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The Determinants of Location Choice: Single-plant versus Multi-plant firms

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Abstract

We intend to evaluate the importance of geographical and technological variables for firms' decision about location. For that purpose, we make use of micro-level data for the Portuguese manufacturing sector and focus on the location choices made by new starting plants during 1992-2000 within 275 municipalities. Our main hypothesis is that location determinants affect unevenly single-plant and multi-plant firms. We consider the entire manufacturing sector and also a partition according to the number of plants. The set of explanatory variables includes variables that are traditionally stressed by urban and regional theory, such as production costs (land, labour and capital costs), demand variables and agglomeration economies as well as technological variables, such as R&D expenditures The model is based on the random utility maximization framework and proceeds through a Poisson model and a Negative Binomial regression. When considering the total manufacturing sector, our results confirm the relevance of agglomeration economies (particularly, urbanization economies) and cost factors (labour and land costs) for firms' location choice. On the contrary, the hypothesis concerning the negative influence of capital costs on location choice is not confirmed in our study. Our research also evidences that the regional market is more significant for the location choice of new single-plant firms, while the local market is more relevant for new multi-plant firms. Also, market accessibility is only relevant for the location choices made by new single-plant firms. We then concluded that new multi-plant firms are particularly sensitive to urbanization economies, land costs and local market, while new single-plant firms are more responsive to labour costs and agglomeration economies.

Keywords: Location; Single-plants; Multi-plants; Poisson model; Negative binomial model
JEL Classification: R12; C25

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1 Introduction

Since long time ago, economic agents – households and firms – tend to agglomerate in a fairly number of cities or industrial clusters. During the last decades, this apparently widely accepted evidence has gained a very special attention in the core of urban and regional science but also attracted economists from other fields of economic science, such as international economics, industrial organization or growth theory.

The evidence and secular tendency for the agglomeration of economic activities lead us to formulate some questions: Why competing firms agglomerate in industrial clusters if competition there is fiercer? Or, what attract domestic and foreign investment? Broadly speaking, *what determines the location decision of economic agents*?

Understanding the determinants of business location choice is the subject of a large body of literature, encompassing both theoretical and empirical research. According to Greenhut (1993), contributes for the location theory may be aggregated into three categories. The *cost minimizing theory* emphasizes the search for the least cost site by abstracting from demand and by assuming competitive pricing, different costs across locations and a given buying center. Early contributes are due to Von Thünen (1966 [1875]) and Weber (1929 [1909]), who claimed that the determinants of each firm's location are the transport costs, labour costs and the agglomerating (deglomerating) forces. The *spatial interaction theory* postulates that the production costs are irrelevant and that the optimal location results from the determination of the optimal market area in a context of spatial competition between firms. Under the influence of Hotelling (39) and Chamberlin (1950), they concluded that the optimal location of the firm is influenced by the elasticity of the industrial demand curve, the height of the freight cost and the characteristics of the marginal production costs. Finally, the *profit maximization theory* suggests that the optimal location depends both on the costs and revenues that derives from each location. Lösch (1954 [1940]) provided the first systematic economic analysis of the location decision and postulated that the optimal location is the one that assures maximum profit for the entrepreneur.

Empirical research on the determinants of location choice may proceed either by using the survey method or by means of econometric modeling. In the first case, firms are required to identify the determinants of its actual location (*stated preferences*). The survey method allows us to obtain very rich data and to understand the ranking among alternatives, being extremely relevant when historical information is unavailable. However, the stated preferences about location may differ from the real ones, while the results are highly responsive to sample characteristics. The second approach appeals to econometric models where the actual location of the firm is put against a set of explanatory variables. In this case, the researcher uses historical data that depict actual choices (*revealed preferences*) and intend to identify the factors influencing choices[2].

Recent advances in econometric techniques and the enrichment of statistical data led to an huge development of econometric studies on firms' location determinants. Most papers focus on the location choices made by new starting firms within a set of geographical alternatives and proceed through discrete choice analysis. Usually, they study the location choices of either domestic or foreign firms, which are putted against a set of explanatory variables that intend to capture the importance of costs factors, demand variables and agglomeration economies for the business site selection process. However, the characteristics of the entrepreneur, and in particular, firms' size or its structure, are seldom taken into account[3].

In this paper, we intend to evaluate the importance of both geographical, sectorial and technological determinants for firms' decision about location. In particular, we aim at assess if location determinants affect unevenly single-plant and multi-plant firms. For that purpose, we make use of micro-level data for the Portuguese manufacturing sector and focus on the location choices made by new starting plants during 1992-2000 within 275 municipalities. We considered the entire manufacturing sector, and also a partition according to the number of plants. The set of explanatory variables includes variables that are traditionally stressed by urban and regional theory, such as production costs (land, labour and capital costs), demand indicators and agglomeration economies (urbanization and localization economies), as well as technological variables, such as R&D expenditures The model is based on the random utility maximization framework and proceeds through a Poisson model and a Negative Binomial regression.

The remainder of the paper is organized as follows. Next section is devoted to a brief explanation of the Random Utility Maximization framework. Next, we proceed through a detailed description of data and variables we considered in our study. Finally, we present the empirical results and concluding remarks.

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[2] Another strand of the literature, prevalent until the 70's, aims at identify the *optimal location* for a given industry under the hypothesis of costs minimization (Isard (1998)).

[3] Another approach to the location choice focus on firms' birth rate, either by adopting an evolutionary approach (new firms/total firms) or a labour market approach (new firms/labour force). In both cases, a linear regression model is usually adopted (e.g. Guesnier (1994), Audretsch and Fritsch (1994), Garofoli (1994) and Armington and Acs (2002)). Typically, the set of explanatory variables includes the rate of change of variables that capture the importance of agglomeration economies, government policy, labor and market conditions for location choice. However, the compatibility of this approach with the profit maximization framework has not been clarified, and, for this reason, we will not adopt this line of research.

2 Methodology

Research on firms' decision about location usually appeals to discrete-choice models that rely on the Random Utility Maximization framework of McFadden (1974). This methodology was first implemented on location choice by Carlton (1983) and most subsequent research on spatial probability choice has relied on his approach (for instance, Bartik (1985), Coughlin *et al.* (1991), Friedman *et al.* (1992) and Woodward (1992)).

In this framework, decision probabilities are modelled in a partial equilibrium setting where firms maximize profits subject to uncertainty that derives from unobservable characteristics. For our purposes, we will consider an economy with K industrial sectors $(k = 1, ..., K)$. Assume that there are N investors $(i = 1, ..., N)$ who independently select a location j from a set of J potential locations $(j = 1, ..., J)$. The potential profit that a firm i assigns to each location j and each industrial sector k is:

$$\pi_{ijk} = \boldsymbol{\alpha}' x_j + \boldsymbol{\theta}' y_k + \boldsymbol{\beta}' z_{jk} + \varepsilon_{ijk} \tag{1}$$

where $\boldsymbol{\alpha}$, $\boldsymbol{\theta}$ and $\boldsymbol{\beta}$ are vectors of unknown parameters, x_j is a vector of location specific variables, y_k is a vector of sector specific variables and z_{jk} is a vector of variables that change simultaneously with the sector and the location. ε_{ijk} is an identically and independently distributed random term with an Extreme Value Type I distribution.

For every spatial option, the investor will compare expected profits and choose alternative r if:

$$\pi_{irk} > \pi_{ijk}, \forall j \neq r$$

Due to the stochastic nature of the profit function, the probability of an investor i of the industrial sector k chooses the location j is:

$$P(j) = Prob(\pi_{irk} > \pi_{ijk})$$

Or, similarly;

$$P_{j|k} = \frac{\exp\left(\boldsymbol{\alpha}' x_j + \boldsymbol{\beta}' z_{jk}\right)}{\sum_{j=1}^{J} \exp\left(\boldsymbol{\alpha}' x_j + \boldsymbol{\beta}' z_{jk}\right)}$$

which expresses the conditional logit model formulation. However, the conditional logit model assumes that the odds of choosing an alternative are a function of its attributes but are independent of other alternatives. This proposition, known as the *Independence of Irrelevant Alternatives* assumption (IIA), may be implausible in location choice analysis, as adjacent locations may have similar characteristics, which make them interdependent. Additionally, if the IIA assumption is violated, then it leads to biased coefficient estimates.

