Getting there fast: Globalization, intercontinental flights and location of headquarters

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Abstract: Information exchanges across firms within cities are considered to be one of the major agglomeration forces in the regional economics literature. In addition, the quality of transport infrastructures arises as one of the major determinants in the location decisions of firms across cities and hence on urban economic growth. However, the significance of information exchanges between cities and the role of airports as a mean of managing such information efficiently has received much less attention. We deal with these issues through the empirical analysis of the determinants of the location of large firms´ headquarters across major European urban areas, focusing the attention on the attractiveness of a city for large firms due to the supply of non-stop intercontinental flights.

Keywords: Headquarters, Airports, Information.

JEL CODES: L93, R10, R58.

I. Introduction

Globalization has been one of the most prominent economic trends of the last decades, with large firms emerging as key players in the new system. Indeed, a common feature of the organization of many such firms is a dispersal of activities all over the world. In addition, the internal organization of those firms promotes spatial separation of headquarters from production plants. Indeed, headquarters are generally concentrated in a very few large metropolitan areas, while plants are dispersed across a much greater demographic and geographic range.

There are two agglomeration forces that are commonly mentioned as explaining the geographical concentration of headquarters. First, large metropolitan areas offer a wide diversity of large-scale business and financial intermediation services that make headquarters operations more efficient. And second, large metropolitan areas allow the clustered headquarters to exchange information and develop a heightened sense of market conditions. Davis and Henderson (2004), Henderson and Ono (2005) and Khan and Vives (2005) provide recent empirical evidence that both forces have strong positive effects on U.S. firms' decisions about headquarters location. Furthermore, Lovely et al. (2005) test empirically whether the need to obtain information contributes to headquarters agglomeration. They find that the spatial concentration of headquarters is higher among exporters to difficult markets than for other exporters or domestically oriented firms. That is, agglomeration increases as the need to obtain information about relative unknown markets also increases.

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Previous analysis of the headquarters location choices has focused on information exchanges within cities rather than between cities. However, executing information exchanges between cities can be critical for the headquarters of large firms that operate on a global scale. Indeed, the role of headquarters in a corporation is to coordinate and command activities within the firm. This always involves managing information across establishments (which are often geographically dispersed), gathering information about outside market conditions, and providing service functions with highly specific knowledge content, such as advertising, accounting and legal services. Thus, analysis of the location decisions of large firms´ headquarters allows us to test explicitly the extent to which place affects the ability to manage inter-city information efficiently.

Within this context, the quality of passenger transportation networks is a key input for processing and transmitting information efficiently because it influences the costs and opportunities for face-to-face contacts between cities. Indeed, it can be argued that large (global) firms should demand international accessibility when choosing a headquarters location.

The objective of this paper is to examine the location choices of headquarters of large firms in major European urban areas. In doing so, we control for factors such as city size, income per capita, relative specialization in high order services, corporate taxes and the provision of air services. In the latter case, we focus particularly on the role of the supply of direct (non-stop) intercontinental flights, as a differential indicator of the quality of air services. Indeed, our methodology relies on estimating an equation system that accounts for the possible endogeneity in the causal relationship between headquarters and intercontinental flights. A significant causal relationship between the location of large firms' headquarters and the supply of direct intercontinental flights would provide evidence of the importance of efficiently managing personal information exchanges between cities. Such a result would also provide additional empirical evidence of the relevance of information exchanges as an agglomeration force. This would be so because airports providing direct intercontinental services are generally associated with large amounts of investment, which would not be economically sound in small cities.

The link between the quality of airport facilities and urban economic growth has been analyzed in several studies. Indeed, Bowen (2002) argues that an increasing proportion of commerce is carried out via air transport, especially for high-value, low-bulk goods. In addition, planes are the preferred mean of travel for tourists, international migrants, and businesspeople. Brueckner (2003) shows that a good endowment of airport facilities fosters intercity agglomeration economies and influences the location decision of firms. Button et al. (1999) find the existence of a very significant relationship between employment in high-technology industries and the availability of a large airport across 321 US Metropolitan Statistical Areas. However, the link between the location of headquarters and the potential of airport services in the efficient management of personal information has not yet been tested empirically. As far as we know, only Khan and Vives (2005) show a positive relationship between the location of U.S. headquarters (of non-manufacturing firms) and the availability of airport services. However, the major effect results from a city either having, or not having, a large airport.

At this point, we must explain why an urban area should seek to attract the headquarters of large firms. First, a high agglomeration of such offices both reflects and is a causal factor in the economic power of a region (Holloway and Wheeler, 1991; Meijer, 1993). Second, headquarters are major consumers of high-skilled and well-paid labor (Klier and Testa, 2002). And third, a high concentration of large firms´ headquarters in knowledge intensive sectors may promote technological spillovers in the neighborhood.

The remainder of this paper is organized as follows. We next state the theoretical framework that motivates our empirical analysis. The third section is devoted to formulating our empirical strategy. We then describe the data used in the empirical analysis. In the fifth section, we comment on the results of our estimates and their implications. The last section is devoted to concluding remarks.

II. The theoretical framework

There are three general trends in the organization of the modern large corporation that are relevant to our purposes. First, large corporations tend to separate production from management functions spatially in spite of the expected increase in coordination costs (Duranton and Puga, 2002). Second, large corporations tend to operate geographically on a global scale, particularly in knowledge–intensive industries (Markusen, 1995). And third, large corporations tend to outsource many activities to external suppliers (Perry, 1989).

