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CAN A KNOWLEDGE-BASED CLUSTER BE CREATED? THE CASE OF THE BARCELONA 22@DISTRICT *

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ABSTRACT: The aim of this paper is to track the location decisions of knowledge-intense firms in a redeveloped urban district in the city of Barcelona in which government policy has promoted the formation of a cluster of knowledge-based activities. After decades of economic and industrial stagnation in a district called Poblenou, in the year 2000 the City Council of Barcelona implemented a plan to renew the area's urban and economic structure. Under the development plan, knowledge-based firms were encouraged to set up in the area creating a cluster of advanced activities. This paper examines the success of this local policy and aims to determine whether cluster amenities have played a part in attracting knowledge-based activities. First, we evaluate the cluster implementation via a differences-in-differences analysis comparing the increase in the number of knowledge-based firms in this specific area with the increase of this kind of firm elsewhere in the city and the metropolitan area. Second, to test whether cluster amenities are determinant factors for the location of knowledge-based firms, we perform a multivariate regression analysis explaining intra-city firm location at the ZIP code level. Data about new firms come from a business-census that contains detailed information about location determinants of these firms as well as their characteristics.

JEL Codes: R12

Keywords: Firm location, cluster, knowledge firms, local public policies.

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1. Introduction

Since the second half of the 1980s, competitive scenarios at both local and international levels have undergone spectacular change. With the increased international competition and the appearance of new sectors, the globalization process has transformed industrial specialization and the competitive capacity of many cities. On the one hand, the traditional industrial sectors, facing competition from less developed countries with much lower production costs, have been in crisis since the mid-1970s; and on the other, the new emerging sectors in industry and services, linked to the knowledge economy, the use of more sophisticated technologies and highly skilled labour, are becoming firmly established. These changes have reshaped the productive structure of cities, although not all cities have been effected in the same way: some medium-sized cities, with a high degree of industrial specialization in more traditional fields, have lost large numbers of jobs, while the expansion of more advanced activities has usually taken place in larger cities, with distinct productive traits. The process of globalization has a clear impact on urban environments. For example, cities dominated by the manufacturing sector or traditional services may be forced to renew their economic foundations. The most advanced manufacturing sectors and high value-added services will tend to concentrate in the city centre, whereas the more labour-intensive activities are likely move towards the outskirts. Cities able to complete their restructuring process successfully will specialize in activities with a greater added value and will be surrounded by areas where complementary and lower value-added activities will take place (Duranton and Puga, 2000).

In recent years, with this new scenario of increasing competition and economic restructuring, local and regional public policies have been redesigned to help the area's economic agents to adapt. Options for local policies range widely, but most focus on the restructuring of production, reinforcing the most advanced activities and those related to innovation and knowledge rather than the traditional ones that are most affected by the economic regeneration (Malecki, 2007). Local and regional strategies for promoting technology-based economic development can be designed in different ways. One of the options is cluster creation (Cooke, 2002). More specifically, innovative cluster creation seems to be a good opportunity to promote knowledge-based economies, allowing local knowledge spillovers and, as a consequence, increasing productivity and competitiveness. However, as Suire and Vicente (2009) point out, some of the Silicon Valley type clusters that were examples of success in the nineties have since declined (French Silicon Sentier or Silicon

Alley), while others have became more stable (Silicon Valley itself, or the French Telecom Valley). In fact, recent papers have raised considerable doubts about the guaranteed success of cluster promotion policies: their empirical evidence shows that the effect of these clusters on urban growth may be much more modest than previously believed (see, among others, Appold, 2005, Martin and Sunley, 2003, Martin *et al* 2008 or Duranton, 2009). The results of these studies have questioned the efficiency of investing large amounts of public resources to promote agglomerations of this kind.

The city of Barcelona, with about one and a half million inhabitants and a metropolitan area around three million, has also been affected by important structural changes in recent years. After decades of industrial growth, concentrated mainly in one district (known as Poblenou), in the 1970s industrial activity started to decrease and the urban area started to lose attractiveness. Considerably later, in the year 2000, the City Council of Barcelona designed a development plan for the redevelopment of the urban and economic structure of the district affected by deindustrialization and urban degeneration. The project was created to transform the old industrial area of Poblenou into a new urban space in which the knowledge economy would play a key role. Specifically, the local development policy set out to develop a cluster of knowledge activities in order to improve competitiveness of the whole city and to generate a specialized knowledge-intense area. The project also involved a process of reurbanization providing land for firms, university/research activities and subsidized housing.

The objective of the paper is to evaluate the success of this local development policy and to examine the location patterns of knowledge-based firms attracted by the amenities provided by the new cluster. To assess its success, we perform a differences-in-differences analysis, comparing the increase in the ratio of advanced firms located a) in the cluster and b) the rest of the city and the metropolitan area. Then, to determine whether the cluster amenities are an important element in attracting knowledge-based activities, we perform a multivariate regression analysis to identify the location variables that determine intra-city firm location. Data on new firms are from a business census published in 2007 which contains detailed information on the location determinants of the firms as well as their characteristics.

The paper is organized as follows: in the second section we review the empirical literature on cluster creation and the location patterns of knowledge-intense firms. In the third section we describe the local development project. In the fourth section we present the empirical part of the paper: a descriptive analysis of the data, the differences-in-differences

analysis to test the success of the cluster creation, and the estimation of an ordered logit model to test the effect of cluster amenities on location decision of the firms. Finally, the last section concludes.