In order to accommodate the IIA assumption in the location choice, some scholars choose to model location decision among highly aggregated regions, such as the US States (e.g. Bartik (1985), Coughlin *et al.* (1991), Friedman *et al.* (1992) and Head *et al.* (1999)). Alternatively, other researchers used large data sets but followed McFaden's suggestion to work with a small sample of location sites randomly chosen from the full data set (e.g. Woodward (1992) and Guimarães *et al.* (2000)). Others authors recurred to the *nested logit model* (e.g. Hansen (1987), Barrios *et al.* (2006) and Head and Mayer (2004)).

A recent strand of the literature has modelled the location choice by means of a *Poisson model* (e.g. Guimarães *et al.* (2004) and Carod (2005)). Under this formulation, the number of new firms that choose a specific location is a count variable and relates with a vector of local characteristics. So, the probability that the number of firms that chooses location j is n_j is given by:

$$P(n_j) = \frac{e^{-\lambda_j}.\lambda_j^{n_j}}{n_j!}$$

Additionally, and as it was demonstrated by Guimarães *et al.* (2003), the coefficients of the conditional logit model can be equivalently estimated by using a Poisson regression. Actually, the coefficients of the conditional logit model (equation 1) can be estimated by maximizing the following log-likelihood, where n_{jk} denotes the number of investments carried out in sector k and region j:

$$\log\ L = \sum_{k=1}^{K}\sum_{j=1}^{J} n_{kj}\ \log P_{j|k}$$

which is equivalent to that of the Poisson model which takes n_{jk} as a dependent variable and includes as explanatory variables x_j and z_{jk} vectors plus a set of dummy variables for each sector. That is, we will obtain the same results if we admit that n_{jk} follows a Poisson distribution with

$$\lambda_j = \exp\left(\boldsymbol{\omega}_k + \boldsymbol{\alpha}' x_j + \boldsymbol{\beta}' z_{jk}\right)$$

where $\boldsymbol{\omega}_k$ is a dummy variable that takes the value 1 for sector k (0, otherwise).

However, the Poisson regression model assumes that the conditional mean λ_j equals the conditional variance, that is, $E(n_{jk}) = Var(n_{jk}) = \lambda_j$. But, empirically, the variance is usually larger than the one assumed by the Poisson model, a result named *overdispersion*. Overdispersion is a form of heteroscedasticity which yields downward biased estimates of the standard errors, although consistent estimates of the parameters. In the case of location choice, it is expected to observe overdispersion due to the concentration of firms in some areas. To overcome this problem, the Poisson model can be extended or transformed into a negative binomial model (e.g. Wu (1999), Coughlin and Segev (2000) and Holl (2004)).

The *negative binomial distribution* is an extension of the Poisson model that allows the variance of the process to differ from its mean. So, the probability that the number of firms that chooses location j is n_j is given by mixing the Poisson model with a gamma distribution:

$$P(n_j) = \frac{\Gamma(\theta + n_j)}{\Gamma(1 + n_j)\Gamma(\theta)} \left(\frac{\lambda_j}{\lambda_j + \theta}\right)^{n_j} \left(\frac{\theta}{\lambda_j + \theta}\right)^{\theta}$$

where Γ is the gamma distribution, $E(n_{jk}) = \lambda_j$ and $Var(n_{jk}) = \lambda_j\,(1 + \lambda_j/\theta)$. The negative binomial model can be estimated by maximum likelihood.

In this research, we will depart from the Random Utility Maximization framework and take advantage of the equivalence between the conditional logit model and the Poisson regression to overcome any potential IIA violation. Additionally, if overdispersion is observed, then the negative binomial model will be taken under consideration.

3 Data and Variables

3.1 Dependent variable

We used *Quadros do Pessoal* (Deep-MTE (1991-2000)) to identify all plant births in each municipality between 1992 and 2000. This statistical database is a yearly survey of the Portuguese Ministry of Employment for all firms operating in Portugal, except family businesses without wage-earning employees. The inquiry collects information at the firm and plant level since 1982 about its location, economic activity, capital structure, number of plants and employees. By using a unique identifying number addicted to each firm and its establishments and employees, we were able to merge data about firms, plants and labor force. However, this identifying number was modified in 1991, leading us to limit our study to the period 1992 to 2000. In the specification of our data-set, we adopted the municipality as geographic unit. By using the *Code of the Administrative Division* (INE 1987), we were able to select 275 municipalities[4]. Additionally, we recur to the *Portuguese Classification of Economic Activities* at two-digit level (CAE - 15 to 37) (INE 1994) to restrict for the manufacturing sector[5]. In our research, we first considered the entire manufacturing sector, and then proceed with a partition according to the number of new plants (single-plant and multi-plant firms).

A plant was identified as *new* if it was the first time it appeared in the merged data set[6]. We were able to identify 37 222 new manufacturing plants between 1992 and 2000. The geographical and sectorial distribution of these newly created establishments are presented in tables 1 and 2.

As we can observe, the most dynamic region is *Região Norte*, which account for more than 50% of total manufacturing plant births between 1992 and 2000. At NUTS3 level, *Grande Porto, Ave* and *Tâmega* are responsible for more than 35% of total plant births between 1992 and 2000. At the sectorial level (table 2), the *manufacturing of wearing apparel, dressing and dyeing of fur* and the *manufacturing of fabricated metal products (except machinery and equipment)* are responsible for more than 34% of total plant births between 1992 and 2000.

[4] We had under consideration the change of the Code of Administrative Division in 1998 that introduced three new municipalities (Vizela, Trofa and Odivelas), and incorporated them into original ones, as our study is largely previous to 1998. Additionally, we excluded the islands of Azores and Madeira, as the number of new plants of the manufacturing sector born during 1992-2000 was quite small.

[5] We had under consideration the change of the Code of Economic Activity from Revision 1 to Revision 2 in 1994.

[6] We exclude possible temporary exits/errors by comparing the birth date of the plant with the age of the oldest employee.

NUTS 3 (NUTS 2)		New manufacturing plants										
Code	**Designation**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**Total**	**%**
10101	Minho-Lima	119	79	104	84	89	109	86	92	116	878	2.36%
10102	Cávado	327	219	399	355	342	347	368	305	393	3 055	8.21%
10103	Ave	505	376	552	529	613	600	635	622	765	5 197	13.96%
10104	Grande Porto	641	487	744	517	482	449	483	413	518	4 734	12.72%
10105	Tâmega	470	368	567	363	228	569	285	616	509	3 975	10.68%
10106	Entre Douro e Vouga	246	222	353	260	222	262	248	229	217	2 259	6.07%
10107	Douro	25	64	61	42	34	30	48	50	45	399	1.07%
10108	Alto Trás-os-Montes	55	55	67	49	57	44	57	54	63	501	1.35%
101	**Região Norte**	**2 388**	**1 870**	**2 847**	**2 199**	**2 067**	**2 410**	**2 210**	**2 381**	**2 626**	**20 998**	**56.41%**
10201	Baixo Vouga	191	154	193	123	160	158	153	141	193	1 466	3.94%
10202	Baixo Mondego	80	76	92	65	69	66	64	54	101	667	1.79%
10203	Pinhal Litoral	151	127	170	114	137	141	159	153	148	1 300	3.49%
10204	Pinhal Interior Norte	55	56	62	47	49	52	48	33	56	458	1.23%
10205	Dão-Lafões	99	64	111	87	80	73	101	105	96	816	2.19%
10206	Pinhal Interior Sul	17	11	11	18	8	16	17	19	24	141	0.38%
10207	Serra da Estrela	21	11	19	16	15	20	14	14	20	150	0.40%
10208	Beira Interior Norte	35	36	45	23	22	27	28	28	30	274	0.74%
10209	Beira Interior Sul	29	13	25	21	17	27	16	26	34	208	0.56%
10210	Cova da Beira	34	31	41	22	26	21	25	27	37	264	0.71%
102	**Região Centro**	**712**	**579**	**769**	**536**	**583**	**601**	**625**	**600**	**739**	**5 744**	**15.43%**
10301	Oeste	186	137	193	126	129	138	148	144	166	1 367	3.67%
10302	Grande Lisboa	574	458	624	365	379	384	404	344	460	3 992	10.72%
10303	Península de Setúbal	225	165	226	146	155	147	172	172	188	1 596	4.29%
10304	Médio Tejo	113	63	117	61	56	64	70	70	87	701	1.88%
10305	Lezíria do Tejo	81	63	99	72	71	91	77	82	93	729	1.96%
103	**Lisboa e Vale do Tejo**	**1 179**	**886**	**1 259**	**770**	**790**	**824**	**871**	**812**	**994**	**8 385**	**22.53%**
10401	Alentejo Litoral	35	37	32	29	26	26	19	14	27	245	0.66%
10402	Alto Alentejo	45	45	40	26	24	32	25	38	31	306	0.82%
10403	Alentejo Central	58	52	62	48	41	96	57	51	71	536	1.44%
10404	Baixo Alentejo	28	36	38	31	23	33	31	27	31	278	0.75%
104	**Alentejo**	**166**	**170**	**172**	**134**	**114**	**187**	**132**	**130**	**160**	**1 365**	**3.67%**
10501	Algarve	83	71	116	74	79	68	77	83	79	730	1.96%
105	**Algarve**	**83**	**71**	**116**	**74**	**79**	**68**	**77**	**83**	**79**	**730**	**1.96%**
	Portugal (mainland)	4 528	3 576	5 163	3 713	3 633	4 090	3 915	4 006	4 598	37 222	100.00%