These general trends can only be profitable for a firm when transport and communication costs are relatively low. The bulk of the globalization process has been based on a substantial reduction in transport costs over the 20th century, while the costs of moving people (communication costs) are as significant as ever (Glaeser, 1998; Glaeser and Kohlhase, 2003). As Glaeser (1998) argues, two factors explain the reduction in the costs of moving goods. Technologies for moving goods have been improved, and the value added per ton has increased, so that we are now shipping fewer tons of goods relative to GDP than we have in the past. On the other hand, two factors explain why moving people is still costly. First, these costs depend mainly on the travel time's opportunity cost, which increases with income. And second, the effects of advances in information technologies on the need for face-to-face interactions are ambiguous. Indeed, electronic and face-to-face contacts, while they can be complements (Gaspar and Glaeser, 1998), are not necessarily equivalents.[1] Storper and Venables (2004) have formalized the idea that face-to-face contacts have unique advantages as a mean of communication, coordination and motivation.

Furthermore, given that codified information is available everywhere, the information that makes a geographic difference is of the type that can be transmitted only by face-to-face contact.[2]

The relevance of face-to-face contacts is such that the costs of organizing human resources across markets (transaction costs) and within firms (management costs) are substantial. To this point, the Cost Transaction approach is one of the most powerful tools for analyzing the modes in which corporations organize production and management functions. This approach is based on the proposition that corporations choose between markets and vertical integration as alternative institutions according to a cost minimization procedure, which includes both production and exchange costs. The recognition that it is costly to obtain, process and transmit knowledge (say, information as a firm specific asset) arises as a crucial feature in the costs involved in the multiple personal relationships that a large corporation must develop (Williamson, 1979; Demsetz, 1988). Regardless of the extent to which a large corporation uses internal or external resources to develop its operations, both transaction and management costs play an important role in the overall cost structure of such firms. Thus, where these costs differ with location, they must play an important role in sitting decisions.

Lower transaction costs must be one reason why many corporations locate their headquarters in places with a high availability of business and financial services providers. Furthermore, large corporations must locate their management centers (headquarters) in places characterized not only by a high availability of business and financial services but also in places that are efficient nodes for managing information within the firm. C*eteris paribus* only locations with a convenient provision of transport services will allow minimization of management costs.

Within this context, it is worth noting that headquarters are not generally treated as independent profit centers, since neither their production nor their prices can be observed as long as their activities are not sold in the market. However, a headquarters will be located in the places with the lowest costs for their sort of activity. Indeed, firms will locate their headquarters where they can maximize their contribution to profits.

[1]Van Geenhuizen and Doornbos (2005) provide recent evidence of the important role of the Amsterdam airport in the management of global knowledge networks. This case study is focused on the behaviour of young high-tech firms. Interestingly, they find that the use of videoconferencing and the expenditures in travel flights are positively correlated.

[2] According to Jacobs (1968), the type of information that is particularly important for urban growth refers to the type of tacit information that can only be transmitted by personal means.

Following Polèse and Sheamur (2004), headquarters specific costs (*CH*) of firm *i* located in region *r* can be expressed by a simple equation:

$$CH_{ir} = I^{in}_{ir} + I^{out}_{ir} + I^{output}_{ir} \quad (1)$$

where the total cost of headquarters is composed by the sum of the cost of obtaining information from within the firm (I^{in}), the cost of obtaining information from outside the firm (I^{out}) and the cost of transmitting its output to other establishments of the firm (I^{output}).

Given that the firm can process the information through internal sources or through outsourcing, equation 1 can be expressed as follows:

$$CH_{ir} = (\omega_l L)_{ir} + (\omega_e E)_{ir} + MC_{ir} + (c_o Q)_{ir} \quad (2)$$

where L and E are the units of labor and external services providers, respectively, required to produce the units of output, Q (information), while ω_l and ω_e are the unit labor costs of employees and external suppliers. MC is the cost involved in acquiring knowledge about outside market conditions from other headquarters. Finally, c_o is the unit communication cost for transmitting Q to other establishments of the firm.

Firms will have a strong preference for setting headquarters in locations with a highly diversified pool of skilled business services providers and skilled labor, because those locations will minimize total labor costs of employees ($CL = \omega_l L$) and external suppliers ($CE = \omega_e E$). The larger the urban area is, the higher the availability of skilled business services providers and skilled labor. However the largest urban areas can afford some congestion costs that lessen such advantages. In addition, costs of information exchanges about market conditions (MC) will be less costly when clustering with headquarters of other firms takes place (Shilton and Stanley, 1999).

Firms will also have a strong preference for setting headquarters either in locations near to their other establishments and/or in places that are nodes of passenger transportation networks, because those locations will minimize the total costs of transmitting information ($CT = c_o Q$).

Choosing the region *r* results in the minimum achievable headquarter costs relative to other locations. Thus, given equation (2), the probability of a firm *i* locating in region *r* follows the rule:

$$\text{Prob}\ (CH_{ir} < CH_{ik}) \text{ for all } k \neq r \quad (3)$$

where

$$CH_{ir} = CL_{ir}(S_r) + CE_{ir}(S_r, ESP_r) + MC_{ir}(.) + CT_{ir}(R_r)$$
$$CH_{ik} = CL_{ik}(S_k) + CE_{ik}(S_k, ESP_k) + MC_{ik}(.) + CT_{ik}(R_k)$$

S_r (S_k) refers to the economic size of location *r* (*k*), ESP_r (ESP_k) refers to the relative specialization of location r (*k*) in business and financial services and R_r (R_k) to the quality of the passenger transportation networks in *r* (*k*).