2. Cluster creation and the location of knowledge-based firms

Cluster creation is a common strategy in local and regional development policies. For policy-makers, clusters bring economic advantages by increasing the productivity and competitiveness of firms in a particular area. This idea has justified large-scale investments by local and regional government to support the creation and development of clusters. The work of Michael Porter (1990) helped to explain the interest of policy makers in this strategy. He defined a cluster as a: "*The development and upgrading of clusters is an important agenda for governments, companies, and other institutions. Cluster development initiatives are an important new direction in economic policy, building on earlier efforts in macroeconomic stabilization, privatization, market opening, and reducing the costs of doing business*". As Martin *et al* (2008) pointed out, the idea of a cluster is close to what other papers in the literature call agglomeration economies. An agglomeration of economic activities implies the emergence of positive externalities which can make the firms located in these agglomerations more productive. The sources and the scope of agglomeration economies have been broadly analysed in the literature. Alfred Marshall (1890) was the first to define three types of incentives for firms to cluster geographically. Briefly, he distinguished between: 1) Input externalities or access to specialised suppliers 2) Labour market pooling or broader access to specialized highly skilled-labour, and 3) Knowledge spillovers or the existence of inter-organizational knowledge transfer among similar firms. Other approaches define the source of agglomeration economies by stressing the effects of geographical specialization in specific activities (localization economies) or the effects on growth of agglomeration economies that arise from the size of an area and its diverse economic environment (urbanization economies). In fact, cluster effects can be captured by estimating localization economies (Viladecans, 2004). Many studies in the literature have attempted to do this: Rosenthal and Strange (2004), for example, did a survey of empirical analysis on agglomeration economies, and Duranton (2009) reviewed papers that have analysed the effects of geographical concentration on productivity, wages, and employment gains. Dumais *et al* (2002), Rigby and Essletzbichler (2002) and more recently Ellison *et al* (2010) test the existence of Marshallian external economies. Most of the empirical evidence seems to confirm the advantages for

firms of being located in agglomerated areas. However, as Duranton (2009) remarks, most of these approaches do not consider the problems of causality and so the results have to be interpreted with care. In any case, the quantitative effects of concentration on efficiency gains are not as impressive as one might expect.

Significantly, however, all the empirical analyses refer to concentration of economic activities that occur naturally: that is to say, without the intervention of any local or regional public policy. There are very few reports of the effects of publicly-supported clusters on firms' performance. Because some clusters are artificially created by local or regional authorities, it is difficult to perform case studies able to make appropriate comparisons (see Baptista and Swan (1998), Garnsey and Hefferman, 2005, Glomerman *et al*, 2005 or Montana and Neride, 2008). One exception is the paper by Martin *et al* (2008) which applies a differences-in-differences approach to empirically analyse a public policy promoting industrial clusters in France in the late 1990s, concluding that the cluster policy had only modest, transitory effects on employment in the firms involved and had been very costly for the government. Other approaches have also been critical of the view that sees the creation of clusters as a *panacea* (Appold, 2005, Martin and Sunley, 2003, Martin *et al* 2008 or Duranton, 2009).

Focusing more specifically on the patterns of location decisions of knowledge-intense firms, empirical contributions have found them to be shaped by the spatial distribution of knowledge infrastructures like universities, public and private R&D centres or technical colleges (Audretsch *et al*., 2005; Carrincazeaux *et al*., 2001; Bade and Nerlinger, 2000). Arauzo-Carod (2005) demonstrates that location decisions of high-tech firms are positively driven by urbanization economies while diseconomies do not affect entries in a negative way as in low-tech industries. Interestingly, however, public R&D institutions seem to have a positive influence over firm location decisions, but the influence of private R&D centres is not clear (Licht and Nerlinger, 1998). Secondly, interaction between firms and public organizations and highly diversified scientific capabilities are needed to develop a cluster of high-tech firms. These interactions are required not only to guarantee the efficiency of these firms but also to attract them to a specialized cluster, as Autant-Bernard point out for the biotech system in France.

Nowadays, knowledge processes benefit from the activities of other firms, public research centers and universities from all over the world (regardless of their location). However, face-to-face interactions are still of great importance for firms and individuals (McCann and Simonen, 2005). As some scholars have shown, innovative capacity is shaped

by firm access to knowledge sources, so knowledge-intensive firms will tend to locate close to these areas in order to benefit from these knowledge spillovers (Audretsch and Feldman, 1996 and Lundvall, 1993). Obviously, this spatial proximity will depend on the knowledge characteristics (Breschi, 2000): if knowledge is (mainly) tacit, firms will tend to be spatially concentrated but if it is (mainly) codified, this concentration is unnecessary as the knowledge can be accessed in non-spatial ways (via publications, licenses and so on). We assume that firms located in a cluster need to catch up this tacit knowledge in order to increase their rate of innovation and, consequently, their productivity.

Finally, bearing in mind that in a cluster the distance between firms is short, several scholars have demonstrated by that face-to-face interactions help firms to innovate (see Duranton and Puga, 2001; Arita and McCann, 2000 and Glaeser, 1999, among others). So, it seems reasonable to assume that this spatial proximity is a strong location factor for knowledge-based firms. Obviously, the way in which spatial proximity is measured affects the empirical results, but the phenomenon seems to be present whatever method is used. Nevertheless, we must take into account whether physical proximity is caused by urbanization economies or by innovation externalities, especially in the case of a large urban area like Barcelona where some congestion effects appear (McCann and Simonen, 2005). So, what are the drivers of spatial proximity: innovation, or just an increase in productivity? Additionally, some recent contributions have shown that face-to-face interactions are not as important in explaining innovation behaviour (Simonen and McCann, 2008), suggesting perhaps that there is no room for a technological cluster, since innovative firms do not really derive important benefits from their presence there.

3. The 22@ Barcelona district project. A description

In the mid-twentieth century, Poblenou had been a very dynamic industrial and logistic area in the city of Barcelona, specializing in traditional manufacturing activities like textiles, food and wine, and metal production. These activities were badly hit by the recession of the 1970s. In 2000, the city council launched a plan to redevelop the area as one of the city's economic motors, replacing the traditional industries with the most advanced economic activities[1]. The project aimed to create a cluster of knowledge-based firms. The common characteristic of these practices, which sets them apart from the area's earlier

[1] For a more detailed description of the project, see Oliva (2004) and *http//:www.22@.com*

business activity, is their high technological content and their intensive use of human capital and knowledge.

The redevelopment project involved the transformation of a large area of industrial land in the centre of the city into an innovative productive district. It aimed to make an impact in three areas: urban, economic, and social. First, as an urban redevelopment plan it responded to the need to create a diverse balanced environment of production centres, subsidized housing and facilities, and green areas to improve the quality of life of the residents. Second, from the economic point of view, the plan offered the opportunity to transform the economic structure of the area and to introduce the most advanced knowledge-based activities. And third, from the social perspective, the plan favoured networking among the professionals employed in the district, promotes innovative projects, and fosters collaboration between companies. To sum up, it was a project with a high real estate potential and a public investment of 180 million euros.