Source: DEEP - MTE (1991-2000), *Quadros do Pessoal*

Table 1: New manufacturing plants (1992-2000), by region

3.2 Explanatory Variables

Location theory suggests that the variables influencing the choice of a particular location can broadly be classified into three categories: cost variables, market variables and agglomeration economies.

The least cost theory claims that the land, labor and capital costs affect firms' decision about location. Following Bartik (1985)'s approach that assumes that industrial and residential users compete for the same space, we adopted population density in each municipality for 1991-2001 as a proxy for *land costs*.

To account for labour market conditions, we included both labour costs and the qualifications of the workforce. *Labour costs* are measured by the real wages per working hour, for each municipality and code of economic activity (CAE) at 2-digit level.

In order to consider the influence of population skills and abilities on the productivity of the workforce, we used the *average years of schooling of the adult population* as a proxy

CAE - Rev. 2	Manufacturing Industry	New manufacturing plants										
		1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**Total**	**%**
15	Manufacture of food products and beverages	470	435	676	409	377	439	387	375	467	4035	10.84%
16	Manufacture of tobacco	0	0	0	0	0	0	0	0	0	0	0.00%
17	Manufacture of textile	270	224	276	269	225	288	287	303	306	2448	6.58%
18	Manufacture of wearing apparel; dressing and dyeing of fur	831	544	891	785	793	847	852	832	987	7362	19.78%
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	250	201	337	229	206	256	199	219	195	2092	5.62%
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of straw and plaiting materials	375	307	461	348	339	382	421	371	415	3419	9.19%
21	Manufacture of paper and paper	29	24	44	24	34	26	25	28	32	266	0.71%
22	Publishing, printing and reproduction of recorded media	258	212	322	209	215	240	226	199	281	2162	5.81%
23	Manufacture of coke, refined petroleum products and nuclear fuel	0	4	0	0	0	0	0	0	0	4	0.01%
24	Manufacture of chemicals and chemical products	50	50	79	38	32	40	40	31	43	403	1.08%
25	Manufacture of rubber and plastics products	83	63	73	46	66	47	41	56	41	516	1.39%
26	Manufacture of other non-metallic mineral products	313	231	353	239	232	272	244	274	345	2503	6.72%
27	Manufacture of basic metals	17	25	14	14	22	15	19	19	29	174	0.47%
28	Manufacture of fabricated metal products, except machinery and	685	567	720	516	509	557	586	631	736	5507	14.80%
29	Manufacture of machinery and equipment n.e.c.	179	153	202	145	136	143	153	133	131	1375	3.69%
30	Manufacture of office, accounting and computing machinery	0	0	1	0	0	1	0	0	1	3	0.01%
31	Manufacture of electrical machinery and apparatus n.e.c.	58	39	51	37	45	47	31	39	34	381	1.02%
32	Manufacture of radio, television and communication equipment and apparatus	25	25	16	11	9	10	7	8	16	127	0.34%
33	Manufacture of medical, precision and optical instruments, watches and clocks	38	23	31	26	29	36	25	26	45	279	0.75%
34	Manufacture of motor vehicles, trailers and semi-trailers	15	20	33	15	15	16	15	15	22	166	0.45%
35	Manufacture of other transport	18	10	24	18	29	23	31	23	23	199	0.53%
36	Manufacture of furniture; manufacturing n.e.c.	557	415	547	328	311	393	306	404	425	3686	9.90%
37	Recycling	7	4	12	7	9	12	20	20	24	115	0.31%
15-37	**Total manufacturing**	4528	3576	5163	3713	3633	4090	3915	4006	4598	37222	100.00%

Source : DEEP - MTE (1991-2000), *Quadros do Pessoal*

Table 2: New manufacturing plants (1992-2000), by economic activity

for *human capital* stock in each municipally. We computed the average years of schooling of the adult population according to the methodology of Barro and Lee (1993):

$$H = \frac{1}{n}\sum_{g=1}^{9}\left[D_g.(n_g|c) + \frac{D_g + D_{g-1}}{2}.(n_g|i) + D_{g-1}.(n_g|a)\right]$$

where

n = Population with age 25 to 64[7];

[7] The availablitilty of statististical information motivated the choice of this age cohort, which account for about 86% of the active population in 2001 in Portugal (INE 2001a).

$n_g|c$ = Population with age 25 to 64 with education level g (complete);

$n_g|i$ = Population with age 25 to 64 with education level g (incomplete);

$n_g|a$ = Population with age 25 to 64 with education level g (attendance);

g = education level, where $g = 1$ (1st cycle), 2 (2^{nd} cycle or ISCED level 1), 3 (3^{rd} cycle or ISCED level 2), 4 (secondary education or ISCED level 3), 5 (post-secondary non-tertiary education or ISCED 4), 6 (Bachelor or ISCED level 5B), 7 (under-graduate degree or ISCED 5A), 8 (Master) and 9 (Ph.D or ISCED level 6);

D_g = Number of schooling years that corresponds to each education level, where $D_1 = 4, D_2 = 6, D_3 = 9, D_4 = 12, D_5 = 13, D_6 = 15, D_7 = 16, D_8 = 17$ and $D_9 = 18$.

After computing the human capital stock for each municipality in 1991 and 2001, we estimated the human capital stock between these years by computing the average annual rate of growth of the human capital stock between 1991 and 2001.

Capital costs are measured by the taxes over companies collected by municipalities, which include both *derrama*[8] and other taxes over firms.

Another strand of the literature focus on the influence of demand variables on the location choice. In order to capture the influence of *market size* on location choice, we considered two variables: we first considered the *Purchasing Power Index*[9] for each municipality between 1993-2002, which intends to capture the *local market* influence[10]. Alternatively, and having under consideration the undersized of most portuguese municipalities, we used the *per capita Gross Domestic Product* at regional level NUTS3 for 1992-2000 as a measure of the *regional market*.

Additionally, we consider the influence of *market accessibility* on firms' location decision, by employing the minor physical distance between each municipality to Porto or Lisbon[11].

Agglomeration economies reflect the benefits that results from the general development of an industry (Marshall (1920 [1890])). The now standard classification of Marshallian externalities is attributed to Hoover (1937) and distinguishes between *urbanization economies*, which reflect the benefits from operating in large population centres with cor-

[8] The municipal surcharge (*derrama*) is a local municipal tax that can be charged annually by municipal authorities up to maximum of 10% of the amount paid in corporate tax (IRC).

