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Transport as a location factor: new start-ups and relocations in Portugal

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Abstract. This paper analyses the spatial pattern of firm birth and firm relocation in Portugal between 1986 and 1997. Fixed effects count data models are estimated with municipality-level data for new and relocated manufacturing plants. Fine measures of accessibility are included to estimate the impacts of road infrastructure as a location factor. The estimates show that road infrastructure significantly affects the relative attractiveness of municipalities for manufacturing location. Differences between plant births and plant relocations exist for most variables and with regard to the road infrastructure, the estimates show that the location decisions of relocating manufacturing plants is much more strongly influenced than start-ups by the provision of new motorways.

JEL classification: L6; R3; R4

Key words: Manufacturing location, road infrastructure, geographic information systems (GIS)

1 Introduction

This paper aims to contribute to a better understanding of the spatial behaviour of firms by analysing the effects of local and regional characteristics on firm birth and relocation. To date, there is little direct empirical evidence on the differences in firm birth patterns and relocation patterns. Although most new plant investment is due to the start-up of business activity, relocations are a significant source of such investment because they involve larger plants. Relocating firms have also been found to experience higher employment growth than existing indigenous firms (Nakosteen and Zimmer, 1987). Because plant birth and plant relocation result from two different spatial decision processes in the firm they are treated separately in this paper. Distinguishing firm birth and firm relocation patterns can help understanding the situations under which certain location characteristics are more important. The present study puts these two events in a dynamic context of the plant life cycle and finds evidence that fits with notions of business dynamics. Plant start-ups are positively influenced by the existence of a local pool of potential entrepreneurs, lower labour costs and a more diversified economic environment. Relocations, on the other hand, prefer areas with a greater availability of producer services and a larger industrial basis. These findings suggest that plant relocations, which are at a later stage of the plant life cycle, add to concentration and geographic specialisation, whilst first locations show a more dispersed location pattern.

In addition to location factors that are now widely used in similar firm location studies, this paper pays special attention to the impacts of road infrastructure improvements on manufacturing plant birth and in attracting manufacturing plant relocations. Some analysts argue that transport infrastructure is no longer an important location factor for industry given today's low transport costs and the increasing importance of non-material flows (Forkenbrock and Foster, 1996, Banister and Berechman, 2000). On the other hand, with industrial restructuring towards more time-based competitiveness, production and distribution systems are becoming more transport intensive (Preston, 2001).

Since Portugal joined the EU in 1986, it has developed an ambitious road building programme extending the motorway network by over 1,000 kilometres. Such a large scale transport development poses important questions as to the role of transport for the spatial distribution of economic activity. The analysis in this paper is carried out at the

municipality level using data from 1986 to 1997. It was during this time, that some of the most important motorway connections were opened. Using Geographic Information System (GIS) techniques to calculate fine measures of accessibility together with the use of data for small geographical areas, overcomes limitations of previous research on transport infrastructure impacts that has largely relied on infrastructure stock measures for fairly large geographical regions. In this way, differences *within* regions are taken into account and the empirical evidence shows that there have been important impacts on the location of economic activity that would have been otherwise overlooked.

A key finding of this paper is that road infrastructure matters for both plant birth and plant relocations, but more so for plant relocations. Relocations show a considerably greater tendency to locate in the new road transport corridors than do start-ups. This indicates that as firms grow, their spatial requirements change to accommodate a greater need for high-quality transport infrastructure to sell output over, and get inputs from, a wider geographic area.

The paper is organised as follows: Section 2 presents the conceptual framework of firm birth and firm relocation. Section 3 discusses the data and model estimation. Section 4 presents the empirical results, and the main conclusions are provided in Section 5.

2 The conceptual framework: Plant birth and plant relocation

Both plant birth and plant relocation can be seen as events in the life cycle of a plant. The concept of firm demography relates to population demography where birth, growth, death and migration (relocation) are central elements of analysis (Van Dijk and Pellenbarg, 2000). The spatial distribution of economic activity is the outcome of a dynamic process of these events that take place at different stages of the plant life cycle (Dumais et al. 1997). Most studies that have looked at firm location have not made a distinction between firm formation and the relocation of existing plants from one place to another. While there is now a wide literature on firm birth (see, for example, Reynolds et al. 1994 for an overview) and increasingly also on firm death or closure (Johnson and Parker, 1996; Dumais et al. 1997, Fotopoulos and Spence, 2001), much less is known about relocations. Some studies have looked at the motives for relocations and characteristics of relocating firms (see, for example, Nakosteen and Zimmer, 1987; Pennings and Sleuwaegen, 2000). As far as the analysis of location determinants is

concerned, little is known about whether the initial establishment and the relocation of plants are affected by the same set of factors.

The location decision is frequently placed in a framework of profit maximisation. A firm's location is a factor that influences profitability because of differences in revenues and costs. Differences in transport costs determine prices of inputs and outputs over space and, hence, a firm's revenues. Consequently, firms choose a plant site after having considered a set of locational characteristics that affect expected profits over the lifetime of the plant. The expected profit p_{ijt} that firm i derives from locating in municipality j at period t can be written as a function of the characteristics of that location and a disturbance term, that is:

$$p_{ijt} = \mathbf{b}'x_{jt} + \mathbf{e}_{ijt} \quad (1)$$

where x_{jt} is a vector of municipality characteristics and \mathbf{e}_{ijt} is a random error reflecting specification errors.