To ensure the success of the three areas of the plan, a set of complementary policy actions had to be implemented in the area. The most important was the redevelopment of the urban landscape changing the urban planning. The area affected by the plan covered 116 hectares classified as industrial land, which made it one of the largest town-planning transformations in Europe in recent times. Under the plan, the old urban classification 22a (which meant that the area was used exclusively for industrial purposes) was replaced with a new classification, 22@, which allowed a mixed used of the land in the neighbourhood of Poblenou. Whereas the levels of residential occupation were low in the old industrial area, the new plan converted nearly 30% of what was previously classified as industrial land into public land for facilities, green areas and housing. One of the most innovative aspects of the new urban plan was to vary the amounts of land available for building, depending on the scheduled use. The area where building was permitted was specifically increased for knowledge-based @ activities: any developer wishing to increase land profitability could choose to create spaces devoted exclusively to @ activities, defined as activities "*related to the new ITC sector, with research, design, culture and knowledge*". Specifically, the list of the @ activities selected were Edition and graphic arts, Office machines and computers, Electronic material, radio and TV equipment and Medical equipment in the manufacturing sector, and Telecommunications, Financial sector, Research and development, Other business activities, and Education and cultural activities in the service sector.

A second policy action focused on the infrastructure network. At the time of the approval of the 22@Barcelona plan in 2000, the infrastructure of the industrial area of Poblenou was found to be clearly wanting. To amend this situation, the project established a new Special Infrastructure Plan to re-urbanize and modernize the 37 km of streets in the district. Finally, the project also involved a housing policy, since it opted for a mix of space dedicated to production and new housing, allowing people to live close to their jobs. It promoted the construction of 4,000 new government protected homes, favouring social diversity and ensuring that all streets and public spaces are accessible throughout the day. To bring together the instruments and management jurisdictions, the company "*22@bcn*" was created and funded entirely by the local council. Its mission includes the management of planning, infrastructure and heritage, promotion of the project collaboration with the town-planning authority and developers. To sum up, all the policy actions had the objective of equipping the area with the amenities most valued by knowledge-based activities.

4. Empirical analysis

4.1 Descriptive analysis

The May 2007 census recorded about 2,000 firms located in the Barcelona 22@ district. Nearly half moved to the area after the year 2000. There are some 42,100 employees in the district, 60% of whom work for firms created in the area after 2000. Additionally, the industrial mix of 22@ district is changing rapidly from a traditional manufacturing basis to a service-oriented one. This transformation is of great importance since in the past (as explained above), the area was more manufacture-oriented than the city of Barcelona as a whole. Specifically, while manufacturing accounted for 62.5% of the area's firms in the 1960s, after 2000 it accounted for only 25%; in contrast, the presence of service industries has risen over the same period from 22% to almost 67%. The transformation of the productive structure is a feature of most big cities since the crisis of the 1970s. In fact, Spanish manufacturing firms in general are relocating their productive activity from city centres to the suburbs in order to reduce costs (Solé and Viladecans, 2004). However, the transformation of the productive structure seems to be more intense in the 22@ district than in the rest of the city of Barcelona. In the last decade the percentage of service activities with regard to the whole economy has increased one point in the city as a whole, but by eight points in the 22@ district.

[INSERT TABLE 1 AROUND HERE]

A detailed analysis of the new activities located in the 22@ district shows that there has been a continuous increase of firms in the knowledge-based economy, known as @ activities. More than half of the firms located in the area in recent years belong to these sectors. New firms located in the district are more knowledge-oriented than their predecessors in the area before the introduction of the 22@ project, since the level of technology (in terms of skilled workers, industry, R&D activities, etc.) is increasing over time. Firms originally present in the area had lower technological intensity than new ones, even though they can shift to higher technological intensity. The data clearly show the increasing involvement of firms located in the 22@ district in R&D activities: from 13.4% of firms in the 1980s to 26.6% in the 1990s, and 43.2% since 2000. Finally, as far as human capital is concerned, firms located in the 22@ district after 2000 also differ from the incumbent ones. In the 1980s, in over half the firms in the area (52%) fewer than 10% of employees were university graduates; university graduates accounted for 75% of the staff in only 4.8% of firms. After 2000, however, only 28% of staff in firms created in the area did not have university qualifications, and an university graduates accounted for 75% of the staff in 18.5% of firms.

All the figures presented seem to give some insights of success according to the capacity of the 22@district to attract new firms more related to the knowledge-based economy. But, it may be that these tendencies can be generalized to the rest of the city or even the metropolitan area; it might be that we see a structural change towards this type of activity wherever we look. If so, perhaps there is nothing special in the 22@district because the structural change affects all the metropolitan economy.

4.2 The effects of cluster creation on the increase in knowledge-based firms

After this brief description of the area's economic structure, the first empirical part of the paper tries to fulfil its first objective, that is, to evaluate the success of cluster creation in the 22@ district. One of the aims of the local policy was to increase the number of knowledge-based firms. To analyse whether the policy was successful, we quantify its impact on the increase in the number of firms in these advanced activities.

Econometric approach: data and methodology

To determine the effect of the cluster creation policy in the Barcelona 22@ district, we estimated the following 'difference-in-differences' (DD) regression[2]:

$$\%@\ firms_{it} = \alpha\, d22@_i \times d(year_t \geq 2000)_t + \lambda_t + \mu_i + \gamma_i t_t + \varepsilon_{it} \qquad (1)$$

Where $\%@\ firms_{it}$ is the share of firms in @ industries in the overall number of firms in the local area *i* and year *t*. The @industries are the ones selected by the development plan. This variable allows us to test for the degree of specialization of the productive structure. The dummy $d22@_i$ represents the area (the ancient industrial district) and $d(year_t \geq 2000)_t$ is a dummy equal to one for years following the implementation of the project in 2000. We use data on the number of firms by local area for the period 1996-2005, which means that there are four years in the pre-treatment period (1996-1999) and six post-treatment years. We also include a set of fixed year effects, λ_t, local area fixed effects, μ_i, and local area-specific time trends, $\gamma_i t_t$.