[9] The *Purchasing Power Index* (IPPC) intends to capture the purchasing power in each municipality. It is an index built by means of a model of factorial analysis and recurring to a set of 20 variables that were selected according to an expenditure criteria upon a larger group of 70 variables (INE 2004).

[10] Otherwise, we used the *potential market (PM)* for each municipality, defined as $PMi = IPPC_i + \sum_{j \neq i} \frac{IPPC_j}{d_{ij}^2}$, where $IPPC$ is the Purchasing Power Index and d_{ij} is the physical distance between municipality i and j, with similar results.

[11] Porto and Lisbon (capital) are the most important cities in Portugal, both equipped with international airport, port and railway stations.

respondingly large overall labour markets and large, diversified service sectors to interact with manufacturing, and *localization economies* that reflect economies of intra-industry specialization that allow a finer division of function among firms, labour market economies that reduce search costs for firm seeking workers with specific training and communication economies that can speed up adoption of innovations.

Variable	Proxy	Expected sign	Data Source
Land costs	Population density, by municipality, 1992-2001	Negative	INE (1991-2000), *Estimativas Definitivas da População Residente;* INE (2001b), *Recenseamento Geral da População e Habitação (Resultados Definitivos);* INE (2003b), *Referenciação Territorial*
Labour costs	Real base-wage over regular working hours, by municipality and CAE, 1992-2000	Negative	DEEP-MTE (1991-2000), *Quadros do Pessoal*
Human capital	Average years of schooling of the adult population, by municipality, 1992-2000	Positive	INE (1991), *Recenseamento Geral da População e Habitação (Resultados Definitivos)*; INE (2001), *Recenseamento Geral da População e Habitação (Resultados Definitivos)*
Capital costs	Derrama plus other taxes over firms divided by total societies, by municipality, 1992-2000	Negative	DGAL (1991-2001), *Finanças Municipais;* INE (1992-2001), *Ficheiro Central de Empresas e Estabelecimentos*
Regional market	Per capita Gross Domestic Product, by NUTS3, 1992-2000	Positive	INE (1990-2002), *Contas Regionais*
Local market	Purchasing Power Index (IPPC), by municipality, 1993-2002	Positive	INE (1993-2002), *Estudo sobre o Poder de Compra Concelhio*
Market accessibility	Minor geographical distance to Porto/Lisbon, by municipality	Negative	INE (2003), *Base Geográfica de Referenciação da Informação*
Localization economies	Share of manufacturing employment for each CAE - 2 digit, by municipality, 1991-1999	Positive	DEEP-MTE (1991-2000), *Quadros do Pessoal*
Urbanization economies	Density of manufacturing and service plants (CAE D, G, H, I, J, K) per square kilometer, by municipality, 1992-2000	Positive	DEEP-MTE (1991-2000), *Quadros do Pessoal;* INE (2003b), *Referenciação Territorial*
R&D	R&D expenditures per capita, by municipality, 1994-2002	Positive	OCES (1995, 1997, 1999, 2001), *Inquérito ao Potencial Científico e Tecnológico;* INE (1991-2000), *Estimativas Definitivas da População Residente;* INE (2001), *Recenseamento Geral da População e Habitação (Resultados Definitivos)*

Table 3: Explanatory variables

In our research, we account for *localization economies* by considering the share of manufacturing employment for each CAE - 2 digit in each municipally for 1991-1999. *Urbanization economies* are measured by the density of manufacturing and service plants (CAE D, G, H, I, J, K) per square kilometer in each municipally for 1991-2000.

Literature on location determinants is usually scarce in what concerns both technological and entrepreneurial features that might influence plant location. So, in an addition to traditional location determinants, we consider the Research and Development (R&D) per capita expenditures at the municipality level for 1995 - 2001 by using a biannual national inquiry[12]. For the years with unavailable information, we used the average of the nearest years[13]. Table 3 summarizes main information about explanatory variables.

4 Empirical Results

In order to evaluate the importance of traditional and technological determinants for location choice, we considered two data sets: First, we used total new manufacturing plants. Second, we make difference between the single-plant and the multi-plant's location decisions.

We modelled the location choice of new manufacturing plants between 1992-2000 within 275 municipalities through a discrete choice analysis. We take advantage of the equivalence between the conditional logit model and the Poisson regression by using a set of dummy variables for each combination of year and CAE 2-digit. Additionally, if data contains overdispersion, then the negative binomial model will be taken under consideration.

4.1 Total New Manufacturing Plants

Empirical results with respect to location choice of new manufacturing plants are represented in Table 4. Regressions (1) and (2) respect to a standard CLM by means of its equivalence with Poisson model, which is guaranteed by using a set of dummy variables for each combination of year and 2-digit CAE sector. Differences in both regressions are due to the use of either a regional or a local market variable. Similarly, regressions (3) and (4) respects to a CLM regression but includes a set of dummy variables for each region NUTS3. In order to more effectively control for the potential violation of IIA assumption, we estimated a Poisson panel regression with either random or fixed effects by municipality [regressions (5) to (10)]. All explanatory variables are included in its logarithmic

[12]The *Scientific and Technological National Potential Survey* (IPCTN) is carry out every two years by the *National Observatory of Science and Technology* (OCES). The inquiry covers both the R&D expenditures carried out on the national territory in the year concerned and also the R&D personnel, expressed in full-time equivalent. The survey covers four sectors of performance of R&D - High Education, Government, Business Enterprise and Private Non-Profit Institutions. It comprises R&D in both natural sciences, engineering, social sciences and humanities. R&D expenditures is subdivided into five sources of funds, from High Education, Government, Business Enterprise, Private Non-Profit Institutions and abroad (OCES 2002).

[13]We also experimented the *potential R&D (PRD)* for each municipality, defined as $PRDi = RD_i + \sum_{j \neq i} \frac{RD_j}{d_{ij}^2}$, where RD is the per capita R&D expenditures and d_{ij} is the physical distance between municipality i and j, but no improvements were observed.

form.

	POISSON MODEL									
	With dummy by year*CAE		**With dummies by year*CAE and NUTS3**		**With random effects by municipality and dummy by year*CAE**		**With random effects by municipality and dummies by year*CAE and NUTS3**		**With fixed effects by municipality and dummy by year*CAE**	
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Land costs	-0.596*	-0.608*	-1.188*	-1.190*	-0.962*	-0.957*	-1.032*	-1.029*	0.001	-0.023
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.998)	(0.941)
Labor costs	-0.913*	-0.787*	-0.866*	-0.864*	-1.088*	-1.078*	-1.079*	-1.073*	-1.096*	-1.089*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Human capital	-2.357*	-1.590*	-0.830*	-0.806*	-0.754*	-0.503	-0.535	-0.453	-0.720	-0.626
	(0.000)	(0.000)	(0.000)	(0.000)	(0.008)	(0.082)	(0.088)	(0.153)	(0.058)	(0.100)
Capital costs	0.050*	0.053*	0.065*	0.065*	-0.008	-0.004	-0.005	0.001	-0.018	-0.011
	(0.000)	(0.000)	(0.000)	(0.000)	(0.600)	(0.825)	(0.751)	(0.968)	(0.298)	(0.529)
Regional market	0.440*	---	0.212	---	0.434*	---	0.599*	---	0.680*	---
	(0.000)	---	(0.261)	---	(0.004)	---	(0.002)	---	(0.001)	---
Local market	---	-0.233*	---	-0.018	---	-0.074	---	-0.062	---	-0.121
	---	(0.000)	---	(0.617)	---	(0.303)	---	(0.401)	---	(0.106)
Market accessibility	-0.116*	-0.141*	-0.208*	-0.209*	-0.203	-0.220*	-0.036	-0.037	---	---
	(0.000)	(0.000)	(0.000)	(0.000)	(0.080)	(0.053)	(0.842)	(0.838)	---	---
Localization economies	0.722*	0.714*	0.722*	0.722*	0.739*	0.739*	0.739*	0.739*	0.742*	0.741*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Urbanization economies	1.069*	1.089*	1.295*	1.298*	1.339*	1.351*	1.402*	1.399*	1.476*	1.470*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R&D	0.059*	0.060*	0.044*	0.049*	0.008	0.008	0.009	0.009	0.005	0.006
	(0.000)	(0.000)	(0.000)	(0.000)	(0.272)	(0.266)	(0.190)	(0.199)	(0.441)	(0.434)
Constant	11.113*	14.020*	13.175*	14.949*	11.664*	15.225*	9.032*	14.004*	---	---
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	---	---
Number of obs.	14332	14332	14332	14332	14332	14332	14332	14332	14323	14323
Log likelihood	-25451.19	-25514.69	-22755.42	-22755.93	-19480.92	-19484.65	-19448.55	-19452.87	-18583.05	-18587.75
Pseudo R^2	0.5165	0.5153	0.5677	0.5677						
LR test	54370.89	54243.88	59762.42	59761.41						
	(0.000)	(0.000)	(0.000)	(0.000)						
Pearson statistic	48886.8	49203.33	41550.2	41563.41						
	(0.000)	(0.000)	(0.000)	(0.000)						
Wald test					27088.84	27081.16	27200.57	27198.29	26766.75	26763.27
					(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Notes: p-values are in parentisis
* significant at 0.05 level of significance