Hence we can model the determinants of the number of firm's headquarters in location r (HQ_r) through the following equation:

$$HQ_r = F\,[CL_r(S_r), CE_r(S_r, ESP_r), MC_r(.), CT_r(R_r)] + \varepsilon_{ir}, \qquad (4)$$

$$\text{where } \frac{\partial HQ_r}{\partial CL_r}\frac{\partial CL_r}{\partial S_r} \geq 0,\ \frac{\partial HQ_r}{\partial CE_r}\frac{\partial CE_r}{\partial S_r} \geq 0,\ \frac{\partial HQ_r}{\partial CE_r}\frac{\partial CE_r}{\partial ESP_r} \geq 0 \ \ and\ \frac{\partial HQ_r}{\partial CT_r}\frac{\partial CT_r}{\partial R_r} \geq 0$$

In equation (4), ε_{ir} represents any unobserved location or firm specific factors. Note that MC_r (MC_k) depend on the amount of headquarters in region r, so that its explanatory variables are the same as those of the dependent variable, HQ_r. This is the case because we are dealing with the influence of regional attributes rather than firm attributes.[3]

Taking into account that the economic size of location r (S_r) will depend on population (*POP*) and income per capita (*GDP*), from (4) the final equation that is the basis of our empirical analysis can be expressed as follows:

$$HQ_r = F\,[POP_r, GDP_r, ESP_r, R_r] + \varepsilon_{ir}. \qquad (5)$$

III. The empirical strategy

Our empirical strategy relies on estimating an equation system that accounts for the determinants of large firms´ headquarters location choices in major European urban areas. The main focus is to test the relevance of those costs related to obtaining and transmitting personal information to these location choices. Controlling for the other factors, we want to disentangle the extent to which lowest cost locations in terms of CT_r are attractive for the headquarters of large firms.

[3] Indeed, our sample is based on data aggregated at the urban area level, so that any influence of firm attributes should be captured by the error term representing unobserved factors.

No doubt the costs of transmitting information from headquarters to other establishments within a firm have trended down. Nevertheless, large multi-location firms (frequently with a transnational orientation) will incur noteworthy costs from the coordination of their worldwide activities. These costs will mainly differ across metropolitan areas according to the quality of transport services supply.

Within Europe, differences in the quality of passenger transportation networks across major urban areas are mainly related to the availability of direct intercontinental flights, both the number of destinations and the flight frequency of each connection.[4] Indeed, urban centers above a critical mass of population can provide the transport infrastructure necessary for firms that operate at a regional, national or European level. However, the largest firms operating at a global scale will tend to move to the top of the urban hierarchy, which is not based uniquely on demographic size.

Thus, our main causal relationship of interest refers to the number of large firms´ headquarters and the availability of direct intercontinental flights across major European urban areas. A crucial issue in the empirical implementation of such a causal relationship is to consider the existence of a possible endogeneity bias. Indeed, headquarters of large firms must be located in urban areas with a convenient provision of direct intercontinental flights but, at the same time, urban areas may only have a good provision of direct intercontinental flights if a critical mass of headquarters demands such air services. Thus, one must estimate simultaneously an equation system that accounts for such a possible endogeneity bias. The equation system to be estimated can be expressed in the following linear form:[5]

$$headquarters_r = \alpha + \beta_1 POP_r + \beta_2 GDP_r + \beta_3 ESP_r + \beta_4 fq^{intercontinental}_r + \beta_5 CT_r + \varepsilon_1 \quad (6)$$

$$fq^{intercontinental}_r = \delta + \gamma_1 POP_r + \gamma_2 D^{capacity}_r + \gamma_3 headquarters_r + \varepsilon_2 \quad (7)$$

where the dependent variables are, respectively, the number of headquarters of the 1000 largest European firms located in the corresponding urban area r ($headquarters_r$) and the weekly frequency of direct intercontinental flights at the airports of the corresponding urban area ($fq^{intercontinental}_r$). Both variables enter as explanatory variables in the other equation of the system. In the next section,

[4] In this regard, recall that most of the major urban areas in Europe are well connected through a dense network of highways and high-speed trains, taking into account that distances around the core spatial areas (e.g blue banana) are short. In addition, large urban areas characterized by a more dispersed location (such as Lisbon, Madrid, Rome or Oslo) have available frequent airline connections (often at a low cost) to a vast number of European destinations.

[5] Kernel regressions between the different variables involved show that the linear form is a suitable functional form to parameterize our equation system. These regressions are available from the authors upon request.

we explain the choice criterion for constructing the sample of major urban areas and for constructing the sample of intercontinental destinations.

We include the population of the urban area (POP_r) as a common explanatory variable. Indeed, as we have mentioned in the previous section, the size of the city will have a major influence in most of the components of the headquarters cost function. The largest urban areas offer the highest availability of high-skilled labor, business and financial service providers, and other firms from the same or different sectors. Although such areas also involve the higher congestion costs, the sign of its coefficient in the headquarters equation is expected to be positive.