We also explore the possibility that the effects of the project are not instantaneous, by estimating separate effects for each year. It could be the case that the project needs time to take off: for example, if firms are expectant regarding the success of the project (i.e., they wait until other firms come in) or if complex infrastructure projects have to be completed before firms are able to settle in the local area. Since the area has to be restructured, the project involves large-scale investment; obviously, this part of the project will take longer than if the area had no pre-existing urban and industrial structure. In this case, the estimated DD regression will be:

$$\%@\ firms_{it} = \sum_t \alpha_t\, d22@_i \times d(year_t = t)_t + \lambda_t + \mu_i + \gamma_i t_t + \varepsilon_{it} \qquad (2)$$

Where $d(year_t = t)_t$ are dummies which identify each of the post-treatment years, α_t being the year-specific treatment effects. We will also show the results allowing this parameter to change for the pre-treatment years, in order to see whether the year 2000 can be really considered as the starting point for the project.

The sample includes the areas in the 22@ cluster project and a control group of the rest of the Barcelona's districts and the 35 municipalities in the metropolitan area of Barcelona. The validity of the 'difference-in-differences' approach rests on the assumption that the paths of $\%@\ firms_{it}$ will not differ systematically in the 22@ local area and the rest of the metropolitan area in the absence of the local policy intervention. As can be seen in Figure 1, the 22@ and full Metro Area trends of $\%@\ firms_{it}$ are virtually parallel. This

[2] See Card and Krueger (1994) and Bertrand *et al* (2004), for applications of the DD approach.

suggests that, prior to the policy intervention, the economies of the whole area and of the 22@ were restructuring their industrial composition (from traditional sectors to @ ones) in a similar way. This means that the Metro Area as a whole could be a priori a good control group for the 22@ local area. An alternative control group would be formed by the local areas which are close enough to 22@ to share some specific location traits. Figure 1 also shows the trend for this potential control group, which includes all the nearby areas. Note that the trend of $\%@\ firms_{it}$ in the nearby areas is much steeper, although it is difficult to establish the magnitude of the bias caused by the difference in the two slopes. This difference might be due to the fact that some of these neighbouring areas were the object of huge infrastructure projects both prior to and after the Olympic Games, and their economies probably took off once the effects of the economic downturn at the beginning of the 1990s had passed. In any case, there is another problem with this group, derived from the (possible) spatial spillovers from the 22@ project. If spillovers exist, the control group would be contaminated by the treatment and the estimated treatment effect would be biased downwards. For these two reasons, we prefer not to use the neighbouring areas (which we will label W22@) as a control but to use them to look for the possibility of spillovers. In this case, the DD regression will look like:

$$\%@\ firms_{it} = \left[\alpha\ d22@_i + \beta\ dW22@_i\right] \times d(year_t \geq 2000)_t + \lambda_t + \mu_i + \gamma_i t_t + \varepsilon_{it} \quad (3)$$

These spillovers can be either positive or negative. They will be positive if the 22@ district also confers benefits on firms located close to the project but not in the core, and negative if some firms that would otherwise locate in the neighbouring areas decide to move instead to the 22@ district because of the benefits conferred by the project. Of course, the validity of the spillover result also rests on the difference between the slopes of the treatment group (now W22@) and the control group (the whole Metro Area). In any case, to assess the validity of the control groups further, we will estimate these equations with and without the local area-specific time trends. If both the treatment and control groups evolve similarly, the inclusion of these trends should not have a great impact on the estimated treatment effect. We will also provide results for the neighbouring area divided into North and South, as the North is less affected by the infrastructure projects than South.

Results

The effect of the 22@ cluster creation project on the share of @ firms in Barcelona's 22@ district, using all the local areas in the Metropolitan Area as control group, is displayed in Table 2. Columns (1), (3) and (5) show the results when area-specific time trends are excluded, while columns (2), (4) and (6) show the results when they are included. The inclusion of the trends does not alter the size and significance of the estimated treatment effects, corroborating our impression that the control group used is appropriate. The effect of

the 22@ project is positive and statistically significant in all the cases. The results in columns (1) and (2) suggest that the project has raised the share of @ firms in the Barcelona 22@ district by 1%, from 13% to 14%. This 1% is approximately half the distance in the share of @ firms between the 22@ district and the average of the Metropolitan Area.

[INSERT TABLE 2 HERE]

In any case, note that this effect is very low, since some of the local areas in the Barcelona Metropolitan Area have much higher shares of @ firms. The results obtained when breaking the post-treatment years into two sub-periods do not indicate a larger impact in the second sub-period (see columns (3) and (4)). When looking at the results by post-treatment year (columns (5) and (6)), we find that the impact of the project is higher during the first years, but seems to decrease slightly in the following years. However, these results should be interpreted with some caution, given the lack of precision of the estimates. In any case, what seems true is that the project had some impact at the beginning but stagnated afterwards; this impression is also suggested by Figure 2, which plots the predicted @ firm shares in the treatment and control groups for the period 1996-2005. This could be due to the fact that, after the initial impulse of the project, the location of additional firms had to wait until the planned infrastructures were built up. After the completion of the major rebuilding project, some of these impediments disappeared. Unfortunately, because of the lack of comparable data for recent years we cannot follow these developments.

Table 2 explores the possibility that some of the benefits of the 22@ project have spilled over its boundaries. The results in column (1) suggest that the effect in the neighbouring areas is positive and even stronger than in the core of the 22@ district (the rise in the share of @ firms is 3% and 1% respectively). However, these spillovers disappear once we allow for local area-specific trends in column (2). At the bottom of the table the t-test results show that while we cannot reject the equality in the 22@ and the full Metro Area trends, we can reject it between the trend of the 22@ neighbours and that of the full Metro Area. This means that our control group is not adequate for 22@ neighbours, and we cannot determine whether or not there are spillover effects. To deal with this problem, we divide the 22@ neighbours according to their geographical situation. The neighbours to the south include the local areas mostly affected by the rebuilding efforts in preparation for the Olympics, and this group is the one that shows a steeper trend in the share of @ firms. Columns (5) and (6) show the results obtaining when splitting the neighbours in this way. The results in Column (5) are quite surprising, suggesting that spillovers are negative for neighbours to the north and positive for the ones to the south. However, after controlling for area trends, both spillovers seem to be negative, although only those for neighbours to the

north are statistically significant at the 90% level. And the t-tests on the equality of trends suggest that the trends between these two neighbour groups differ from the ones found in the 22@ district and the full Metro Area. So, the path is also steeper of the northern neighbours than in the 22@ district. However, in this case, the difference between trends is not so great, and the negative spillovers found when not including the trends persist afterwards. Admittedly this result is not entirely robust, but its implications are quite interesting: it seems that part of the positive effect of the 22@ project on the 22@ district comes at the expense of a negative effect on the neighbourhood.