Table 4: Total new manufacturing plants (1992-2000): Poisson model

As we can observe, estimation results of regressions (1) to (4) are very similar. All variables are highly significant and with the expected signs, except for human capital, local market and capital costs. We find evidence that production costs had a significant and negative impact on location choice, except for capital costs. The regional market size has a significant and positive impact on location choice, except when a dummy for region is included. On the contrary, when we included the local market size, the variable has the unpredictable sign. Also, the municipalities' accessibility to main markets is also significant and with the expected sign. Our results also reveal that the most significant location determinants are the agglomeration economies, namely, the urbanization economies, which accords with existing literature. On the opposite side, the R&D variable has the smallest impact on location choice. As it was expected, the inclusion of the regional dummy variable in regressions (3) and (4) improve the overall significance, as it can be deduced from the increase of the log likelihood, the likelihood-ratio index or the "$pseudo - R^2$".

In order to improve our estimation procedure, we consider specific random effects by municipality through a Poisson panel regression with or without dummies by region [regressions (5) to (8)]. We then observe an increase of the corresponding log-likelihood of the random effects model when comparing with the corresponding Poisson regression, which sustain the hypothesis of random effects by municipality. At the same time, the results remain quite similar, except for the R&D variable, which loses significance. The results also gives consistency for the hypothesis of the regional market variable (instead of the local one) and for the inclusion of dummy variables by region. Alternatively, we performed a Poisson regression with fixed effects by municipality [regressions (9) and (10)], with some perceptible changes in results. In effect, on the costs side, only labour costs maintain its significance, while, at the demand side, market accessibility loses relevance. Agglomeration economies (both urbanization and localization) are still significant and with the predicted sign.

However, the Pearson statistics for the goodness of fit indicates that the Poisson regression is not adequate to our data, suggesting that we should try the negative binomial model. Table 5 resumes main results from our estimation.

As before, we ran several models, which performed quite well, as we can observe from the log-likelihood, likelihood-ratio and Wald tests. Additionally, the likelihood-ratio test of $\alpha = 0$ indicates that the probability of observing this data conditional to a Poisson distribution is nearly zero, which confirms that the negative binomial model is more suitable. We started with a simple negative binomial regression with a set of dummies for each combination of year and 2-digit CAE sector [regressions (11) and (12)] and included a dummy variable for each region NUTS3 [regressions (13) and (14)] in order to capture other regions' characteristics that might affect firms' location choice. Finally, we estimated a negative binomial panel regression with either random or fixed effects by municipality, with or without dummies for region [regressions (15) to (22)].

Let us consider the negative binomial model without "specific-effects" by municipalities [regressions (11) to (14)]. As we can observe, some variables have a very regular behavior across regressions: land and labour costs and agglomeration economies are always significant and with the expected signs. On the other side, capital costs and human capital are almost never significant or with the correct sign. Demand variables are usually

	NEGATIVE BINOMIAL MODEL											
	With dummy by year*CAE		With dummies by year*CAE and NUTS3		With random effects by municipality and dummy by year*CAE		With random effects by municipality and dummies by year*CAE and NUTS3		With fixed effects by municipality and dummy by year*CAE		With fixed effects by municipality and dummies by year*CAE and NUTS3	
Variables	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
Land costs	-0.692*	-0.627*	-1.060*	-1.003*	-0.480*	-0.466*	-0.491*	-0.494*	-0.591*	-0.589*	-0.467*	-0.472*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.005)	(0.004)
Labor costs	-0.644*	-0.607*	-0.637*	-0.647*	-0.872*	-0.859*	-0.869*	-0.863*	-0.850*	-0.837*	-0.857*	-0.852*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Human capital	-0.992*	-1.097*	0.009	-0.310	2.297*	2.383*	0.558	0.573	2.864*	3.105*	0.237	0.277
	(0.000)	(0.000)	(0.953)	(0.088)	(0.000)	(0.000)	(0.083)	(0.082)	(0.000)	(0.000)	(0.493)	(0.429)
Capital costs	0.014	0.015	0.029*	0.031*	-0.018	-0.012	-0.028	-0.022	-0.032	-0.021	-0.034	-0.028
	(0.303)	(0.282)	(0.039)	(0.026)	(0.358)	(0.539)	(0.165)	(0.267)	(0.120)	(0.290)	(0.103)	(0.172)
Regional market	0.288*	---	0.291	---	0.592*	---	0.465*	---	0.734*	---	0.435	---
	(0.000)	---	(0.326)	---	(0.000)	---	(0.052)	---	(0.000)	---	(0.066)	---
Local market	---	0.227*	---	0.249*	---	0.287*	---	0.002	---	0.307*	---	-0.035
	---	(0.002)	---	(0.001)	---	(0.002)	---	(0.983)	---	(0.002)	---	(0.688)
Market accessibility	-0.149*	-0.170*	-0.205*	-0.201*	-0.071	-0.113	-0.314*	-0.322*	-0.136	-0.182*	-0.564*	-0.571*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.328)	(0.117)	(0.027)	(0.023)	(0.127)	(0.041)	(0.001)	(0.001)
Localization economies	0.525*	0.526*	0.531*	0.532*	0.571*	0.569*	0.545*	0.544*	0.556*	0.554*	0.532*	0.531*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Urbanization economies	1.096*	1.031*	1.150*	1.085*	0.506*	0.484*	0.711*	0.705*	0.392*	0.384*	0.663*	0.663*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R&D	0.029*	0.027*	0.047*	0.044*	0.012	0.010	0.022*	0.022*	0.012	0.009	0.019*	0.019*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.161)	(0.257)	(0.015)	(0.016)	(0.201)	(0.307)	(0.045)	(0.042)
Constant	8.848*	10.06*	9.164*	10.80*	1.971	5.625*	7.031*	10.81*	0.812	5.367*	8.846*	12.49*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.130)	(0.000)	(0.002)	(0.000)	(0.566)	(0.000)	(0.000)	(0.000)
Number of obs.	14332	14332	14332	14332	14332	14332	14332	14332	14323	14323	14323	14323
Log likelihood	-19689.8	-19699.1	-19160.9	-19155.7	-18639.2	-18645.6	-18536.3	-18538.2	-17704.1	-17713.6	-17559.5	-17561.1
Pseudo R^2	0.1949	0.1945	0.2165	0.2167								
LR test	9530.95	9512.38	10588.7	10599.1								
	(0.000)	(0.000)	(0.000)	(0.000)								
Likelihood-ratio test of alpha=0	12000	12000	7189.05	7200.47								
	(0.000)	(0.000)	(0.000)	(0.000)								
Wald test					8922.58	8904.79	9212.34	9203.24	8856.01	8837.73	9242.52	9236.61
					(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Notes: p-values are in parentisis
* significant at 0.05 level of significance

Table 5: Total new manufacturing plants (1992-2000): Negative binomial model

significant and with the expected sign. The regional market variable have a positive and significance influence on location choice, except when dummies for regions are included, while local market is always significant and with the predict sign. Additionally, the municipalities' accessibility to main markets is also significant and with the expected sign. The R&D variable is significant but has the smallest elasticity. In fact, we estimate that, everything else constant, a 1 percent increase in urbanization economies leads to about 1.1 percent increase in the number of new plants, while the same elasticity for the R&D variable is about 0.03-0.04. The inclusion of dummy variables by region is supported by the increase of the log-likelihood or the "$pseudo - R^2$".