Firm survey research has shown that apparently non-economic motives often related to the place of origin of the entrepreneur are an important factor in firm location decisions. However, Figueiredo et al. (2001) argue that investors choose the area with the highest expected profit, but under conditions of asymmetric information. Since searching for relevant information is costly, entrepreneurs familiar with their locality have low information costs compared to those searching unfamiliar locations. Moreover, access to social capital and local institutional and organisational networks in the form of contacts and experiences can generate positive returns for entrepreneurs setting up their business locally. These can be important assets that are costly to establish in other locations, and that explain why many locational choices favour the founders' local area.

Independent of the initial reasons that made a firm choose a particular site, once it is established the firm needs to attain a certain level of profit to survive (Van Dijk and Pellenbarg, 2000). Firms therefore monitor their own profits and evaluate their current location relative to profit opportunities elsewhere. The initial investment decision involves a significant commitment of resources in fixed capital, but over time the conditions related to the initial location choice can change, making alternative locations more attractive sites.

Van Dijk and Pellenbarg (2000) in studying micro data of Dutch firms conclude that, once a firm is located at a site, the propensity for relocation is low and mainly depends on internal factors related to the life cycle of the firm. Relocation costs are usually very high and only when firms face internal constraints do they start to consider the possibility for relocation. Factors that frequently induce relocations are capacity needs and physical space constraints, demand growth and market expansion, and restructuring to respond to new market opportunities. Because relocations are costly, they tend to take place at later stages of a firm's life cycle when firms also have a better capacity to absorb those costs. Not surprisingly, it is mainly the larger firms that relocate activities (Pennings and Sleuwaegen, 2000).

The location decision of both relocating establishments and new start-ups is the same to the extent that both seek locations where they expect to maximise profits. There are, however, reasons to suspect that the spatial context of the location decision process for new start-ups and relocations is different. Behaviour theory of the firm and theories about learning provide frameworks in which to place the decision process of firm location and relocation. Taylor (1975) argues that the area within which a firm makes location decisions expands with time and the growth of a firm. When a firm is first set-up, the initial location decision is often limited to the area of the company founder's origin because of the cost of obtaining information about all possible locations (Figueiredo et al., 2001). Choosing a familiar location can involve less perceived risks and uncertainties related to setting up a new business. As firms grow and develop, they learn and obtain more information. They may expand their market areas and they are likely to gain better knowledge about new business possibilities and alternative locations. In further investment decisions, firms consequently already have information on a wider area. Because of reduced perceived risks and uncertainties firms can 'become spatially more adventurous with age' (Taylor, 1975, p. 314). At this stage, relocations may take place if advantages from moving to a better-suited location exceed relocation costs.

As firms grow, not only their decision space may expand, but also their activity space, leading to different spatial requirements, that is, for example, less need of local market linkages and greater need of good transport infrastructure to sell output over a wider area. The relative importance of location factors for relocating establishments may therefore well be different from those of new start-ups.

There is little empirical evidence to date on differences in the spatial behaviour of new start-ups and relocating firms. Some evidence in this regard is reported in Duranton and Puga (2000) in the context of diversity versus specialisation of cities. Referring to French establishment data, they find that new plants have been set-up mainly in more diversified areas, whereas relocations have been towards more specialised areas. According to the model developed by the authors, diversified areas provide a better environment for process innovations in the early learning stages of the firm. By contrast, once firms have found their ideal production process, they relocate towards more specialised areas, where they can take advantage of localisation economies among similar activities, and avoid competition with unrelated activities for immobile factors.

The work of Figueiredo et al. (2001) on domestic location in Portugal provides empirical evidence that location factors have different importance according to whether the firm is set up in the founder's place of origin or founders move to new locations to set up their business. Firms set-up in a location different from the founders' place of origin are more strongly influenced by agglomeration economies and accessibility to the main markets. Both market accessibility and Marshall's agglomeration economies can be thought of as substitutes for familiarity with the locations since in addition to reducing costs they reduce risks and uncertainty. Factor costs, on the other hand, seem more important for firms that are set-up in the place of origin of the founder.

3 Empirical model

3.1 Model specification

To model where manufacturing plants are likely to open, the standard approach is to start from profit maximisation (Eq. 1), where firms evaluate relevant site characteristics that affect expected profits in alternative locations. This naturally leads to McFadden's (1974) conditional logit model that is based on the 'random profit maximisation' framework.

Although profits are unobserved, the probability that a new establishment of sector i locates in municipality j at period t is known and given by:

$$prob_{ijt} = prob \left(\mathbf{p}_{ijt} > \mathbf{p}_{ikt}, k \neq j; k, j \in J \right) \quad (2)$$

According to McFadden (1974), if the error terms are distributed independently and follow a Weibull distribution, then the probability that firm i locates in municipality j in period t is:

$$prob_{ijt} = \frac{e^{b'x_{jt}}}{\sum_{k=1}^J e^{b'x_{kt}}} \quad (3)$$

However, the assumptions of independently and Weibull distributed error terms imposes the restriction of ‘independence of irrelevant alternatives’. By this property, the decision not to locate a plant in a given area is independent of rejecting other areas, including nearby ones. In a spatially disaggregated analysis this is likely to be problematic since unmeasured attributes will be correlated for close neighbours. Hence, the omission of unobserved explanatory variables can cause a violation of the ‘independence of irrelevant alternatives’ assumption. One way to account for common omitted variables and for the potential violation of the ‘independence of irrelevant alternatives’ assumption is to include dummies for each choice (Guimarães et al., 2002). Unfortunately, with a high number of available choices such as in a municipality level analysis, this leads to a prohibitive computational burden in the conditional logit model.