[INSERT TABLE 3 HERE]

4.3 Location patterns of technological knowledge-based firms

After seeing that the results of the cluster creation policy are positive but modest in terms of the number of new firms created, the second step of the empirical analysis consists in identifying the factors that play a role in attracting this type of knowledge-based activities. We have seen that the effects of the cluster policy are not impressive. In this second empirical part, we hypothesize that the location amenities arising through the cluster creation may be decisive for the attraction of new firms; in this case, the effects of the cluster will not be negligible.

Econometric approach: data and methodology

To test for this possibility, we perform a multivariate regression analysis explaining intra-city firm location at the ZIP code level over the 2001-07 period. We use data on new firms from a survey of firms located in the 22@ district from January 2001 until May 2007. This survey, which included 289 firms, contains detailed information about their location determinants and their characteristics. Focusing on location determinants, the survey required firms to rank a series of factors according to their importance in the decision to locate in the Barcelona 22@ district on a scale of 1 to 5 (with '1' representing "not at all important" and '5' representing "very important").

We chose factors that could reflect location amenities associated with cluster creation. First, we tested for the importance of "location economies" as a determinant of firm location.

The literature on agglomeration economies suggests that a specialized environment – provided by a cluster – can be seen as a good location amenity for a firm. We chose to test the importance of this factor the answers given by the firms to the question: "*Rank from 1 to 5 the importance of being close to firms belonging to your own industry as an attractive location amenity in the 22@district*"

Second, we introduced some variables that could be good proxies of Marshallian externalities. As it has been explained before, these three external economies could be important to explain the geographical clustering of firms. First, we test for the existence of input externalities. We chose to test them the answers given by the firms to the question: "*Rank from 1 to 5 the importance of being close to supplier firms as an attractive location amenity of the 22@district*". Second, we test for the importance of the labour pooling as a location amenity in the area taking into account the answers given by the firms to the question: "*Rank from 1 to 5 the importance of the availability of skilled labour as an attractive location amenity of the 22@district*". Finally, we test if the firms consider the existence of knowledge spillovers as an important amenity of the 22@district. To do it we choose the answers given by the firms to the question: "*Rank from 1 to 5 the importance of having an innovative environment as an attractive location amenity in the 22@district*".

Given the nature and characteristics of the data, the most appropriate model is an ordered logit model.[3] The dependent variable is the rank given by firms to the location factors mentioned, and the independent variables are characteristics of those firms that are hypothesized to explain the importance given to those location factors: i) being a knowledge-based firm (@ Firm); ii) being a knowledge-based firm which located in the 22@ district after the year 2000 (the year when local policy was implemented, @Firm2000); iii) firm size; iv) being a multinational firm and v) the age of the firm. These characteristics were selected on the basis of findings in empirical location literature regarding the effect of firm characteristics on location decisions (see Arauzo *et al.* 2010, for a review).

We stress that informants were only required to rank the location factors in terms of importance to their decision to locate in the 22@ district. They were not asked to compare these location amenities and they were not given additional explanations; conceivably,

[3] We also carried out a probit estimation but for the most part our results remained unaltered. In this probit estimation we grouped the scores given by respondents assuming that scores of 4 or 5 indicated that the location factor was important for their decision, while scores of 1, 2 or 3 indicated that the factor was not important.

interviewees may have interpreted a specific location factor in different ways[4]. As regards econometric methodology, an ordered logit model is a specific case of multinomial logit model in which the dependent variable is allowed to have more than two possible outcomes. Specifically, the five measures of location importance of the factors are ordered scales where 1 < 2 < 3 < 4 < 5. In any case, we stress that the distances between adjacent ranks (e.g., between 2 and 3) are unknown.

Following Greene (1999), there is a latent variable model:

$$y^* = \beta' + \varepsilon$$

where y^* is the unobserved dependent variable, x is a vector of explanatory variables, β is an unknown parameter vector and ε is the error term (with a standard logistic distribution). Given that y^* is unobserved, it is possible to observe:

$$\begin{aligned} y &= 0 \quad if \quad y^* \le 0 \\ y &= 1 \quad if \quad 0 < y^* \le \mu_1 \\ y &= 2 \quad if \quad \mu_1 < y^* \le \mu_2 \\ &\vdots \qquad\qquad \vdots \\ y &= J \quad if \quad \mu_{J-1} \le y^* \end{aligned}$$

where y is the frequency of attendance, μ is the vector of unknown parameter estimated with the β vector and J is the number of categories. The ordered logit model allows us to estimate parameter vectors for β and μ. Note that the estimated μ shows dividing lines between Y = 0 and 1 (μ_0), Y = 1 and 2 (μ_1), Y = 2 and 3 (μ_2) and so on.

Here we analyse how firms' perceptions of the importance of several location factors is shaped by their characteristics. As we explained above, we analyse the following location determinants: a) Location economies (Column 1); b) Proximity to suppliers (Column 2); c) Availability of skilled labour (Column 3) and d) Innovative environment (Column 4).

Results

Table 4 shows the maximum likelihood estimation results for the ordered logit model according to the four location amenities related to the existence of a cluster and five firm characteristics, which explain why firms rate these location amenities better or worse.

[INSERT TABLE 4 HERE]

[4] See Bertrand and Mullainathan (2001) and Senik (2005) for a detailed analysis of methodological problems linked with using subjective variables.

The location economies factor, which tries to capture the attraction to new firms of being located in a specialized environment and which emphasizes the idea of a cluster, is positive and significant for the knowledge-based firms (@ firms). This result suggests that knowledge-based firms prefer to concentrate in areas with some level of specialization in these activities, so creating a knowledge-based cluster of firms belonging to the same industry is perceived as an attractive factor for new firms of the same characteristics. For the @ firms that arrived in the district after the year 2000, the perception of this location factor is the same and the coefficient is not significantly different.