We then consider "specific-effects" by municipalities through a negative binomial regression with either random or fixed effects [regressions (15) to (22)]. The difference in the log-likelihoods of the models with specific-effects and the one without specific-effects is statistically significant and provides evidence that the inclusion of specific effects is convincing. At the same time, the inclusion of dummy variables by region (NUTS3) is supported by the increase of the log-likelihood, which gives reason for the existence of regional characteristics that are not captured by other variables. Likewise, the inclusion of the regional market, instead of the local market, is consistent with the increase of the overall significance.

In order to test for the inclusion of random or fixed effects by municipality, we performed an Hausman test, which test the null hypothesis that the coefficients estimated by the efficient random effects estimator are the same as the ones estimated by the consistent fixed effects estimator. We compared regressions (17) and (21) and the resulting statistic equals 0.71, which lead us to not reject the null hypothesis at 1 percent level of significance. Therefore, our results sustain the hypothesis of random specific effects by municipality.

Focusing on regression (17), we may conclude that the most relevant determinants for location choice are the labour and land costs and urbanization and localization economies. In fact, we estimated that, everything else constant, a 1 percent increase in urbanization or localization economies leads to about 0.71 or 0.55 percent increase in the number of new plants, respectively. These results are supported by several empirical studies [e.g. Carlton (1983), Hansen (1987), Coughlin *et al.* (1991), Woodward (1992), Guimarães *et al.* (2000), Head and Mayer (2004), among others].

Comparable elasticities with respect to labour and land costs are 0.87 and 0.49, respectively. The negative influence of labour costs on location choice is evidenced in several studies [e.g. Coughlin *et al.* (1991), Friedman *et al.* (1992), Coughlin and Segev (2000), Cheng and Kwan (2000) and Guimarães *et al.* (2004)]. At the same time, few authors confirmed the significance and negative influence of land costs [e.g. Guimarães *et al.* (2004)]. On the contrary, capital costs are never statistically significant, which can be justified by the absence of noteworthy differences in the cost of capital across Portuguese municipalities. This result is also confirmed in several studies [e.g. Carlton (1983), Woodward (1992), Shaver (1998) and Head and Mayer (2004)]. The uneven behavior of the human capital variable may be justified by the aggregate nature of the indicator, which do not allow to evaluate the importance of some specific skills (e.g. engineers) for the location choice. At the same time, this outcome is supported by several other empirical studies (e.g. Woodward (1992), Kittiprapas and McCann (1999), Guimarães *et al.* (2000) and

Carod (2005)).

On the demand side, we may observe that the regional market size and the accessibility to main markets and infrastructures have a significant and positive influence on location choice, which can be justified by the undersized of most municipalities. These results are confirmed by several studies [e.g. Coughlin *et al.* (1991), Friedman *et al.* (1992), Head *et al.* (1999), Cheng and Kwan (2000), Guimarães *et al.* (2000), Carod (2005) and Head and Mayer (2004), among others]. Finally, the R&D variable has a significant and positive influence on location choice. However, its elasticities is the lowest one. In fact, a 1 percent increase in per capita R&D expenditures leads to about 0.02 percent increase in the number of new plants.

4.2 Multi-plant and Single-plant Firms

Previous results show data in an aggregated way, without considering that entrepreneurs could have different environmental requirements depending on their characteristics (like firms' size or sectorial characteristics). Literature on location choice have stressed the relevance of capital structure by focusing on decisions made by foreigner and domestic firms [e.g. Friedman *et al.* (1992), Woodward (1992), Shaver (1998), Head *et al.* (1999), Coughlin and Segev (2000) and Guimarães *et al.* (2000), among others]. Further, location decisions might vary according to firms' structure. In fact, we might expect that entrepreneurs that extend its multi-plant firm might have different motivations than entrepreneurs that create a one plant-firm. For this reason, we now aim at evaluate the importance of location determinants for multi-plant and single-plant firms.

Geographical location of new single-plant and multi-plant firms is presented in table 6. As we can observe, there is a strong evidence that single-plant and multi-plant firms locate differently: single-plant firms concentrate in *Região Norte*, while multi-plant firms distribute between *Região Norte* and *Lisboa and Vale do Tejo.*

We modelled the location choice of new single-plant and new multi-plant through a conditional logit model by means of its equivalence with Poisson model, which is guaranteed by using a set of dummy variables for each combination of year and 2-digit CAE sector. Additionally, we estimated a CLM with a set of dummy variables for regions (NUTS3) in order to capture the influence of other non-observable variables. Results are presented in table 7.

As we can observe, location factors that affect single-plant and multi-plant firms act differently. In fact, while some location factors have a similar performance (land and labour costs, agglomeration economies and R&D are always significant and with the

NUTS 3 (NUTS 2)		New Single-Plants (1992-2000)		New Multi-Plants (1992-2000)	
Code	Designation	Total	%	Total	%
10101	Minho-Lima	774	2.33%	104	2.62%
10102	Cávado	2 850	8.57%	205	5.17%
10103	Ave	4 863	14.62%	334	8.43%
10104	Grande Porto	4 211	12.66%	523	13.19%
10105	Tâmega	3 808	11.45%	167	4.21%
10106	Entre Douro e Vouga	2 146	6.45%	113	2.85%
10107	Douro	348	1.05%	51	1.29%
10108	Alto Trás-os-Montes	457	1.37%	44	1.11%
101	**Região Norte**	**19 457**	**58.50%**	**1 541**	**38.87%**
10201	Baixo Vouga	1 342	4.04%	124	3.13%
10202	Baixo Mondego	565	1.70%	102	2.57%
10203	Pinhal Litoral	1 167	3.51%	133	3.36%
10204	Pinhal Interior Norte	423	1.27%	35	0.88%
10205	Dão-Lafões	747	2.25%	69	1.74%
10206	Pinhal Interior Sul	132	0.40%	9	0.23%
10207	Serra da Estrela	143	0.43%	7	0.18%
10208	Beira Interior Norte	242	0.73%	32	0.81%
10209	Beira Interior Sul	176	0.53%	32	0.81%
10210	Cova da Beira	231	0.69%	33	0.83%
102	**Região Centro**	**5 168**	**15.54%**	**576**	**14.53%**
10301	Oeste	1 225	3.68%	142	3.58%
10302	Grande Lisboa	3 233	9.72%	759	19.15%
10303	Península de Setúbal	1 274	3.83%	322	8.12%
10304	Médio Tejo	599	1.80%	102	2.57%
10305	Lezíria do Tejo	624	1.88%	105	2.65%
103	**Lisboa e Vale do Tejo**	**6 955**	**20.91%**	**1 430**	**36.07%**
10401	Alentejo Litoral	185	0.56%	60	1.51%
10402	Alto Alentejo	242	0.73%	64	1.61%
10403	Alentejo Central	421	1.27%	115	2.90%
10404	Baixo Alentejo	237	0.71%	41	1.03%
104	**Alentejo**	**1 085**	**3.26%**	**280**	**7.06%**
10501	Algarve	593	1.78%	137	3.46%
105	**Algarve**	**593**	**1.78%**	**137**	**3.46%**
	Portugal (mainland)	33 258	100.00%	3 964	100.00%

Table 6: New single and multi-plant firms (1992-2000), by region

expected sign; capital costs never have the expected sign), we may identify different features. In fact, labor costs, urbanization and localization economies have always higher elasticities when talking about the single-plant sample. On the contrary, the R&D and the human capital variables have always a better performance in the multi-plant case. Additionally, the local market is only relevant in the multi-plant sample. As before, the increase of the log-likelihood sustains the hypothesis of inclusion of dummies by NUTS3. Finally, we performed a Pearson test to evaluate the goodness of fit, which evidenced overdispersion and justified the estimation of a negative binomial model.