Guimarães et al. (2002) show that the coefficients of the conditional logit model can be estimated by means of a Poisson model. Using a fixed-effects specification in the Poisson model is equivalent to including dummy variables for each choice in the conditional logit model to correct for restrictions of the ‘independence of irrelevant alternatives’ assumption. However, the Poisson fixed-effects model is much easier to implement in the case of large choice sets. Given the equivalence of the two models, Poisson estimations are compatible with the Random Utility Maximisation framework, the theoretical underpinning of the conditional logit model.

The basic Poisson probability function for municipality j receiving a count of n_{jt} manufacturing plants in period t is:

$$prob(n_{jt}) = \frac{e^{-I_j} I_j^{n_{jt}}}{n_{jt}!} \quad I > 0, n_{jt} = 0, 1, 2, \dots, n \quad (4)$$

where with municipality-specific fixed effects a_j , the Poisson parameter is given by:

$$I_{jt} = e^{x_{jt}b + a_j} \quad (5)$$

Following the conditional fixed effects approach of Hausman et al. (1984), the fixed effects are not estimated but accounted for by conditioning on the sum of manufacturing plants opened and relocated in a particular municipality over the sample period. The likelihood function of this model is:

$$prob \left(n_{j1}, \dots, n_{jT} \mid \sum_t n_{jt} \right) = \frac{\left(\sum_t n_{jt} \right)!}{\prod_t n_{jt}!} \prod_t \left[\frac{e^{x_{jt}b}}{\sum_s e^{x_{js}b}} \right]^{n_{jt}} \quad (6)$$

The Poisson model imposes the restriction of equality between conditional variance and mean. Many count data sets are, however, overdispersed with the conditional variance exceeding the conditional mean. While parameter estimates are consistent, the estimates of the standard errors are downward biased. The standard model used to account for overdispersion is the negative binomial model, where the Poisson parameter follows a gamma distribution. Hausman et al (1984) extends the negative binomial model to account for individual specific-effects. Conditional on the sum of plant openings for a given municipality over the observed years, the probability of municipality receiving a plant count is

$$prob \left(n_{j1}, \dots, n_{jT} \mid \sum_t n_{jt} \right) = \left(\prod_t \frac{\Gamma(\mathbf{g}_{jt} + n_{jt})}{\Gamma(\mathbf{g}_{jt}) \Gamma(n_{jt} + 1)} \right) \left[\frac{\Gamma(\sum_t I_{jt}) \Gamma(\sum_t n_{jt} + 1)}{\Gamma(\sum_t \mathbf{g}_{jt} + \sum_t n_{jt})} \right] \quad (7)$$

where $\mathbf{g}_{jt} = e^{x_{jt}b}$. In firm location data overdispersion can be caused by the concentration of firms in some areas due to unobserved location-specific heterogeneity. In this case, the fixed-effects in the Poisson may be sufficient (Cameron and Trivedi, 1998). A recommended practice, however, is to estimate both Poisson and negative binomial models.

The implementation of fixed-effects estimations explicitly accounts for unobserved location heterogeneity and is therefore preferable to cross-section regression models. In

general, it may be sensible to assume the existence of factors influencing location decisions that are either not observable, difficult to measure or for which no data exists. Cross-section estimations will be biased if these unobserved location characteristics are correlated with the independent variables. Fixed-effects techniques also provide a control for the correct specification of the causal relationship between firm location and road infrastructure construction. High firm location in earlier periods could induce the government to build new roads nearby, which potentially affects future firm location behaviour. Cross-section associations between firm location and road infrastructure will therefore not provide correct estimates of road infrastructure effects. Estimations have to account for the fact that locations have historically attracted higher numbers of new firms. Unobserved location-specific characteristics that influence both the placement of road infrastructure projects and firm location have to be controlled for. By exploring the time variation ‘within’ each municipality and comparing how changes in road infrastructure affect changes in firm location, consistent estimates can be obtained.¹

3.2 Dependent variable

To study manufacturing plant location in Portugal, I use establishment-level data from the Portuguese Ministry of Employment and Social Security (DEMESS). Information is collected on all firms and establishments with paid employees via an annual survey (Quadros do Pessoal).² Each establishment is assigned a unique identifier number. The methodology applied in this study to identify newly created establishments is similar to Guimarães et al. (2000). Newly created establishments in a given year are all those establishments that appeared for the first time in the database in that year. However, some firms may not respond to the questionnaire in the year they were established, but start returning the questionnaire in subsequent years. Since 1995, the data on all firms provide the year the firm was established. This additional information has been used as a control mechanism. In addition, a firm may not appear in one or more years. The firm may not have had paid employees in that year or it may have failed to return the questionnaire. In order to avoid identifying those firms as new when they start returning the questionnaire again, each establishment data entry has been compared with information on previous years. Only if the establishment had no data entry in any of the previous years, was it identified as a new establishment.

Municipalities may not only receive a manufacturing plant due to a plant birth, but a company may relocate an existing manufacturing establishment from a different location. Since each establishment has a unique identifier, it is also possible to identify all those manufacturing plants that have been moved from another municipality. Relocated establishments in a given year are all those establishments that appeared for the first time in a given municipality and had been located in previous years in another municipality.

Table 1 presents summary statistics. Over the period from 1986 to 1997, a total of about 40,000 manufacturing establishments were opened in Portuguese municipalities. Of these, slightly over 90 percent were new start-ups and only a small part was the result of relocations. At the same time, most newly created manufacturing plants have been of fairly small size (Table 1). About 80 percent of all new start-up establishments had less than ten employees. Compared to the relocating firms, Table 1 also confirms that new start-ups occur above all in the smaller size classes (Caves, 1998). In contrast, plants that have been relocated were generally of larger size. More than half of the relocating firms had more than 10 employees compared to only 20 percent of the new start-ups. Of the relocating establishments, 14 percent had more than 50 employees compared to just over 2 percent of new start-ups.