The existence of location economies is also an important factor for the more mature firms; the variable *Age* is positive and significant. However, the effect is smaller than the one obtained by the @ firms. This result could indicate that location economies have a positive effect on the survival of firms. That is to say, being located in an area with strong location economies makes firms more efficient. Garnsey and Heffernan (2005) find that survival rates for the Cambridge technology-based firms are consistently higher than the regional or national averages. Similarly, analysing information technology firms in Canada, Globerman *et al* (2005) found evidence that firms located in the Toronto CMA, and more specifically those located in a relatively small area within Toronto, experience faster growth. Their conclusion is that the impact of clustering on growth and survival performance is highly localized. But there is also empirical evidence that points in the opposite direction; Staber (2001), for instance, showed that location in clusters of firms in the same industry increased business failure rates, but that location in diversified clusters of firms operating in complementary industries reduced failure rates.

Finally, it is interesting that multinational firms perceive the existence of location economies as a negative location amenity. In fact, the estimated coefficient is negative and significant and its value is higher than the others. This result may indicate that multinationals make their location decisions considering a bigger geographical environment than the 22@ district – for example, the whole city or the metropolitan area (a more diversified environment).

As for the location factors related to the Marshallian externalities, first, supplier proximity is not significant, whatever the characteristics of the firm. This result could mean that the geographical area taken into account by firms in this respect may be larger than the district and so the providers could be located in the rest of the city or even elsewhere in the metropolitan area. Second, labour pooling is not significant for the knowledge-based firms, and is significant only for the most aged firms. This result may be surprising since the

positive effect of the workforce's educational level on the entry of new firms has been amply demonstrated (Coughlin and Segev, 2000 and Acs *et al*, 2008). However, most of these studies have centred on larger geographical areas like US states or counties. In the case of the spatial area used in this analysis (a district inside a city) it seems natural to assume that firms look for skilled labour not only inside the district but (at least) throughout the whole city, and so the availability of labour in the 22@district is not a key determinant since firms can easily access skilled labour elsewhere in Barcelona and its metropolitan area. Finally, Marshall's third external economy – the existence of knowledge spillovers – seems to be an attractive location factor only for multinational firms, perhaps reflecting the differences in technology profiles between national and multinational firms. To sum up, then, Marshall's external economies do not seem to be strong location determinants for firms in the period studied.

5. Discussion and conclusion

In this paper we have evaluated a local development policy applied inside an urban district in the city of Barcelona (the 22@ district). After decades of economic decline – above all in industrial activity – in the year 2000 the local government introduced a plan to transform the urban and the economic structure of this district. Part of the plan involved the creation of a cluster of knowledge-based activities. The descriptive analysis of firm structure in the district shows a substantial difference between the firms created since 2000 and those in operation before this date: *i*) two thirds of the recently created firms are in the service sector, evidence of the productive transformation from manufacturing firms to tertiary firms; *ii*) there has been a continuous increase in the presence of innovation and knowledge-related firms (more than half of the firms located in the area since 2000 belong to those sectors); *iii*) there are more multinational firms; *iv*) the human capital of the newly created firms is higher than that of the incumbents; *v*) the recently created firms carry out more R&D activities. This evidence suggests that the 22@ project was a success, given its capacity to attract new firms related to the knowledge economy. However, it may be that these results can be generalized to the rest of the city or even the metropolitan area; it may be that we see a structural change towards this type of activity wherever we look. If so, it might be concluded that there is nothing special in the 22@ district because the structural change affects the economy of the entire metropolitan area. To test this hypothesis, the first objective of the paper was to evaluate the success of this local policy. The results of the differences-in-differences analysis to test the incidence of the cluster creation on the share of knowledge-based firms in the 22@

district – using all the local areas in the metropolitan area as control group – are positive and statistically significant in all the cases. In any case, the effect is modest in size. These results are in line with the ones obtained by Martin *et al* (2008) in their study of cluster development policy in France. Additionally, it seems that the effect was larger at the beginning, but stagnated afterwards. When we consider whether some of the benefits of cluster creation spilled over the boundaries of the district, the evidence indicates that the positive effect of the 22@ cluster creation might come at the expense of a negative effect on the neighbouring area.

After establishing that the cluster policy had an effect (albeit modest), the second objective of the paper was to test whether the cluster amenities are decisive factors for the location of the new knowledge-based firms. Using data on the creation of new firms, we estimated the attractiveness of some location factors related to the existence of a cluster – location economies – and the Marshallian external economies (input externalities, labour pooling and knowledge spillovers) for different firm characteristics. The results indicate that location economies are a significant location factor for knowledge-based firms. In contrast, the three Marshallian externalities do not seem to be determinant for the location of firms inside the district.

To understand the evidence obtained in both analyses, several aspects of the empirical approach should be taken into account. First, given the complexity of the project, the periods analysed (five years for the first analysis and seven years for the second) may not be long enough to obtain a reliable assessment of the effects of a cluster creation in a district. Second, we analyse the attractiveness of a very small area (the 22@ district) located inside a big city and its metropolitan area. This means that it could be difficult to separate the attractiveness of the district from that of the city or the rest of the metropolitan area: the geographical area of reference may be larger than the one we have considered. And finally, as Duranton (2009) pointed out, when we try to measure the cluster creation effect we have to pay particular attention to the industrial aggregation we use. In our case, we use @firms, considering all the activities related to the knowledge economy (as described in the local plan). But of course inside this aggregation there are a variety of industries that might react to a cluster strategy in different ways.