In tables 8 and 9 we present main estimation results for both single-plant and multi-plant firms. As before, we ran a simple negative binomial model with and without specific-effects by municipality. We also consider dummies by regions NUTS3 and both local and regional market influence.

As we can observe, the increase of the log-likelihood supports the addition of dummies by region NUTS3 and the inclusion of specific effects by municipality. The statistics of the

	SINGLE-PLANT FIRMS				MULTI-PLANT FIRMS			
	Poisson model				Poisson model			
	With dummy by year*CAE		With dummies by year*CAE and NUTS3		With dummy by year*CAE		With dummies by year*CAE and NUTS3	
Variables	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
Land costs	-0.599*	-0.615*	-1.198*	-1.207*	-0.656*	-0.493*	-1.130*	-0.992*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Labor costs	-1.003*	-0.868*	-0.926*	-0.924*	-0.382*	-0.314*	-0.536*	-0.561*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.006)	(0.000)	(0.000)
Human capital	-2.742*	-1.866*	-1.064*	-0.990*	0.549*	0.309	0.744*	0.052
	(0.000)	(0.000)	(0.000)	(0.000)	(0.007)	(0.216)	(0.005)	(0.872)
Capital costs	0.051*	0.054*	0.064*	0.065*	0.072*	0.074*	0.072*	0.072*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	(0.003)	(0.009)	(0.008)
Regional market	0.472*	---	0.130	---	0.406*	---	0.039	---
	(0.000)	---	(0.522)	---	(0.000)	---	(0.942)	---
Local market	---	-0.271*	---	-0.054	---	0.386*	---	0.604*
	---	(0.000)	---	(0.147)	---	(0.001)	---	(0.000)
Market accessibility	-0.116*	-0.141*	-0.226*	-0.225*	-0.135*	-0.165*	-0.075	-0.079
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.283)	(0.258)
Localization economies	0.747*	0.738*	0.744*	0.743*	0.498*	0.499*	0.534*	0.538*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Urbanization economies	1.099*	1.125*	1.311*	1.323*	0.887*	0.718*	1.206*	1.038*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R&D	0.059*	0.060*	0.047*	0.047*	0.066*	0.061*	0.078*	0.071*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	11.857*	14.987*	14.522*	15.711*	1.527*	2.694*	7.364	5.832*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.134)	(0.004)	(0.102)	(0.000)
Number of obs.	14332	14332	14332	14332	14332	14332	14332	14332
Log likelihood	-23517.82	-23575.48	-21093.24	-21092.42	-6386.72	-6389.46	-6104.79	-6094.89
Pseudo R^2	0.5259	0.5247	0.5748	0.5748	0.2260	0.2256	0.2601	0.2613
LR test	52168.80	52053.48	57017.96	57019.61	3729.18	3723.68	4293.03	4312.83
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Pearson statistic	47920.95	48024.28	41136.69	41138.76	18926.82	18975.18	18671.02	18638.48
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Notes: p-values are in parentisis
* significant at 0.05 level of significance

Table 7: New Single and Multi-plant Firms (1992-2000): Poisson model

Hausman test for the inclusion of random [regression (37)] versus fixed [regression (41)] effects equals 0.02, which lead us to consider random effects by municipality. We may then observe that single-plant firms are strongly influenced by agglomeration economies, land and labour costs and market accessibility. At the same time, market size and human capital have high elasticities but are only significant and with the expected sign if dummies for regions are not included. Furthermore, regional market have clearly a higher influence on location choice than local market. Finally, the R&D variable, while significant, has the lowest elasticity.

When talking about the location decision of new multi-plant firms, we may observe that although main location determinants still be the agglomeration economies and both land and labour costs, there are some noteworthy differences. The first remarkable difference is the relevance of the local market variable, instead of the regional market, which may be deduced from both overall and individual significance tests. In fact, we estimate

	NEGATIVE BINOMIAL MODEL											
	With dummy by year*CAE		**With dummies by year*CAE and NUTS3**		**With random effects by municipality and dummy by year*CAE**		**With random effects by municipality and dummies by year*CAE and NUTS3**		**With fixed effects by municipality and dummy by year*CAE**		**With fixed effects by municipality and dummies by year*CAE and NUTS3**	
Variables	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)	(42)
Land costs	-0.659*	-0.614*	-1.041*	-0.997*	-0.501*	-0.500*	-0.489*	-0.492*	-0.650*	-0.660*	-0.462*	-0.464*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.008)	(0.008)
Labor costs	-0.742*	-0.689*	-0.715*	-0.722*	-0.957*	-0.945*	-0.957*	-0.952*	-0.929*	-0.917*	-0.940*	-0.936*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Human capital	-1.286*	-1.255*	-0.191	-0.444*	2.072*	2.238*	0.453	0.503	2.749*	3.085*	0.177	0.250
	(0.000)	(0.000)	(0.238)	(0.019)	(0.000)	(0.000)	(0.184)	(0.150)	(0.000)	(0.000)	(0.632)	(0.505)
Capital costs	0.004	0.004	0.022	0.023	-0.028	-0.022	-0.037	-0.032	-0.042*	-0.031	-0.044*	-0.039
	(0.779)	(0.766)	(0.135)	(0.109)	(0.167)	(0.276)	(0.075)	(0.121)	(0.051)	(0.144)	(0.044)	(0.074)
Regional market	0.301*	---	0.189	---	0.595*	---	0.433	---	0.746*	---	0.419	---
	(0.000)	---	(0.545)	---	(0.000)	---	(0.088)	---	(0.000)	---	(0.096)	---
Local market	---	0.144	---	0.197*	---	0.227*	---	-0.036	---	0.250*	---	-0.076
	---	(0.055)	---	(0.010)	---	(0.019)	---	(0.681)	---	(0.014)	---	(0.392)
Market accessibility	-0.151*	-0.174*	-0.212*	-0.209*	-0.122	-0.165*	-0.293*	-0.298*	-0.206*	-0.254*	-0.568*	-0.571*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.113)	(0.031)	(0.052)	(0.048)	(0.031)	(0.008)	(0.002)	(0.002)
Localization economies	0.550*	0.549*	0.551*	0.552*	0.599*	0.599*	0.574*	0.573*	0.583*	0.582*	0.558*	0.557*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Urbanization economies	1.091*	1.046*	1.143*	1.093*	0.535*	0.525*	0.719*	0.719*	0.424*	0.428*	0.664*	0.669*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R&D	0.029*	0.026*	0.045*	0.043*	0.015	0.014	0.026*	0.026*	0.015	0.013	0.022*	0.023*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.095)	(0.144)	(0.007)	(0.007)	(0.120)	(0.174)	(0.026)	(0.022)
Constant	9.600*	11.05*	10.60*	11.56*	3.169*	7.06*	7.78*	11.40*	2.01	6.827*	9.38*	12.99*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.022)	(0.000	(0.001)	(0.000)	(0.183)	(0.000)	(0.000)	(0.000)
Number of obs.	14332	14332	14332	14332	14332	14332	14332	14332	14323	14323	14323	14323
Log likelihood	-18390	-18402.1	-17895.1	-17891.9	-17406.2	-17413.8	-17318.9	-17320.2	-16492.6	-16502.8	-16366.3	-16367.3
Pseudo R^2	0.2017	0.2011	0.2231	0.2233								
LR test	9290.14	9265.84	10279.98	10286.27								
	(0.000)	(0.000)	(0.000)	(0.000)								
Likelihood-ratio test of alpha=0	10000	10000	6396.39	6401.03								
	(0.000)	(0.000)	(0.000)	(0.000)								
Wald test					8444.84	8428.34	8615.28	8606.52	8346.90	8329.83	8563.91	8558.37
					(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Notes: p-values are in parentisis
* significant at 0.05 level of significance