Insert Table 1 around here

There have also been considerable spatial variations in the location of manufacturing plant openings. Figure 1 illustrates the spatial unevenness of newly set-up and relocated manufacturing plants in Portugal over the whole period. The picture is one of a highly polarised pattern in the regions containing the two main urban centres of the country, Lisbon and Porto. The two cities together with municipalities in their vicinity stand out with the highest numbers of manufacturing plant location between 1986 and 1997. Some concentration of manufacturing plant openings due to birth and relocation also appears along the corridor between Lisbon and Porto and in some other larger district capitals.

Insert Figure 1 and 2 around here

Figure 2 summarises the differences in the spatial location pattern of manufacturing plant birth and relocation. The map is based on the difference of two terms: the regional share of relocating plants and the regional share of plant births. Where the spatial

distribution of relocating plants has occurred in proportion to plant births, the measure is zero. The emerging map indicates that there are, indeed, differences in the location pattern of new and relocating manufacturing plants. Relocations take place to a larger degree in the more urbanised western part of the country between the main cities, Lisbon and Porto. The aim of this research is to identify reasons for these differences at the municipality level.

3.3 Independent variables: location factors

Firms are assumed to choose locations according location characteristics that affect expected profits. These include municipality (concelhos or NUTS5) characteristics and wider area characteristics (NUTS3) that relate to factors that work at the wider labour market areas. Table 2 summarises the independent variables used in estimating the number of manufacturing plants that have appeared in Portuguese municipalities over the period 1986 to 1997. The independent variables include measures of road infrastructure access and accessibility, and location determinants that have been widely used in the firm location literature and can be grouped into measures of local and regional market demand, agglomeration economies, and factor costs and labour market factors. Except for distance to the new motorway network, which is calculated for the periods 1986-1989, 1990-1993, 1994-1997, all other independent variables are calculated as the three-year averages previous to the year of plant location.

Insert Table 2 around here

Measures of local and regional market demand

Some measures of market demand feature in most industrial location studies. Other thing being equal, areas of greater market demand are expected to offer greater profit opportunities for both, new and relocated plants. Local and regional market demand has been found to influence in particular small business location (Bartik, 1989; Keeble and Walker, 1994). In this paper, GDP per capita at the NUTS3 level is used as proxy for market area size for firms producing mainly for the regional market.³ Total municipality population is included to take into account variations in local markets and the fact that larger municipalities are likely to have more new plants. National market access is better described by a gravity-adjusted measure (Woodward, 1992). Such measures

account for both size and relative position of municipalities to each other and are described below. Because start-ups are in general smaller than relocations and are more likely to operate over smaller geographical areas, they are expected to be more strongly influenced by the market demand measures.

Agglomeration economies

Locating in urban areas and areas with more existing firms may provide advantages through localisation and urbanisation economies. The literature on agglomeration economies and spatial spillovers suggest that such forces operate over relatively short distances (Ellison and Glaeser, 1997; Wallsten, 2001). For that reason, sectoral employment data are used at the municipality level to characterise local agglomeration economies. The degree to which an area is specialised in few manufacturing sectors is measured by the Herfindahl index H of sectoral concentration of the municipality employment.

$$H_j = \sum_s \left(\frac{e_{sj}}{e_j} \right)^2 \quad (8)$$

where e_{sj} is the employment in sector s in area j , e_j is the total employment in area j . The index is based on 10 two-digit manufacturing industries. The larger the index, the larger the employment concentration in fewer sectors in a particular municipality, with a value of 1 if employment is concentrated in just one sector. Thus, if diversity plays a more important role for firm births and specialisation for relocations, as suggested by the model in Duranton and Puga (2000), then the coefficient for this index is expected to be negative in the birth model and positive in the relocation model. In addition, the size of the local industry can reflect the importance of an existing industrial base in attracting new manufacturing plants, but it can also be important for the ‘spin-off’ of new firm founders. Since the municipality share of total industrial employment is highly correlated with municipality population, the industrial share is included at the NUTS III level.⁴

Proximity to producer services measured as the employment density in insurance, financial, and transport and communication services is included to capture urbanisation economies. Such a variable measures the cost of face-to-face contacts and the cost of

outsourcing support services. These costs are supposed to be lower if suppliers of those services are located nearby. Proximity of firms in financial, legal and business services can also increase the information flows on particular product and market knowledge (Cornish, 1997). The variable is modelled in the logarithmic form allowing for a non-linear relationship that reflects a declining importance of additional employment in those sectors.

Factor costs and labour market factors

Firm profits are negatively influenced by factor costs and, hence, all else the same, firms are assumed to be deterred from locating in areas with higher costs. Most studies include some measure of labour costs. In this study, wages are calculated as indices of the regional average annual wages for manufacturing workers and are assumed to negatively influence both firm start-ups and relocations.

Firms, in making a location decision, will not only look at wage levels, but also at differences in labour force qualifications since this can lead to productivity differences. Here, the percentage of the regional labour force with no more than a secondary school education is included. This variable is hypothesised to show a negative relationship with plant birth and relocation. Both can be assumed to prefer areas with a better qualified labour force. However, for firm birth, labour force qualification can also be an indicator of a potential pool of entrepreneurs (Keeble and Walker, 1994). Labour market variables are calculated for NUTS3 regions, since municipalities are likely to be smaller than labour market areas.