Additionally, population should condition the availability of major transport infrastructures as long as it determines the scale of its demand. Indeed, airlines should choose their hubs according to several location factors (Martin and Roman, 2004): potential traffic in and out of the urban areas (which depends mostly on population and the degree of tertiary activities), quality of airport facilities and geographical location in relation to markets served. In order to capture the quality of airport services, we include, as an additional explanatory variable of the supply of intercontinental flights, a variable for airport capacity ($D^{capacity}_r$). The geographical location should not affect the overall supply of intercontinental flights because those locations that, for example, are best placed to serve American destinations are, at the same time, worst placed to serve Asian destinations.[6]

Additional explanatory variables of the location of headquarters include a variable for income per capita (GDP_r), whose sign is a *priori* ambiguous. Indeed, the variable for income per capita captures the lower recruitment costs (because highly skilled workers are more common in wealthier regions) but also higher costs in terms of salaries. Furthermore, since corporate taxation differs between European countries, corporate taxes (CT_r) could also play a significant role in the headquarters location choice, so that this variable is also incorporated in the equation to estimate.[7]

Finally, a higher specialization in business and financial services (ESP_r), controlling for population, should negatively influence the costs of dealing with external suppliers. Any possible endogeneity bias for this variable is avoided as long as we use data of a previous period in relation to the data used for the headquarters variable.

[6] In fact, we experimented with different measures of geographical location in the empirical analysis but those measures result insignificant.
[7] See Oates (2001) for a survey about fiscal competition focused on the European Union case.

ε_1 and ε_2 are random error terms identically and independently distributed. In the appendix, we explain in detail the construction of each variable, the data sources and the sector composition of the headquarters data.

Even accounting for the possible endogeneity bias and the control variables, one could argue that the finding of a significant relationship among the location of headquarters and the supply of non-stop intercontinental flights could simply reflect the fact that headquarters locate in the most prominent European economic poles, which logically have the major airports. In order to take our analysis beyond such a correlation, that is, in order to assure its causal underpinning, we estimate alternative specifications of our equation system according to the treatment of the headquarters variable.

Indeed, we differentiate between sectors according to the OCDE classification of knowledge-intensive sectors (see table A1 in the appendix for details). For comparative purposes, we differentiate among sectors according to their knowledge content using a common threshold in the volume of sales. In particular, we choose as a criterion annual net sales greater than 10,000 million U.S. dollars: a volume of sales high enough to consider them to be large size firms.

Knowledge-intensive sectors are supposed to be more sensitive to the benefits and costs of specific information exchanges than non-knowledge-intensive sectors. In the former case, information as a firm specific asset is more valued. Additionally, knowledge-intensive activities should be freer to locate away other firms' establishments and distant from final markets, as long as the transportation of heavy goods is not involved. In contrast, the positive correlation among the number of headquarters and the prominence of an urban area as an economic and demographic center, and hence the size of the corresponding airport, should be the same for both knowledge-intensive and non-knowledge-intensive sectors.

Indeed, alternative specifications of the headquarters location equation should be expressed as follows:

1. Knowledge-intensive sectors (ki):

$$headquarters^{ki}_{r} = \alpha^{ki} + \beta_1^{ki} POP_r + \beta^{ki}_2 GDP_r + \beta^{ki}_3 ESP_r + \beta^{ki}_4 fq^{intercontinental}_{r} + \beta^{ki}_5 CT_r + \varepsilon^{ki} \qquad (8)$$

2. Non-Knowledge-intensive sectors (nki):

$$headquarters^{nki}_{r} = \alpha^{nki} + \beta_1^{nki} POP_r + \beta^{nki}_2 GDP_r + \beta^{nki}_3 ESP_r + \beta^{nki}_4 fq^{intercontinental}_{r} + \beta^{nki}_5 CT_r + \varepsilon^{nki} \qquad (9)$$

where $headquarters^{ki}$ ($headquarters^{nki}$) refers to the number of headquarters of firms with annual net sales greater than 10,000 million U.S. dollars in knowledge-intensive sectors (non knowledge-intensive sectors). The quality of passengers transport networks should have a major influence on the headquarters location decision for knowledge-intensive sector than for non knowledge-intensive sectors if its effect is related to managing personal information more efficiently. Thus, a positive correlation among headquarters location and the supply of intercontinental flights will imply a causal relationship in terms of processing personal information more efficiently only in case that $\beta^{ki}_4 > \beta^{nki}_4$.

Furthermore, some sort of localization economies could be inferred in case that the relative specialization in business and financial services have a major influence on the headquarters location decision for knowledge-intensive sectors than for non knowledge-intensive sectors. Indeed, we would find evidence that benefits from information exchanges between firms of the same sector are relevant only in case that $\beta^{ki}_3 > \beta^{nki}_3$. This is so because a high proportion of knowledge-intensive sectors focus on business services (excluding real state) and financial intermediation. Table A2 in the appendix provides the details of the sector composition of the headquarters data, both for knowledge-intensive and non knowledge-intensive activities.

IV. Data

In the sample of European cities we include major urban areas from the EU25 + Switzerland and Norway. Major urban areas refer to the most populated areas (urban areas with more than 1 million inhabitants) and/or urban areas with a population of about 1 million inhabitants and with a large airport (airports included in the European top 50 in terms of total traffic). Our sample of cities concentrates about 80 per cent of the headquarters of the 1000 largest firms and about 100 per cent of the supply of intercontinental flights from European airports. Table 1 provides the list of the European cities included in our sample.