Table 8: New single-plant firms (1992-2000): Negative binomial model

that everything else constant, a 1 percent increase in local market size leads to about 0.7 percent increase in the number of new plants, while the regional market variable is often non-significant. As before, our estimation results supports the inclusion of dummies by region NUTS3 and the existence of specific effects by municipality. Also, the statistics of the Hausman test for the inclusion of random [regression (50)] versus fixed [regression (54)] effects equals 0.0, which supports the hypothesis that the specific effects are not correlated with the explanatory variables. We may also remark that, accepting the evidence of specific random effects by municipality [regressions (47) to (50)], the elasticity of plant births with respect land costs and urbanization economies is higher in multi-plant sample when comparing with the single-plant sample, while the opposite happens

	NEGATIVE BINOMIAL MODEL											
	With dummy by year*CAE		**With dummies by year*CAE and NUTS3**		**With random effects by municipality and dummies by year*CAE**		**With random effects by municipality and dummy by year*CAE and NUTS3**		**With fixed effects by municipality and dummy by year*CAE**		**With fixed effects by municipality and dummies by year*CAE and NUTS3**	
Variables	(43)	(44)	(45)	(46)	(47)	(48)	(49)	(50)	(51)	(52)	(53)	(54)
Land costs	-0.772*	-0.568*	-1.146*	-0.991*	-1.205*	-1.043*	-1.226*	-1.104*	-0.480	-0.487	-0.320	-0.368
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.249)	(0.232)	(0.545)	(0.484)
Labor costs	-0.293*	-0.278*	-0.440*	-0.468*	-0.597*	-0.597*	-0.603*	-0.606*	-0.686*	-0.681*	-0.653*	-0.649*
	(0.028)	(0.036)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Human capital	0.830*	0.213	0.988*	0.227	1.085*	0.291*	0.736	0.065	-0.518	-0.436	-0.659	-0.677
	(0.000)	(0.480)	(0.001)	(0.532)	(0.030)	(0.609)	(0.206)	(0.918)	(0.632)	(0.681)	(0.516)	(0.503)
Capital costs	0.074*	0.078*	0.071*	0.072*	0.071	0.075	0.079	0.083*	0.049	0.054	0.053	0.062
	(0.010)	(0.006)	(0.019)	(0.016)	(0.092)	(0.074)	(0.058)	(0.043)	(0.347)	(0.294)	(0.323)	(0.240)
Regional market	0.367*	---	0.121	---	0.390	---	0.271	---	0.100	---	0.439	---
	(0.001)	---	(0.838)	---	(0.128)	---	(0.633)	---	(0.858)	---	(0.450)	---
Local market	---	0.628*	---	0.644*	---	0.783*	---	0.683*	---	0.483	---	0.321
	---	(0.000)	---	(0.000)	---	(0.002)	---	(0.007)	---	(0.111)	---	(0.266)
Market accessibility	-0.146*	-0.169*	-0.136	-0.134	-0.156	-0.184	-0.160	-0.170	0.683	0.678	-1.139	-1.154
	(0.004)	(0.001)	(0.089)	(0.093)	(0.216)	(0.144)	(0.429)	(0.393)	(0.123)	(0.115)	(0.087)	(0.079)
Localization economies	0.459*	0.467*	0.503*	0.507*	0.523*	0.523*	0.526*	0.526*	0.542*	0.539*	0.520*	0.519*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Urbanization economies	0.990*	0.780*	1.193*	1.011*	1.453*	1.278*	1.465*	1.293*	1.368*	1.303*	1.557*	1.496*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R&D	0.053*	0.047*	0.073*	0.065*	0.007	0.004	0.021	0.019	-0.016	-0.018	-0.021	-0.022
	(0.000)	(0.001)	(0.000)	(0.000)	(0.719)	(0.842)	(0.305)	(0.372)	(0.491)	(0.434)	(0.377)	(0.355)
Constant	1.256	1.744	6.041	5.028*	7.104*	7.648*	8.561	8.552*	6.017	4.533	10.716	13.262
	(0.291)	(0.108)	(0.224)	(0.000)	(0.006)	(0.000)	(0.084)	(0.000)	(0.308)	(0.229)	(0.217)	(0.064)
Number of obs.	14332	14332	14332	14332	14332	14332	14332	14332	13674	13674	13674	13674
Log likelihood	-6224.49	-6219.82	-6026.789	-6017.92	-5907.96	-5903.73	-5880.27	-5876.46	-5381.55	-5380.19	-5357.97	-5357.61
Pseudo R^2	0.1680	0.1686	0.1944	0.1956								
LR test	2514.12	2523.47	2909.53	2927.27								
	(0.000)	(0.000)	(0.000)	(0.000)								
Likelihood-ratio test of alpha=0	324.45	339.29	156.00	153.94								
	(0.000)	(0.000)	(0.000)	(0.000)								
Wald test					1931.14	1933.12	2031.17	2044.03	1872.40	1852.39	1791.07	1790.89
					(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Notes: p-values are in parentisis
* significant at 0.05 level of significance

Table 9: New multi-plant firms (1992-2000): Negative binomial model

in what concerns labor costs and localization economies. That is, new multi-plant firms are particularly sensitive to urbanization economies, land costs and local market, while new single-plant firms are more responsive to labour costs and agglomeration economies. Other differences concern to market accessibility, which is not significant for multi-plant's location decision, and the R&D variable, which is only significant if no specific effects were considered, and, in this case, with higher elasticities than in the single-plant sample.

5 Concluding remarks

In this chapter, we exploited the importance of geographical, sectorial and technological determinants for firms' decision about location by means of an econometric model of the location decisions made by new manufacturing plants across Portuguese municipalities. Our main conclusions are summarized in table 10:

	Total new plants*		New single-plants*		New multi-plants*	
Hypotheses	Without NUTS3 dummies	With NUTS3 dummies	Without NUTS3 dummies	With NUTS3 dummies	Without NUTS3 dummies	With NUTS3 dummies
High land costs negatively influences new investments	✓	✓	✓	✓	✓	✓
High labour costs negatively influences new investments	✓	✓	✓	✓	✓	✓
High human capital positively influences new investments	✓	✗	✓	✗	✓	✗
High capital costs negatively influences new investments	✗	✗	✗	✗	✗	✗
High regional market size positively influences new investments	✓	✓	✓	✗	✗	✗
High local market size positively influences new investments	✓	✗	✓	✗	✓	✓
High distance to Porto or Lisbon negatively influences new investments	✗	✓	✗	✓	✗	✗
High localization economies positively influences new investments	✓	✓	✓	✓	✓	✓
High urbanization economies positively influences new investments	✓	✓	✓	✓	✓	✓
High R&D expenditures positively influences new investments	✗	✓	✗	✓	✗	✗

* Negative binomial model with random effects by municipality

Table 10: Location determinants of new manufacturing plants: Hypotheses

Our results confirm the relevance of agglomeration economies, and, in particular, urbanization economies for firms' location choice, which accords with existing literature. In fact, either when considering the entire manufacturing sector or when allowing for a partition according to number of plants, the most important location determinants are the agglomeration economies. Estimation results also evidence that firms' location decision are oriented by cost factors, particularly, land and labor costs. On the contrary, the hypothesis concerning the negative influence of capital costs on location choice is not confirmed in our study, which might be justified by the absence of significant differences in the cost of capital across Portuguese municipalities. Our research also evidences that, in spite of an irregular behavior, the regional market is rather more significant than the local market for firms location choice, except when considering the location decision made by new multi-plant firms. Also, the accessibility to main important cities in Portugal is only relevant for the location choices made by new single-plant firms. In what concerns the technological variable, we might conclude that the elasticity of plant births with respect to R&D expenditures was quite small. Finally, we might also observe that the human capital stock has an uneven behavior, which might be explained by the aggregate nature of the indicator.

The study of location choice may proceed with some improvements in our research. An appealing research topic is to focus on the human capital variable and considering its different components (primary, junior and senior education; technical versus non-technical education) in order to evaluate the influence of different types of human capital on firms' location choice. Another research topic is to evaluate the importance of location determinants for small, medium and large firms. Finally, we intend to extend our research to access how costs factors, demand variables and agglomeration economies affect firms' location and relocation decisions.

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