Road transport infrastructure

Since Portugal joined the EU in 1986, it has developed an ambitious road building programme. In the first half of the eighties, there were only about 200 km of motorways, mostly in the Lisbon and Porto metropolitan areas. By 1998, the motorway network had been extended to over 1,300 kilometres. Most of the new motorway sections that had been opened over this period were to provide faster connections between Lisbon and Porto, the two major economic centres of the country and to improve connections to Spain and Europe in general.

The attractiveness of a municipality as a manufacturing plant location is assumed to depend on the characteristics of the road transport infrastructure in place. Better transport infrastructure allows higher levels of accessibility, that is, better links to input and output markets, and thereby lower transport costs. Given the huge investments that took place in the Portuguese road network, it seems of particular interest to take these changes into account in a location analysis. Using geographic information systems (GIS), accessibility measures are constructed, expressing the location of each municipality within the Portuguese road network in terms of intra-regional and inter-regional accessibility for different points in time. The advantage of accessibility measures is that they take into account the network characteristic of transport infrastructure and are not confined to the infrastructure stock within the boundaries of municipalities. The approach adopted follows that of Holl (2001) in a study of manufacturing plant location in Spain.

Intra-regional accessibility is based on road network access. This is calculated as the ‘crow flies’ to measure the municipalities’ location with respect to the new corridors created and capture the advantage of higher levels of accessibility close to the transport corridors. There is evidence that the impacts of new road infrastructure depend on how far away from the network the municipality is located (Holl, 2001, Chandra and Thompson, 2000). To avoid imposing a particular structure of the distance effect, I use a specification of discrete distance intervals of 10 kilometres with dummy variables to indicate the location of a municipality with respect to new road infrastructure. Taking the first 10 kilometres from a motorway as the base, the coefficient of the other distance dummy variables should be negative, if transport improvements increase the attractiveness of nearby municipalities for manufacturing plants relative to municipalities at greater distance.

Inter-regional accessibility reflects the general opportunities for engagement in national markets. This is best expressed by a gravity-type measure where the potential between two locations is positively related to their size and negatively related to the distance between them.

$$Acc_j = \sum_k \frac{W_k}{c_{jk}} \quad (9)$$

Here, c_{jk} is the travel time between municipality j and k , where travel time is calculated from each of the 275 municipalities to the main markets. $c_{jk} = 1$ for all municipalities that are less than half an hour travel time apart. W_k is the size or attraction term of the destinations k and is based on the population of the 82 largest cities (those with more than 25,000 inhabitants) covering about 75 percent of the population of mainland Portugal. The measure takes into account that, in general, larger destinations offer greater opportunities, but destinations at greater distances are visited less frequently. Given the strong concentration of population in the two areas of Lisbon and Porto, it is dominated, above all, by accessibility to these two cities.

In addition, a number of other factors has been argued to be relevant for determining firm location, such as, for example, the innovative ability of local authorities, a favourable business climate or public services and amenities which directly or indirectly benefit firms (see, for example, Kohler, 1997). Here, these factors are not explicitly taken into account, but controlled for via the implementation of fixed effects estimations.

4. Empirical Results

Table 3 presents the results of the conditional fixed-effects Poisson and negative binomial estimations for the pooled total of opened manufacturing plants, plant births and relocations from 1986 to 1997 in Portuguese municipalities. Overall, the results for the independent variables show high levels of significance. Table 3 also includes the results of a Wald test on the appropriateness of the conditional fixed-effects models. The models are supported for the pooled estimations and the separate estimations of plant births and plant relocations. The coefficients estimated in the Poisson models are remarkably consistent with the estimates from the negative binomial models.

Insert Table 3 around here

Column 1 and 4 show the pooled results. Overall, the location of manufacturing plant openings (due to firm birth and relocations) is significantly influenced by issues of local market size as indicated by the positive sign of the population variable. On the other hand, contrary to expectations, the coefficient for the regional market size variable GDP per capita is not significant in any of the estimations. The proxy for the degree to which

an area is specialised in few sectors has a negative and significant effect in both estimations. While firms preferred more diversified areas, manufacturing plant openings were also positively influenced by an already larger existing industrial base. Availability of producer services also shows the predicted positive effect on plant openings in a municipality, but is only significant in the negative binomial specification. The wage variable shows the expected negative sign, but is only significant in the Poisson model, whereas the variable capturing the qualification of the labour force, that is the number of persons with only secondary education, is both negative, as expected, and significant in all cases.

Potential population accessibility, which most strongly reflects access to the large urban areas of Lisbon and Porto, shows a positive and positive and significant effect in the Poisson model. New manufacturing establishments also show a clear tendency to locate close to the interregional road infrastructure constructed. All distance dummy variables exhibit a negative effect, attesting to the preference for municipalities in the first 10 kilometres around a motorway. The coefficient for the pooled sample predicts that municipality outside the 10-kilometre motorway corridors show between 15 and 37 percent less predicted manufacturing plant openings. The negative distance effect is most strongly felt in municipalities between 20 and 30 kilometres from the nearest motorway. With an average size of 20 kilometres in diameter, these tend to be municipalities adjacent to those through which motorways pass directly. These results are similar to those found in Holl (2001) for manufacturing plant location in Spain and suggest negative spillover effects where new motorways increase the attractiveness of municipalities in the new corridors at the cost of adjacent municipalities.

As can be seen in Column 2 and 3, and 5 and 6 for the separate estimations for plant births and relocations, the results show that there is considerable variation in the effects of the independent variables. The difference in preferred locational characteristics of the two types of plants is confirmed by the Chow test. The test finds a chi-squared statistic, which is significant at the one percent level.