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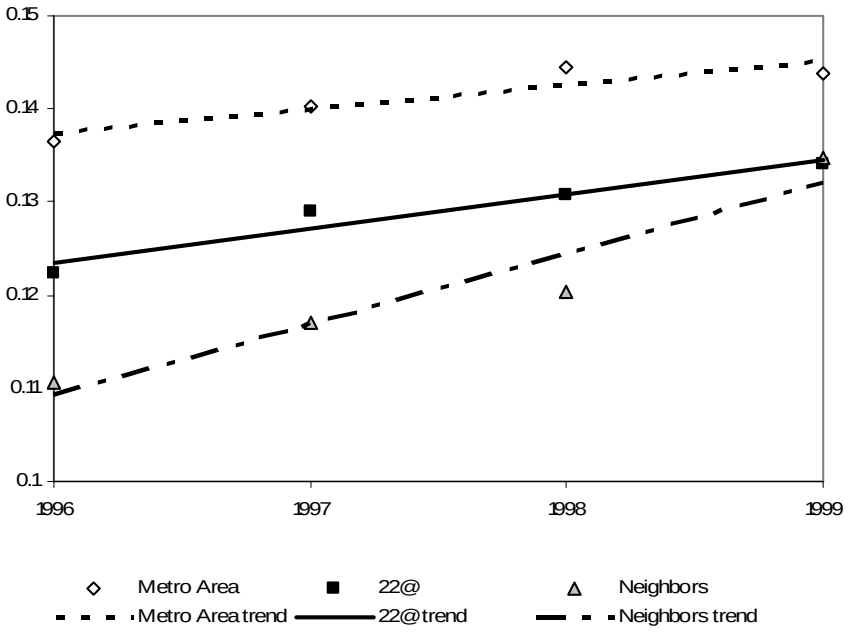
Table 1: Firms located at Barcelona 22@ district: Descriptive analysis[(1)]

	Before 1980	1980-1990	1990-2000	After 2000
Number of new firms	113	232	513	892
Mean size (workers)	20,1	13,2	16,5	38,6
Human capital intensity:				
% of firms with less than 10% of high qualified employees[(2)]	52,4%	54,3%	53,3%	28,1%
% of firms of more than 75% of high qualified employees	4,8%	8,7%	14,4%	18,5%
R&D intensity:				
% of firms doing R&D activities	38,1%	13%	26,7%	43,2%
Mean surface (m^2) of the plant	277	278	209	231

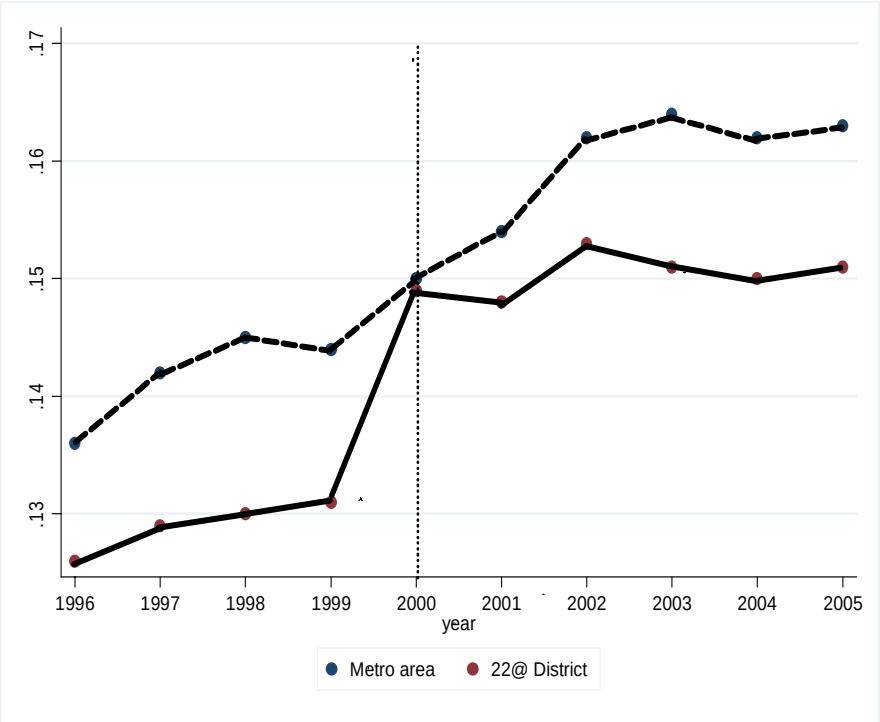
Notes: (1) The date groups ("*before 1980*", "*1980-1990*", "*1990-2000*" and "*After 2000*") refer to the year in which the firm was located at 22@ (no matter their age), but the firm characteristics are from 2006
Source: Own elaboration.

Figure 1: *Pre-treatment trends in %@firms in treated* (22@) *and* (*potential*) *control groups* (*Metro Area and* 22@ *Neighbors*)



Notes: (1) 22@ = Barcelona's 22th district (Poblenou); Neighbors = 22@ neighbors (local areas belonging to the St. Martí district); Metro Area = all local areas belonging to Barcelona's Metropolitan Area.

Figure 2: *Predicted % @firms in the treated* (22@) *and control groups* (*Metro Area*)



Notes: (1) *% @firms* predicted on the basis of (6) of Table 2.

Table 2:
The effect of the 22@ *project on the share* of @ *firms* (%@*firms*$_{it}$)
in Barcelona's 22th *district* (*Poblenou*). *Control group: full Metro Area*

	(1)	(2)	(3)	(4)	(5)	(6)
$d22@_i \times d(year_t \geq 2000)_t$	0.011 (3.580)***	0.010 (3.041)***	0.010 (3.201)***	0.009 (2.891)***	0.016 (2.765)***	0.015 (2.552)**
$d22@_i \times d(year_t \geq 2002)_t$	--.--	--.--	-0.000 (-0.054)	-0.001 (-0.071)	--.--	--.--
$d22@_i \times d(year_t = 2000)_t$	--.--	--.--	--.--	--.--	0.010 (2.381)**	0.010 (2.411)**
$d22@_i \times d(year_t = 2001)_t$	--.--	--.--	--.--	--.--	0.014 (2.119)**	0.013 (2.331
$d22@_i \times d(year_t = 2002)_t$	--.--	--.--	--.--	--.--	0.007 (1.461)	0.008 (1.560)
$d22@_i \times d(year_t = 2003)_t$	--.--	--.--	--.--	--.--	0.007 (1.761)*	0.006 (1.889)*
$d22@_i \times d(year_t \geq 2004)_t$	--.--	--.--	--.--	--.--	0.009 (2.171)**	0.008 (2.091)**
$d22@_i \times d(year_t \geq 2005)_t$	--.--	--.--	--.--	--.--	0.017 (2.591)**	0.014 (2.341)**
Adjusted – R^2	0.952	0.986	0.958	0.986	0.960	0.988
F(*zero slopes*)	235.05 [0.000]	947.07 [0.000]	234.11 [0.000]	907.81 [0.000]	230.10 [0.000]	905.33 [0.000]
$F(\mu_i = \mu, \forall i)$	182.10 [0.000]	184.22 [0.000]	182.32 [0.000]	183.89 [0.000]	188.02 [0.000]	191.19 [0.000]
$F(\lambda_t = \lambda, \forall t)$	52.991 [0.000]	49.201 [0.000]	50.910 [0.000]	51.443 [0.000]	47.992 [0.000]	49.002 [0.000]
$F(\gamma_i t_t = 0, \forall i)$	--.--	710.33 [0.000]	--.--	690.44 [0.000])	--.--	685.44 [0.000]
$t(t_t \times d22@ = t_t)$	--.--	(0.545)	--.--	(0.511)	--.--	(0.445)
Area fixed effects	YES	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES	YES
Local area trends	NO	YES	NO	YES	NO	YES
Number of obs.	820	820	820	820	820	820