The sample of intercontinental destinations includes the largest non-European airports in terms of international scheduled traffic to and from each geographical area (North America, Latin America, Middle East, Far East, Africa and Oceania) which are located more than 3450 kilometers (2150 miles) from any European airport. The distance threshold is related to the longest intra-European route with direct flights; Lisbon-Stockholm. We exclude tourist destinations because our main purpose is to examine the influence of air traffic on firms´ headquarters location. Table 2 provides a list of the intercontinental destinations included in our sample.

Insert table 1 about here
Insert table 2 about here

Concerning intercontinental flights, table 3 shows travel time differences among direct and non-direct flights for selected destinations. We compute travel times of direct flights with the lowest price and travel times of the non-direct flights with the lowest total travel time. We use this criterion in order to obtain the maximum comparability between the alternatives. Indeed, Lijensen et al. (2002) show that direct and non-direct flights are imperfect substitutes. However, an indirect flight is not a substitute if it lasts twice or more as long as the direct flight.

According to table 3, travel time differences between direct and indirect flights seem to be about 20 per cent or more, recognizing that average differences should be in practice higher due to the conservative criterion that we use. Additionally, non-direct services carry additional costs in terms of lower quality that are not captured by the total travel time. The overall inconvenience and uncertainty of taking two flights is significant, and the waiting time is higher when a direct alternative is not available.[8] Following the seminal work of Mohring (1972), the empirical literature on transportation costs, which has developed the concept of generalized cost that includes both monetary and time costs, assigns a high weight to waiting time. Time costs, in general, are logically much higher for business trips than for leisure trips.

Insert table 3 about here

Tables 4 and 5 show the descriptive statistics and the correlation matrix of the variables used in the empirical analysis. From the correlation matrix, it can be inferred that an endogeneity bias could take place due to the high correlation between the supply of intercontinental flights and the number of headquarters across urban areas. Additionally, the matrix shows that all the variables for the number of headquarters are highly correlated with the size of the urban area in terms of population and with the size of the airport in terms of capacity. Thus, the analysis of the causal relationship associated with efficiencies in information exchange needs further empirical analysis. The next section is devoted to comment on the results of the equation system estimates

Insert table 4 about here
Insert table 5 about here

V. Results

It can be easily shown that our system of equations is identified because excluded exogenous variables from one equation in the system identify the other equation in the system. It is common to estimate identified systems through some method based on the Instrumental Variables Technique. Tables 6 and 7 show the results of the equation system estimated, using both the

[8] The waiting time is the difference between the most preferred time of departure and the real time of departure.

Ordinary Least Squares (OLS) and the Three Stage Least Squares (3SLS) estimators.[9] Some differences are found in the results according to the technique, although they are not substantial. Thus, the possible endogeneity bias could be statistically troublesome.

Insert table 6 about here
Insert table 7 about here

Regarding the supply of intercontinental flights, the variables for headquarters and airport capacity have the expected signs and are highly significant. The variable for population is generally not significant. This last result does not imply that population has no influence on the supply of intercontinental flights. Our results show that above a threshold level (e.g. 1 million inhabitants) the size of the city does not matter. In fact, some of the largest European hubs (such as Frankfurt, Amsterdam or Zurich) are not much above the threshold level. Strategic considerations of airlines (and governments) must play a significant role. Such strategic considerations are beyond the scope and objectives of this paper.

It could be argued that income per capita and the relative specialization in financial and business services should be also relevant explanatory variables concerning the demand of intercontinental flights due to specific economic activity requirements. Both variables are highly correlated with the number of headquarters, so that if all were included that would lead to multicollineality. In fact, they capture essentially the same factor with regard to the effect on the supply of intercontinental flights; the volume of tertiary activities in an urban area. All variables are significant when estimated separately. However, the variable for headquarters increases the global significance of the equation by about ten per cent.

Regarding the location of headquarters, the variables for the supply of intercontinental flights, population and income per capita have a positive and significant effect. Given the value of the coefficients, such significance arises both in statistical and economic terms. Regarding intercontinental flights, a 10 per cent increase in their provision involves around a 4 per cent increase in the number of headquarters located in the corresponding urban area (see table 8 below).

The variable for corporate taxes is not significant. This could be reflecting the fact that variability in corporate taxation across European countries is low, although there are some exceptions, such as Ireland at the lower bound and Germany at the upper. Finally, evidence on the relevance of the specialization in business services and financial intermediation is mixed.

Table 8 shows the elasticity estimates derived from the headquarters equation according to the data used for constructing the variable for number of headquarters. The coefficient of the

[9] We do not present results with the Two Stage Least Square Estimator (2SLS) because they are substantially identical to 3SLS results.

variable for the supply of intercontinental flights more than doubles its value when data refers to knowledge-intensive activities than when data refers to non-knowledge-intensive activities. In fact, this variable is not significant in the estimation using the 3SLS estimator for non-knowledge-intensive activities.

In a similar fashion, the coefficient of the variable for the relative specialization in business services and financial intermediation takes a greater (and statistically significant) value when data refers to knowledge-intensive activities than when data refers to non-knowledge-intensive activities.

Finally, both the coefficients of the variables for population and income per capita take a lower value in relation to knowledge-intensive activities than to non-knowledge-intensive activities. A possible interpretation of this result is that headquarters of knowledge-intensive activities do not need to locate near dense final markets because costs of moving goods are even less relevant than for other activities.