The importance of spatial patterns of market areas is apparently perceived differently by firms setting up new plants from those relocating their plants to another municipality. Municipality population, that is the local market size variable, significantly influence the location decision of new plant start-ups but has no significant effect on relocations. Relocations, in contrast, have been more strongly attracted to areas with a higher

density of producer services. This would suggest that relocating plants, given that they are at a later stage of their life-cycle, are not constrained by local market demand, but operate over wider geographical areas, while concentrating on their core activities by making greater use of producer services. At the same time, it is also the relocating firms that place more importance on the existence of an industrial base in the area, which also enhances the possibility of finding more suitable firms for outsourcing non-core activities.

Specialisation as measured by the Herfindahl-index has a negative and significant effect on manufacturing plant births, while it is insignificant in the relocations' estimation. The greater importance of diversity for plant birth is consistent with the 'nursery city' argument of Duranton and Puga (2000) where new firms prefer more diversified areas. Since it is there where they find greater opportunities to learn about different processes from different activities. That helps firms in their early stages to improve their own production process, but it is also argued to lead to higher innovative activity (Jacobs, 1960).

The results also indicate that firms in their early stages are more concerned about factor costs. Higher wages decrease the expected number of births, but have no significant effect on relocations. In this sense, new start-up plant location behaviour is similar to that found for companies set-up in the founders' place of residence in Figueiredo et al. (2001). While both relocations and start-ups have preferred areas with a better qualified labour force.

The effect of potential population accessibility is unclear and signs and significance change between the Poisson and negative binomial model. However, relocations are, much more strongly drawn into the new transport corridors. This is shown by the much stronger distance dummy coefficients, which are on average 2.5 times larger for relocations than for firm births. Moreover, the very large negative coefficients for municipalities within a distance of 20 to 30 kilometres from an interregional motorway indicate that these locations have become much less attractive for firm relocation with the development of the inter-regional motorway network. By locating within the interregional motorway corridors the relocated plants gain good access to a wide number of potential destinations. This seems consistent with Taylor's (1975) argument that firms increase their activity space with age.

The difference in the location behaviour of those firms that set-up a new manufacturing plant and those that relocate an existing one could be related to plant size. Additional estimations have been carried out using only the larger newly created firms with 5 and more employees. The results are qualitatively the same to those of all newly created firms, but with a lower overall explanatory power.

5. Conclusions

This paper has attempted to identify the factors affecting the location choice of new and relocated manufacturing plants in Portugal for the period from 1986 to 1997 in Portugal. The novelty of the paper lies in the use of microeconomic panel data that distinguishes firm births and firm relocations at the level of the municipality, combined with GIS techniques to include the evolution of the road network as a location factor. The results indicate that, overall, manufacturing plants prefer locating in areas with larger local markets, more agglomeration economies, lower wages and better qualified labour forces. Moreover, road transport infrastructure and its improvement has significantly influenced manufacturing plant location in Portugal at the municipality level.

A primary finding of this paper is that differences exist between those manufacturing establishments that have been relocated and those that have been newly set-up. Firm births and firm relocations display a different locational behaviour because these events occur at different stages of a firm's life cycle. It might well be that new plant start-ups are mainly founded in the first place close to the owner's place of residence. The findings for new start-ups in the present analysis provide some support for this phenomenon with labour force qualification and municipality population as positive determinants of start-ups. The literature on firm birth has frequently argued that among other factors, population and labour force qualification are also indicators of a pool of potential entrepreneurs (see, for example, Storey, 1988; Keeble and Walker, 1994). Together with the greater importance of diversity and lower labour costs for start-ups the results suggest that first locations follow a more dispersed location pattern than relocations that have been attracted to the more industrial areas and those with greater availability of producer services and therefore appear to add to concentration. As firms grow they seem to start valuing different location factors and they seem to become spatially less restricted to the place of origin of their founder as was suggested by

Taylor (1975). Both a greater industrial basis and availability of producer services can reduce uncertainties related to setting up a plant in a location different from the founder's place of origin and in Figueiredo et al. (2001) such factors are found to influence non-local investment decisions. One of the most interesting results is that the importance of closeness to interregional road transport infrastructure is considerably higher for relocating firms than for new start-ups.

The findings are important, because for any spatial policy to be effective it has to be placed into the context of the forces driving the spatial pattern of firm location. A number of barriers such as limited market access, inefficient transport networks and the lack of agglomeration economies, appear more important than access to cheap labour in the more peripheral areas, especially for growing manufacturing firms. This has resulted in many cases in a choice of location in the newly created transport corridors connecting the core regions, where firms share both the opportunity to enjoy good market access and many of the agglomeration advantages of core regions, namely Lisbon and Porto. Spatial policy that aims to stimulate investment in certain areas has to take into account that not all investment is attracted or deterred by the same factors. Much depends on the stage of a firm's life cycle.

At a more general level, this analysis supports the view that a comprehensive understanding of the relationship between transport and economic development must include the analysis of impacts taking place at the intra-regional and local level (Banister and Berechman, 2000). It is difficult to analyse differences in location patterns at large geographical units when the forces that cause them operate primarily over shorter distances. Important impacts are due to changes in firm's spatial behaviour as a response to changes in transport networks and these are better identified at the micro-level.

¹ See Pitt et al. (1993) for a more complete discussion of the shortcomings of cross-section estimations in analysing impacts of public programmes.