Notes: (1) $d22@_i$ = 1 for 22@ district (Poblenou) and 0 for the other local areas belonging to Barcelona's Metropolitan Area; $d(year_t \geq 2000)_t$= 1 for the years following the implementation of the 22@ project. (2) Numbers in parenthesis are t-statistics; ***, ** & * = statistically significant at the 99%, 95% and 90%; Numbers in brackets are p-values. (3) Standard errors are clustered at the Group x Year level; there are three Groups making a total of 30 clusters; one of the groups is the treated one and the other two contain the control areas (the city of Barcelona and the other local areas belonging to the Metropolitan Area of Barcelona). (4) F(*zero slopes*) = F-statistic for the joint-significance of all the variables; $F(\mu_i = \mu, \forall i)$ = F-statistic for the joint-significance of the local area fixed-effects; $F(\lambda_t = \lambda, \forall t)$= F-statistic for the joint-significance of the year fixed-effects; $F(\gamma_i t_t = 0, \forall i)$)= F-statistic for the joint-significance of the local area specific time trends; $t(t_t \times d22@ = t_t)$ = t-statistic for the equality of 22@ trend and the trend in the control group.

Table 3:
Spillover effects of the 22@ *project on the share of @ firms* (%@*firms*$_{it}$) *in a neighborhood of Barcelona's* 22th *district* (*d*W22@: *St. Andreu*): *Control group: full Metro Area*

	(1)	(2)	(3)	(4)	(5)	(6)
$d22@_i \times d(year_t \geq 2000)_t$	0.011 (5.390)***	0.010 (1.969)**	0.010 (2.887)***	0.008 (2.389)**	0.010 (5.132)**	0.010 (1.991)**
$d22@_i \times d(year_t \geq 2002)_t$	--.--	--.--	-0.000 (-0.071)	-0.003 (-0.045)	--.--	--.--
$dW22@_i \times d(year_t \geq 2000)_t$	0.032 (10.421)***	-0.022 (-0.323)	0.021 (5.690)***	-0.002 (-0.411)	--.--	--.--
$dW22@_i \times d(year_t \geq 2002)_t$	--.--	--.--	0.021 (5.690)***	-0.001 (-0.300)	--.--	--.--
$dW^N22@_i \times d(year_t \geq 2000)_t$	--.--	--.--	--.--	--.--	-0.018 (-4.981)***	-0.007 (-1.788)*
$dW^S22@_i \times d(year_t \geq 2000)_t$	--.--	--.--	--.--	--.--	0.043 (12.290)***	-0.004 (-0.744)
Adjusted – R^2	0.957	0.986	0.958	0.986	0.951	0.987
F(*zero slopes*)	226.96 [0.000]	938.28 [0.000]	234.44 [0.000]	908.85 [0.000]	227.22 [0.000]	901.12 [0.000]
$F(\mu i = \mu, \forall i)$	184.55 [0.000]	183.38 [0.000]	181.03 [0.000]	188.71 [0.000]	180.34 [0.000]	181.23 [0.000]
$F(\lambda_t = \mu, \forall t)$	58.091 [0.000]	56.291 [0.000]	54.311 [0.000]	50.023 [0.000]	48.91 [0.000]	45.56 [0.000]
$F(\gamma i t_t = \gamma t_t, \forall i)$	--.--	698.01 [0.000]	--.--	677.60 [0.000]	--.--	666.30 [0.000]
$t(t_t \times d22@ = t_t)$	--.--	(0.488)	--.--	(0.471)	--.--	--.--
$t(t_t \times dW22@ = t_t)$	--.--	(3.441)***	--.--	(3.211)***	--.--	--.--
$t(t_t \times dW^N22@ = t_t)$	--.--	--.--	--.--	--.--	--.--	(1.745)*
$t(t_t \times dW^S22@ = t_t)$	--.--	--.--	--.--	--.--	--.--	(4.551)***
Area fixed effects	YES	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES	YES
Local area trends	NO	YES	NO	YES	NO	YES
Number of obs.	820	820	820	820	820	820

Notes: (1) See Table 1. (2) $dW22@_i$ = 22@ neighbors (local areas belonging to the St. Andreu district); $dW^N22@_i$ = 22@ North neighbors; $dW^S22@_i$ = 22@ North neighbors.

Table 4:
The effect of cluster location amenities on the location of firms at the Barcelona 22@ district

		Marshallian external economies		
Firms' characteristics	*Location economies*	*Input externalities*	*Labour pooling*	*Knowledge spillovers*
@Firm	0.711*	-0.024	-0.100	-0.206
	(0.395)	(0.422)	(0.450)	(0.411)
@Firm after 2000	-0.538	-0.008	0.262	0.790
	(0.503)	(0.531)	(0.550)	(0.513)
Firm size	0.001	-0.002	-0.000	0.001
	(0.001)	(0.002)	(0.001)	(0.001)
Multinational	-0.834*	-0.481	-0.339	0.752*
	(0.451)	(0.454)	(0.442)	(0.414)
Age	0.009*	0.005	0.010**	0.000
	(0.005)	(0.004)	(0.005)	(0.005)
Number of obs.	289	289	289	289
Log likelihood	-390.279	-384.212	-348.250	-433.991
LR chi2(5)	9.82	4.64	5.01	8.52
Pseudo R2	0.012	0.001	0.007	0.001

Note: (1) ** & * = statistically significant at the 95% and 90%;

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