Insert table 8 about here

To sum up, our results demonstrate the relevance of information exchanges between cities in deciding were to locate headquarters. Such exchanges involve personal information since air travel reflects the value of the face-to-face contact in contrast to the coded information that flows by electronic means. Furthermore, our results show the relevance of the quality of air services to the appeal of an urban area for large firms, and hence offer additional empirical evidence of the contribution of airports to urban economic growth.

VI. Concluding remarks

In this paper we have measured the existence of a causal relationship between the supply of direct intercontinental flights and the location choices of large firms´ headquarters, estimating an equation system for a sample based on major European urban areas.

Controlling for several factors and taking into account the existence of a possible endogeneity bias in such a relationship, we find that the supply of direct intercontinental flights is effectively a major determinant in the location choices of large firms´ headquarters. Indeed, a 10 per cent increase in the supply of intercontinental flights involves around a 4 per cent increase in the number of headquarters of large firms located in the corresponding urban area. In addition, our results show that headquarters of knowledge-intensive sectors are much more influenced by the supply of direct intercontinental flights than are those of non-knowledge-intensive sectors.

Given the substantial benefits that urban areas can obtain from attracting large firms´ headquarters, our results provide new evidence of the contribution of transport infrastructures to urban growth. Additionally, as long as the causal relationship measured appears to be much stronger for knowledge-intensive sectors than for non-knowledge-intensive sectors, our results provide empirical evidence of the importance of exchanges of personal information between cities. Finally, since these exchanges are between cities on different continents, new insights into the globalization process can be inferred.

Regional policies aimed at attracting headquarters of large firms and/or knowledge-intensive activities must promote the development of international airports. In particular, investments to expand and/or improve their capacity and possibly the implementation of commercial strategies to attract major airlines are critical factors for the success of such policies.

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Tables

Table 1. Sample of European urban areas (EU25 + Norway and Switzerland)

Amsterdam	Helsinki	Paris
Athens	Köln-Bonn	Porto
Barcelona	Leeds	Prague
Berlin	Lille	Rome
Bielefeld	Lisbon	Rotterdam-The Hague
Birmingham	Liverpool	Seville
Brussels	London	South Ruhr (Düsseldorf-Wuppertal)
Budapest	Lyon	Stockholm
Central Ruhr (Essen-Dortmund-Duisburg)	Madrid	Stuttgart
Copenhagen	Manchester	Toulouse
Dublin	Marseille	Turin
Frankfurt	Milan	Valencia
Geneva	Munich	Vienna
Glasgow	Naples	Warsaw
Gothenburg	Newcastle	Zurich
Hamburg	Oslo	

Table 2. Sample of destinations for intercontinental flights

Atlanta	Hong Kong	Osaka
Bangkok	Houston	Philadelphia
Beijing	Islamabad	Rio de Janeiro
Bogotá	Jakarta	Santiago de Chile
Bombay	Johannesburg	Sao Paulo
Boston	Kuala Lumpur	Seoul
Buenos Aires	Los Angeles	Shangai
Caracas	Manila	Singapore
Chicago	Miami	Sidney
Colombo	Montreal	Taipei
Dallas	Mexico DF	Tokyo
Denver	Nairobi	Toronto
Doha	New York	Washington
Dubai	New Delhi	

Table 3. Ratio of travel times between non direct and direct flights in selected intercontinental destinations (February 2005)

Destination	Distance range (kilometers)[1]	Travel time direct flight (average minutes per km)[2] (1)	Travel time non direct flight (average minutes per km)[2] (2)	Ratio Travel time direct and non direct flights (2)/(1)
Dubai (DXB)	4500-5000	0.066	0.117	1.78
	5000-5500	0.067	0.099	1.48
	5500-6000	0.065	0.090	1.38
	6000-6500	0.067	0.094	1.40
New York (JFK, EWR)	6000-6500	0.075	0.106	1.41
	6500-7000	0.076	0.097	1.28
	7500-7500	0.074	0.092	1.25
Pekin (PEK)	8000-8500	0.066	0.082	1.24
	8500-9000	0.064	0.086	1.33
	9000-9500	0.066	0.078	1.17
Bangkok (BKK)	9000-9500	0.064	0.085	1.33
	9500-10000	0.063	0.079	1.25
	10000-10500	0.060	0.072	1.20
	10500-11000	0.061	0.075	1.22
Sao Paulo (SAO)	9100-9600	0.069	0.084	1.23
	10600-11100	0.065	0.079	1.21
Los Angeles (LAX)	9600-10100	0.068	0.087	1.27
	10100-10600	0.070	0.087	1.25
	10600-11100	0.066	0.080	1.20

[1]We compute distance ranges in which our data covers more than one city-pair link with direct flights and more than one city-pair link with non direct flights. Results show average values across the corresponding city-pair link in each distance threshold.

[2] We compute travel times of direct flights with the lowest price and travel times of the non direct flights with the lowest total travel time.

