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Mercedes Teruel Carrizosa
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CHAPTER 5

FIRM GROWTH:
IS THERE AN EQUILIBRIUM OR A MULTIPLICITY OF EQUILIBRIA?

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CHAPTER 5

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"*Industrial economics is a rich source of 'puzzles' for economic theory. One of them — certainly the most discussed — regards the co-existence of firms (and plants) of different sizes, displaying rather invariant skewed distributions*".

Dosi et al. (1995)

5.1. INTRODUCTION

The heterogeneity of firm sizes of new entrants is a well-known stylised fact. However, differences in firm size affect not only the initial period of creation but also the post-entry firm development. The survival likelihood, firm growth and future equilibrium of firm size depends on the initial characteristics of the firm.

Firm growth plays a key role in the post-entry evolution of any firm. Several reasons justify the importance of firm growth analysis. First, it is a strategy for firm survival in the long run. Second, knowledge of firm growth patterns will enable policy makers to apply the appropriate policies, which has been a crucial issue in Spain over the last few decades. Moreover, the firm growth process will determine the evolution of the distribution of firms in the industry and, consequently, the level of concentration: if large firms grow more quickly than small firms, market concentration will increase and, conversely, if small firms grow faster than large firms, there will be more market competition.

Our aim is to compare the impact of firm size on firm growth and differences in speeds of convergence over time for Spanish firms between 1994 and 2002. This study makes several contributions to the literature on firm growth. Firstly, we contribute to the scarce literature on Spanish firm growth. Secondly, the panel data we use covers the medium term, while previous contributions in Spanish literature have covered shorter periods. Thirdly, we distinguish between firms in the manufacturing sector and firms in the service sector. Finally, we examine the impact of regional differences on firm growth. Gibrat (1931) presented the first model of the dynamics of firm size and industry structure. Gibrat's Law suggests that the expected increase in a firm's size in each period is proportional to its current size.

As we have pointed out in previous chapters, most of the literature analyses the behaviour of manufacturing firms, and there have been few contributions on service industries (Audretsch et al., 2004). There are two main reasons why the differences between sectors are of interest. First, each industry has specific characteristics, which may lead to unique firm sizes. Second, the literature has focused particularly on characteristics such as firm size and age and indicated that the initial characteristics of a firm can influence its long-run behaviour. Our purpose is to analyse the impact of these characteristics on firm growth, paying particular attention to differences between sectors.

Few studies have analysed the growth of Spanish firms. Fariñas and Moreno (2000) and Calvo (2006) showed evidence about growth for Spanish manufacturing firms, while Correa et al. (2003) analysed all

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firms in Canary Islands. However, there has been no comparison between firms in the service sector and firms in manufacturing for the whole of Spain.

Our results show that Gibrat's Law is rejected not only in the manufacturing but it also in the service sector. Moreover, regional differences are extremely important when analysing manufactures and services separately. This suggests that firms in the manufacturing and services industries behave differently, and we should analyse them separately.

This study is structured as follows. In section 2 we summarise the literature on firm growth. In section 3 we present the relationship between locational externalities and firm growth. In section 4 we review the methodological contributions in the literature on Gibrat's Law. In section 5 we present the data description of the Spanish SABI data base (*Sistema de Análisis de Balances Ibéricos*). In section 6, we present the econometric methodology and empirical estimation. In section 7 we present the speed of firm growth depending on the export-import behaviour. Finally, in section 8 we summarise our main findings and present our conclusions.

5.2. LITERATURE

In this section we review the literature on firm growth. First we describe several economic approaches to the analysis of firm growth. Second, we focus on the Gibrat's Law, or the Law of Proportionate Effects. Finally, we report several gaps we found in the reviewed literature[1].

[1] See Chapter 2 for a more detailed review of the literature.

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5.2.1. Different approaches to firm growth

The firm growth process has been analysed from several perspectives. From the perspective of classical economists to the stochastic growth theory, firm growth has been a focus of attention. However, each of these perspectives has its own limitations.

The classical theory has its origin in Viner (1932), who predicted the existence of an optimal size in the market. Consequently, all firms would grow until they reached the same size. However, the reality is much more complex and the empirical evidence shows the presence of heterogeneous sizes: a large number of small firms usually coexist with a few large firms in the same industry.

