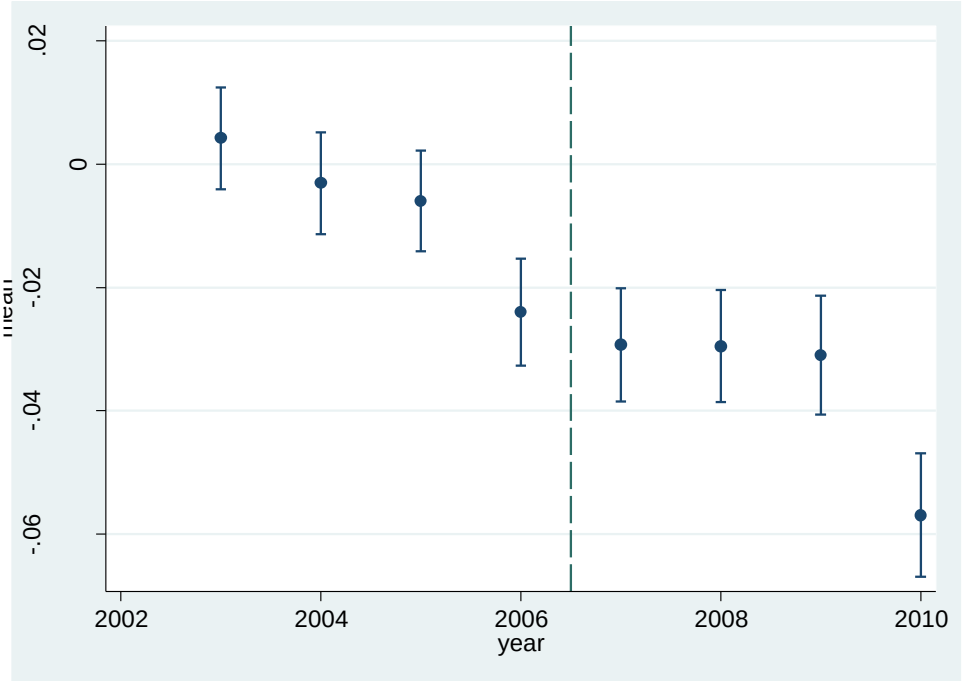
Note: Network carriers with flights in our sample are: Aegean airlines, Aer Lingus, Air Algerie, Air Europa, Air France, Air Mauritania, Alitalia, Austrian airlines, Brussels airlines, Egyptair, Iberia, KLM, Libyan airlines, Lufthansa, Luxair, Olympic airlines, Portugalia, Royal Air Maroc, SAS, Spanair, Sudan Airways, Swiss, TAP and Tunisair. Low-cost airlines are Arabia Maroc, Air Arabia Egypt, Air Berlin, Air One, Blue Wings, Clickair, easyjet, Eurofly, Flyglobespan, Germanwings, Jet2, Niki, Norwegian, Ryanair, Sterling, Transavia and Vuerling. Airlines that provide both charter and scheduled flights are Aero Flight, Air Austral, Aigle Azur, Air Finland, Atlas Blue, Condor, Corsair, First Choice, Flynordic, Fly Me Sweden Germania, Hahn air, Hapagfly, Hellenic Imperial Airways, HI Hamburg International, Jetairfly, Jet4you, LTU, MyTravel Airways, Monarch, Nouvelair Tunisie, Regional Air Lines, Thomas Cook, Thomson Airways, TUIfly, XL Airways.

Figure 3. Mean differences in seats offered by period. Treated and control groups.



Notes: The dot line divides periods in pre and post Openskies. The null hypothesis of equality of means between control and treated groups cannot be rejected for all years of the pre-reform period. The base category is the control group, so that greater differences after the OSA reflects the increase in the seats offered in the treated routes in relation to the control routes.

Figure 4. Mean differences in the probability of opening of new routes by period. Treated and control groups.



Notes: The dot line divides periods in pre and post Open skies. The null hypothesis of equality of means between control and treated groups cannot be rejected for 2003-2005 pre-reform

period. The base category is the control group, so that the greater differences after the OSA reflect the increase in the probability of openings in the treated routes in relation to the control routes.

Appendix

Table A1. Correlation matrix of the variables used in the empirical analysis (sample of existing routes)

	Seats	D^{Open_skies}	Distance	Pop origin	Pop destination	GNI or	GNI dest	Openness or	Openness dest	Tourist	Immigrants	HHI
Seats	1											
D^{Open_skies}	0.14	1.0										
Distance	-0.01	-0.05	1.00									
Pop origin	0.31	-0.05	0.23	1.00								
Pop destination	0.36	0.05	0.05	0.01	1.00							
GNI or	-0.01	-0.26	-0.11	-0.06	0.06	1.00						
GNI dest	-0.01	0.19	0.26	-0.04	-0.13	0.16	1.00					
Openness or	-0.04	0.06	-0.43	-0.3	0.01	0.28	0.22	1.00				
Openness destination	-0.16	0.03	0.22	-0.01	-0.32	0.003	0.59	0.1	1.00			
Tourist	-0.25	-0.21	0.4	-0.4	-0.17	-0.06	0.13	0.02	0.14	1.00		
Immigrants	0.18	0.31	-0.35	-0.10	0.11	-0.18	-0.16	-0.21	-0.17	-0.4	1.00	
HHI	-0.36	-0.13	-0.05	-0.07	-0.03	-0.04	-0.11	0.08	0.06	-0.1	-0.1	1.00

Table A2. Correlation matrix of the variables used in the empirical analysis (sample of potential routes)

	$D^{air\_services}$	Distance	Pop origin	Pop destination	GNI or	GNI dest	Tourist	D^{Open_skies}	Immigrants	Openness or	Openness dest
$D^{air\_services}$	1.00										
Distance	-0.06	1.00									
Pop origin	0.10	0.20	1.00								
Pop destination	0.18	0.02	0.0002	1.00							
GNI or	0.004	-0.24	-0.05	0.003	1.00						
GNI dest	0.02	0.15	0.009	-0.08	0.11	1.00					
Tourist	0.02	0.12	-0.24	-0.00	-0.08	0.00	1.00				
D^{Open_skies}	0.05	-0.09	-0.05	0.01	-0.23	0.12	-0.14	1.00			
Immigrants	0.10	-0.31	-0.03	0.03	-0.18	-0.2	-0.05	0.27	1.00		
Openness or	0.02	-0.29	-0.27	0.003	0.24	0.16	0.14	0.08	-0.06	1.00	
Openness destination	0.01	0.1	0.001	-0.15	0.02	0.61	0.00	0.01	-0.19	0.04	1.00