Source: Web site of Travelocity

Table 4. Descriptive statistics

Variable	Mean	Standard deviation	Minimum value	Maximum value
$fq^{intercontinental}$ (number of weekly flights)	76.38	180.14	0	1021
headquarters (1000 large firms)	16.72	26.66	0	143
headquarters (large firms of non knowledge-intensive sectors)	23.53	29.59	0	135
headquarters (large firms of knowledge-intensive sectors)	13.23	20.76	0	110
population (number of inhabitants of the urban area)	2,213,801	1,840,403	471,314	9,932,000
regional income per capita (euros)	27,999	11,842	8,162	63,170
relative specialization in business services and financial intermediation (Hoover-Balassa index)	2.11	0.55	1.26	3.53
corporate taxes	4.83	1.006	1	6
$D^{capacity}$	0.12	0.33	0	1

Table 5. Correlation matrix

	fq^{int}	hq	hq2	hq3	Pop	GDP	$D^{capacity}$	CT	ESP
fq^{int}	1								
Hq	0.86	1							
hq2	0.86	0.97	1						
hq3	0.89	0.97	0.94	1					
Pop	0.70	0.72	0.72	0.72	1				
GDP	0.28	0.42	0.47	0.41	0.05	1			
$D^{capacity}$	0.75	0.61	0.58	0.67	0.49	0.17	1		
CT	0.07	0.18	0.20	0.17	0.23	-0.17	0.13	1	
ESP	0.51	0.51	0.54	0.58	0.20	0.52	0.49	0.03	1

Abbreviations of the variables:

fq^{int}: weekly frequency of intercontinental flights in the corresponding airport
hq: Headquarters of the 1000 largest European firms
hq2: Headquarters of large European firms in non knowledge-intensive sectors
hq3: Headquarters of large European firms in knowledge-intensive sectors

Table 6. System equation estimates (number of observations: 47).

Dependent variable (Headquarters of 1000 largest firms)		
	OLS	**3SLS**
POP	4.59e-06 (1.73e-06)**	5.60e-06 (1.95e-06)***
GDP	0.0005 (0.0002)**	0.0004 (0.0001)***
ESP	2.46 (3.78)	5.52 (4.35)
$fq^{intercontinental}$	0.080 (0.017)***	0.065 (0.026)**
CT	0.49 (2.87)	-0.51 (1.59)
Intercept	-21.43 (15.92)	-22.69 (11.88)*
R^2	0.82	0.81
Test F[1]	55.27***	189.87***
Dependent variable ($fq^{intercontinental}$)		
	OLS	**3SLS**
POP	0.000012 (0.000011)	0.000011 (0.000011)
$D^{capacity}$	188.41 (76.94)**	185.70 (48.30)***
headquarters	3.70 (1.04)***	3.81 (1.15)***
Intercept	-37.64 (24.00)	-37.18 (18.02)**
R^2	0.82	0.83
Test F[1]	14.79***	203.36***

Note 1: For 3SLS, we use Test Wald (χ^2)
Note 2: Standard errors robust to heterocedasticity
Note 3: Significance at 1% (***), 5% (**),10% (*).

Table 7. System equation estimates (number of observations: 47).

Dependent variable (Headquarters)	(1) Headquarters of firms in non knowledge intensive industries (sales > 10,000 million USD)		(2) Headquarters of firms in knowledge intensive industries (sales > 10,000 million USD)	
	OLS	**3SLS**	**OLS**	**3SLS**
POP	6.95e-06 (1.85e-06)***	7.39e-06 (2.30e-06)***	2.65e-06 (1.01e-06)**	2.99e-06 (1.25e-06)**
GDP	0.0008 (0.00025)***	0.0007 (0.0002)***	0.0003 (0.0001)***	0.0003 (0.0001)***
ESP	7.24 (4.68)	9.02 (5.30)*	4.97 (2.20)**	5.80 (2.86)**
$fq^{intercontinental}$	0.050 (0.018)***	0.045 (0.03)	0.070(0.008) ***	0.066 (0.02)***
CT	3.71 (3.11)	2.47 (1.95)	1.87 (1.54)	1.02 (1.02)
Intercept	-51.10 (18.81)	-48.47 (14.58)***	-25.85 (8.68)***	-23.56 (7.83)***
R^2 **Test F***	0.80 39.30***	0.79 178.24***	0.87 92.36***	0.88 230.10***
Dependent variable ($fq^{intercontinental}$)	**(1) Headquarters of firms in non knowledge intensive industries (sales > 10,000 million USD)**		**(2) Headquarters of firms in knowledge intensive industries (sales > 10,000 million USD)**	
	OLS	**3SLS**	**OLS**	**3SLS**
POP	0.00002 (0.000015)	0.00002 (0.00001)*	0.000010 (0.00011)	0.00016 (0.000010)
$D^{capacity}$	229.37 (85.71)**	223.09 (50.43)***	143.06 (64.30)**	166.73 (49.91)***
Headquarters	2.23 (0.85)**	2.47 (0.98)**	5.53 (1.43)***	4.62 (1.36)***
Intercept	-54.19 (33.95)	-54.16 (20.09)***	-38.95 (22.19)*	-41.50 (16.63)**
R^2 **Test F***	0.77 10.08***	0.76 148.20***	0.85 18.85	0.85 230.10***

Note 1: For 3SLS, we use Test Wald (χ^2)
Note 2: Standard errors robust to heterocedasticity
Note 3: Significance at 1% (***), 5% (**),10% (*).