Out of this friction between theory and reality, the Behaviourists appeared. Following Penrose (1959), firms have a potential for growth that is limited only by their own organization. Separating ownership and management will result in continuous growth that is limited only by the capabilities of the organisation.

As with the last approach, stochastic growth theory is a development of Gibrat's Law. Gibrat (1931) postulated that firm growth is independent of firm size. This means that all firms have the same probability to grow[2]. Consequently, in the market a high number of small firms will be coexisting with a small number of large firms[3]. Geroski (1999), Caves (1998) and Sutton (1997) pointed out the stylised regularities of firm demography. In particular they found that:

a) the rate of growth declines with the initial size of the firm,

[2] Due to the inconsistency between the empirical evidence and the Classical Theory and Behaviourists, Geroski (1999) argues in favour of Gibrat's Law.
[3] This phenomenon would explain the skewed distribution of firms in an industry.

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b) entry and exit are closely related to the growth-size relationship; small firms dominate entry, and exit declines with size, and
c) growth and exit rates decline with age.

5.2.2. Empirical evidence

From the empirical perspective, in the last few decades there have been a large number of contributions related to stochastic models and learning models[4]. The aim of this subsection is to review some of the most important contributions to Gibrat's Law. Finally, we present several studies on the Theory of Learning.

Early studies by Hart (1962) and Prais (1976) for the United Kingdom and Ijiri and Simon (1977) for the United States accepted Gibrat's Law. This is because Gibrat's Law provides a good explanation for the skewed distribution of firm sizes observed in the market.

However, Mansfield (1962) highlighted some interesting results. He stated that Gibrat's Law is relevant for surviving firms whose size exceeds the minimum efficient scale[5], while the smallest surviving firms tend to have a positive relationship between firm growth and size. Mansfield (1962), therefore, seemed to explain the diverse results.

Empirical evidence from the last few decades has been inconsistent with the Law of Proportionate Effects. Some studies have accepted Gibrat's Law, while others have rejected its hypothesis of independence between firm growth and initial size.

[4] Growth has been measured differently depending on the studies. Different contributions have analysed sales, income and employment, etc. (See Chapter 2). However, the literature has not taken into account this aspect (Sutton, 1997).
[5] We understand minimum efficient scale as the point where economies of scale are fully exploited.

The post-entry performance of firms has also attracted attention in the theoretical literature. Jovanovic (1982) presented the passive Learning Theory, where firms enter, exit and grow. His model is characterised by passive learning, which means that firms cannot modify their unknown initial efficiency level. In his model, Gibrat's Law is only supported for those new firms that exceed the minimum efficient scale, while smaller firms have a negative relationship between size and growth.

Later, Ericson and Pakes (1995) and Pakes and Ericson (1998) developed a model with firm dynamics and firm-specific uncertainty. In this case, firms are heterogeneous and their survival depends on investment and the behaviour of other firms, the characteristics of the industry and external shocks. Consequently, there is an interaction between all the agents of the model. The result will be active learning, where firms can modify their initial efficiency level through investment.

5.2.3. Gaps in the literature

Having presented the literature related with Gibrat's Law, in this section we highlight an important aspect that affects firm growth but that has been ignored in the analysis of Gibrat's Law: the lack of studies related with the service sectors.

Though the literature on firms in the manufacturing sector has been prolific, recent studies of the service sector have been scarce (Audretsch et al., 2004). Some exceptions are those by Audretsch et al. (2004) and Oliveira and Fortunato (2004a, 2004b). Audretsch et al. (2004) analysed the Dutch hospitality sector (restaurants, cafeterias, cafes, hotels and camp sites) and showed that the different subsectors behave heterogeneously. Oliveira and Fortunato (2004a, 2004b) analysed the

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firm growth patterns of Portuguese firms in the manufacturing and service sectors[6]. They showed that firms in the service sector behave in the same way as those in the manufacturing sector and rejected Gibrat's Law[7].

Audretsch, Klomp and Thurik (1999) argued that firms in the service sector will perform differently from those in the manufacturing sector since firms in service industries grow more slowly than firms in manufacturing industries. This is because in services scale economies are inferior to those in the manufacturing sector and firms are not forced to reach a given minimum efficient scale in order to survive. This lower level of scale economies in the service sector implies that firms will have no incentive to increase in size in order to reduce their total average costs.