² This survey has to be returned by law to the Ministry by all firms with paid employees. Hence, its comprehensiveness is similar to a census of firms, particularly with regard to firms in the manufacturing sector. However, the data set does not include very small firms with only self-employed workers. These are not required to return the questionnaire. Moreover, those new start-ups that had only a very short life, i.e. a couple of months up to less than twelve month, are also under-represented, because if an establishment was formed and closed down between the annual collections of the questionnaire it would not appear in the statistical records.

³ NUTS 3 is the finest level of spatial disaggregation at which GDP per capita data is available in Portugal.

⁴ Correlation between the municipality industrial share and municipality population is almost 90%; municipality population and NUTS III industrial share shows a correlation of about 67% and correlation

between municipality industrial share and NUTS III industrial share is also of about 67%. This suggests that the explanatory part of the industrial share variables lies in the NUTS III level.

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Table 1. Summary statistics and size distribution by number of employees of new plant start-ups and relocations: 1986-1997

A. Summary statistics				
	Start-ups	Relocated Plants		
Mean	10.99	1.06		
Standard Deviation	23.11	3.13		
Min.	0	0		
Max.	246	54		
B. Size distribution				
Size distribution	Number of Start-ups	Share of Start-ups	Number of Relocated Plants	Share of Relocated Plants
1 employee	5721	15.77	212	6.07
2 to 4 employees	14859	40.96	698	19.99
5 to 9 employees	8137	22.43	761	21.79
10 to 49 employees	6691	18.45	1338	38.32
50 and more employees	867	2.39	483	13.83
Total	36275	100.00	3492	100.00
<i>Data source: DEMESS "Quadros do Pessoal", Portugal.</i>				

Table 2. Independent variables: definition, expected effects and data sources

Variables	Definition	Geo. Scale¹	Expected Effect	Data Source
<i>Market size</i>				
GDP/capita	Index of annual GDP/capita (base = national average)	NUTS III	+	INE/Eurostat
Population	Absolute size of population (in hundred thousands)	NUTS V	+	INE
<i>Agglomeration economies</i>				
Area specialisation	Herfindahl employment specialisation index	NUTS V	+/-	DEMESS
Industry share	Share in total national industry employment	NUTS III	+/-	DEMESS
Producer services density	Log of producer service employment per km ²	NUTS V	+	DEMESS
<i>Labour cost</i>				
	Index of manufacturing wage (base = national average)	NUTS III	-	DEMESS
<i>Labour force qualification</i>				
	% of labour force with only secondary education (schooling until 15)	NUTS III	-	DEMESS
<i>Accessibility</i>				
Population Accessibility	Index of potential population accessibility	NUTS V	+	GIS own calculations
Motorway access	Log of distance to nearest district capital (in 10 kilometres)	NUTS V	-	GIS own calculations
Distance 0-10 km	Municipalities within 10 km of nearest motorway = 1	NUTS V	+	GIS own calculations
Distance 10-20 km	Municipalities between 10 and 20 km of nearest motorway = 1	NUTS V	-/+	GIS own calculations
Distance 20-30 km	Municipalities between 20 and 30 of nearest motorway = 1	NUTS V	-/+	GIS own calculations
Distance 30-50 km	Municipalities between 30 and 50 of nearest motorway = 1	NUTS V	-	GIS own calculations
Distance beyond 50 km	Municipalities beyond 50 km of nearest motorway = 1	NUTS V	-	GIS own calculations

¹ NUTS III regions are similar in size to districts but boundaries do not correspond; NUTS V corresponds to municipalities (concelhos).

Table 3: Conditional fixed effects estimation: pooled sample, plant births and plant relocations

Variables	Poisson fixed-effects			Negative Binomial fixed-effects		
	Pooled sample	Firm births	Relocations	Pooled sample	Firm births	Relocations
Population	0.204*	0.263*	-0.117	0.161*	0.215*	-0.162
GDP per capita	-0.001	-0.001	0.004	0.001	0.001	0.002
Area specialisation	-0.505*	-0.490*	-0.100	-0.358**	-0.505*	-0.202
Industry share	0.043*	0.046*	0.166*	0.027**	0.026***	0.134*
Producer service density	0.008	-0.018	0.038	0.078***	-0.026	0.336*
Wage	-0.008*	-0.014*	-0.008	-0.004	-0.008**	-0.002
Labour Force qualification	-0.061*	-0.074*	-0.079*	-0.027**	-0.022***	-0.101*
Population accessibility	0.005*	0.008*	-0.002	0.0003	-0.0002	0.010*
Motorway access						
Distance 10-20 km	-0.152*	-0.152*	-0.256**	-0.128*	-0.117*	-0.269**
Distance 20-30 km	-0.370*	-0.310*	-0.964*	-0.312*	-0.231*	-0.755*
Distance 30-50 km	-0.280*	-0.235*	-0.597*	-0.229*	-0.172*	-0.437*
Beyond 50 km	-0.294*	-0.304*	-0.644*	-0.222*	-0.199*	-0.713*
Observations	3300	3300	2676	3300	3300	2676
Log likelihood	-6694.04	-6280.36	-2232.31	-6373.82	-6100.19	-2123.18
Wald test	1006.37*	1063.84*	1389.75*	410.23*	458.23*	804.3*

Notes: All regressions include unreported time dummies, and the negative binomial regressions also include an unreported intercept
Significant coefficients are indicated by *, **, ***, for significance at the 1%, 5% and 10% level, respectively.