Table 8. Elasticity (evaluated at sample means) of the headquarters located in an urban area with respect to the explanatory variables

	Headquarters of 1000 largest firms	**Headquarters of firms in non knowledge intensive industries (sales > 10,000 million USD)**	**Headquarters of firms in knowledge intensive industries (sales > 10,000 million USD)**
$fq^{intercontinental}$	0,37 (0.09)***	0,16 (0.06)**	0,40 (0.06)***
Pop	0,74 (0.61)**	0,65 (0.18)***	0,44 (0.17)***
GDP	0,76 (0.85)**	0,94 (0.28)***	0,62 (0.21)***
ESP	0,70 (0.31)	0,65 (0.40)	0,79 (0.33)**

Appendix

Description of the variables

$fq^{intercontinental}$: Sample of 41 destinations (13 from North America, 7 from Latin America, 15 from Far East, 3 from Middle East, 2 from Africa, 1 from Oceania), using data of Official Airlines Guide (OAG). Data refers to weekly frequency of direct flights for the first week of October 2004 in the summer time and for the second week of February 2005 in the winter. By direct flights, we mean non-stop flights that do not involve a stop in-between to a flight with the same or different flight number. We present the results of our estimates using a simple average of data for the two seasons. Results do not change substantially when using data for each season separately.

headquarters: Data refers to the number of headquarters of the 1000 largest European companies, in terms of the annual volume of net sales, located in the corresponding urban area (the main city plus municipalities located in a distance threshold of 50 kilometers or 30 miles). Data for banks is ranked through total assets, so that we include 100 largest banks in our sample According to the OECD Science, Technology and Industry Score Board, we expand our sample to include the number of headquarters of European firms in knowledge-intensive and non knowledge-intensive sectors of firms with annual net sales greater than 10,000 million US dollars.. See tables A1 and A2 for details. Source: ELC Europe's 15,000 largest companies. 2003

pop: population of the corresponding urban area. Urban area refers to contiguous built-up areas where houses are not more than 200 meters apart (discounting rivers, parks, roads, industrial fields, etc.). Source: web site wordiq.com. Time Period: 2002

GDP: GDP per capita of the region. Region refers to NUTS 2. Source: Eurostat.2002

$D^{capacity}$: Dummy variable that takes value 1 for high capacity airports. Airports are considered to be high capacity airports when the capacity indicator is higher than the sample mean. The capacity indicator is built through the aggregation of data for number of runways, terminal space (M^2), number of check-in-counters and number of desks. Source: ATRS benchmarking report and airport web sites. Time Period: 2003

CT: Index of the combined (central plus sub-central government tax rates) corporate income tax rate. The index takes value 1 when tax rates are in the range 10-15 (Ireland), 2 in the range 15-20 (Hungary), 3 in the range 20-25 (Switzerland), 4 in the range 25-30 (Denmark, Finland, Norway, Poland, Sweden), 5 in the range 30-35 (the rest except Germany) and 6 when higher than 35 (Germany). Source: OECD Tax database. Time Period: 2003

ESP: Index of the relative specialization in business and financial sectors (ISIC Rev 3 categories: J,K) at the administrative city level. This index is constructed through the Hoover-Balassa index, which measures the relative concentration of a specific sector in an urban area with respect to the average concentration in the EU15 area. We compute the share of the employment in the business and financial sectors in total employment of the corresponding location divided by the share of such sectors in EU15 total employment. We use data for EU15 as the territorial reference area due to data restrictions. Source: Eurostat (Urban audit) except for cities at Norway, Netherlands, Belgium, Austria, Denmark, Czech Republic and Hungary, where data was collected from the corresponding national statistics offices, and cities in Switzerland, where data was collected from the canton statistics offices. Data for Greece is not available (we compute data of the city with the lowest value because Greece is the country with the lowest value at the country level). Time Period: 2001

Tables

Table A1. Technology-and-knowledge intensive industries (ISIC REV3)

High-technology manufactures	Post and telecommunications services	Finance and insurance services	Business services (excluding real estate activities)
2423 - Manufacture of pharmaceuticals, medicinal chemicals and botanical products	64 - Post and telecommunications	65 - Financial intermediation, except insurance and pension funding	71 - Renting of machinery and equipment without operator and of personal and household goods
30 - Manufacture of office, accounting and computing machinery		66 - Insurance and pension funding, except compulsory social security	72 - Computer and related activities
32 - Manufacture of radio, television and communication equipment and apparatus		67 - Activities auxiliary to financial intermediation	73 - Research and development
33 – Manufacture of medical, precision and optical instruments, watches and clocks			74 - Other business activities 741- Legal, accounting, book-keeping and auditing activities;market research and public opinion pooling; business and management consultancy 742- Architectural, engineering and other technical activities 743 – Advertising 744 – Business activities n.e.c
353 - Manufacture of aircraft and spacecraft			

Source: OCDE

Table A2. Sector structure of headquarters data

Sector	Headquarters of 1000 largest firms	Headquarters of firms in non knowledge intensive sectors (sales > 10,000 million USD)	Headquarters of firms in knowledge intensive sector (sales > 10,000 million USD)
Non High-technology manufactures	22,00%	25,86%	0%
High-technology manufactures	5,20%	0%	15,44%
Wholesail & retail	19%	32,90%	0%
Financial intermediation, investment and insurance	22,80%	0%	51,52%
Business services (excluding real state)	6,90%	0%	22,78%
Real state	2,30%	3,63%	0%
Personal services (utilities except post and telecommunication services, social services, other personal services	4,10%	10,34%	0%
Post and telecommunication services	2,60%	0%	10,25%
Agriculture, mining and construction	5,70%	10,01%	0%
Food, Leverage and Tobacco	4,90%	7,86%	0%
Transportation and allied services	3,80%	7,86%	0%
Hotels, restaurant and leisure	0,70%	1,48%	0%
TOTAL	**1000**	**1489**	**790**