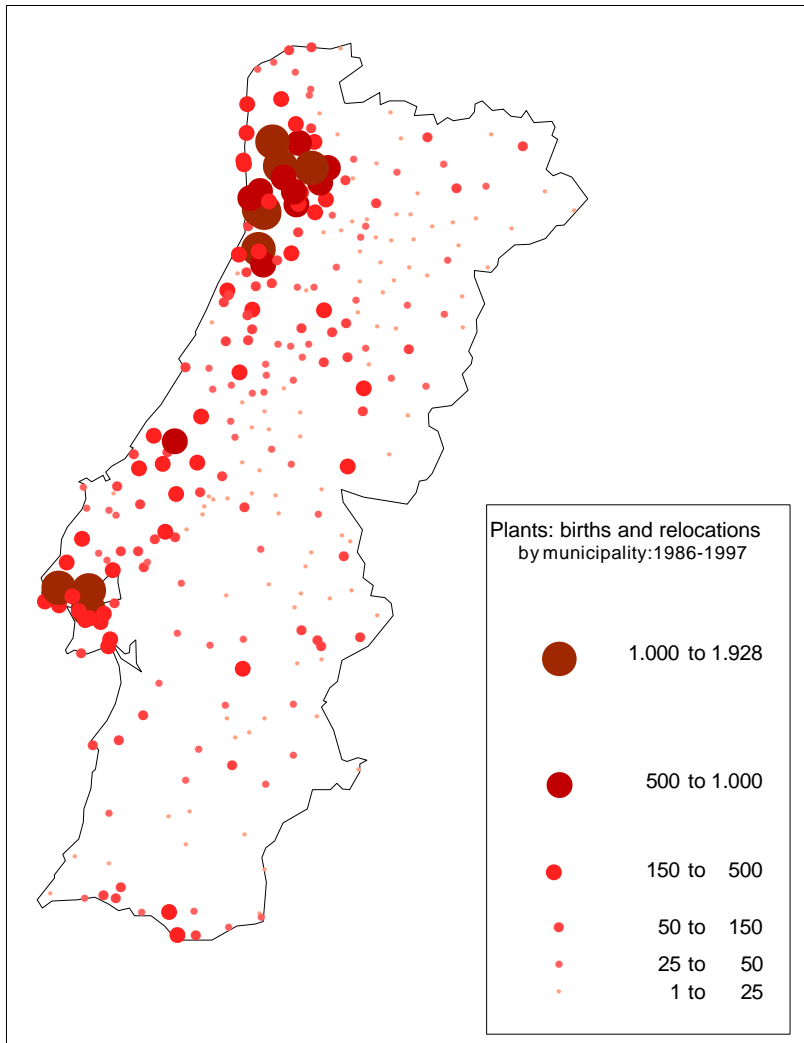


Figure 1. Spatial distribution of all plants (plant births and plant relocations)

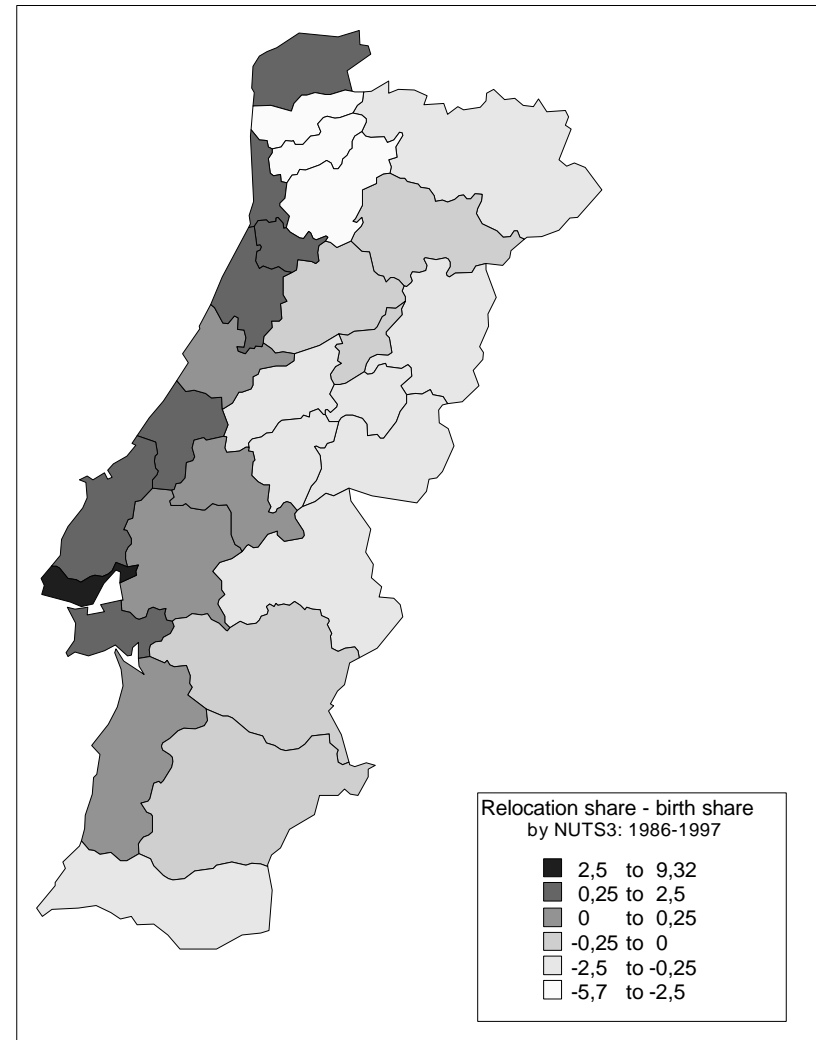


Figure 2. Spatial difference between plant relocations and plant births