Audretsch et al. (2004) only analysed the Dutch service sector and few empirical studies have compared the performance of firms in the manufacturing sector with the performance of firms in the service sector. Because of the scarcity of such comparisons, our objective is to compare the performance of firms in the two industries during the same period of time and from the same source of information[8]. We expect to obtain different patterns of firm growth between the two sectors if there is a heterogeneous behaviour of the firm growth between manufacturing and service sectors.

[6] Oliveira and Fortunato's (2004a, 2004b) used unbalanced panel data with 8072 firms, but only 419 firms belong to the service sectors.
[7] Their results show that small firms grow faster than large ones. As dependent variable they have a current size, and the independent variable will be the previous size.In this case, their coefficient is smaller than 1.
[8] We consider that the homogeneity of the data is crucial to examine Gibrat's Law. Different sources of information may reduce comparability and therefore distort the results.

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5.3. ESTIMATING GIBRAT'S MODEL

In this section we summarise the different estimation procedures used in the literature to estimate Gibrat's Law. Gibrat (1931) presented a model in which the current size of a firm depends on the size of the firm in the previous period plus a random error. From this initial point, contributions have evolved towards an estimation of firm growth, measured as the difference in size between two periods in logarithms, as a function of the firm's size in the initial period[9]:

$$\Delta \log S_{i,t} = \alpha_i + \beta_i \log S_{i,t-1} + \varepsilon_{i,t} \qquad (5.1)$$

where $S_{i,t}$ is the size of firm i in the period of time t, and $\varepsilon_{i,t}$ is an error term. Most of the studies assume that the intercept and the slope are identical for all firms (ie, $\alpha_i = \alpha_j$, $\beta_i = \beta_j$). Equation 5.1 would be:

$$\Delta \log S_{i,t} = \alpha + \beta \log S_{i,t-1} + \varepsilon_{i,t} \qquad (5.2)$$

However, Gibrat's Law has been criticised because it can result in mean-reversion or Galtonian fallacy bias, which can overestimates firm growth (small firms may appear to grow more quickly than they do in reality). When does this bias appear? Firstly, when there is a measurement error when classifying firms into size classes in terms of the size in the initial year. Secondly, when there are transitory fluctuations towards the equilibrium size, which is particularly important when firms are observed in short periods of time.

Cefis et al. (2002) analysed mean-reversion and the multiplicity of equilibria using two databases. The first one contains the 199 largest

[9] The literature contains several formulations of the dependent variable, including the arithmetic mean rate of growth, the annual rate of growth and the difference in size.

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pharmaceutical corporations from major western countries[10] between 1987 and 1998. The second one contains 267 UK manufacturing firms between 1988 and 1992. As they excluded new entrants from the data set, they had a balanced panel. They defined firm size in terms of sales. Their results show that the majority of the firms converge towards a steady state, which is different for each firm. They also observed that the velocity of convergence does not depend on the initial size but that the steady state does.

Lazarova et al. (2003) analysed the growth of 147 large UK firms that survived between 1955 and 1985. They measured firm growth in terms of total net assets. Lazarova et al. (2003) stated that panel data with a large number of firms but few time periods amplifies changes in size that would be less evident over a longer period of time. For example, if in the long run there is slow convergence, in a short period of time the hypothesis of convergence could be rejected. Moreover, if the parameter $\varepsilon_{i,t}$ is autocorrelated, the β parameter would be inconsistent (Chesher, 1979). Lazarova et al. (2003) suggest using longitudinal data with at least 30 periods of time.

These authors point out that equation 5.2 assumes convergence to the same steady state (the convergence would be towards the average of the group). Similarly, the β parameter would be an estimate for the whole group of firms. An alternative would be to apply a fixed effects panel to correct for unobservable and invariable determinants of the size in equilibrium[11].

[10] Cefis et al.'s (2002) data base includes firms from France, Germany, Italy, Spain, UK, Canada and USA.

[11] However, Pesaran and Smith (1995) pointed out that fixed effects can increase the problems of heterogenous β, and propose an indirect estimation of α and β with observable variable.

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A third problem that emerges is the assumption that any change in firm size is a transition towards an equilibrium, and that the growth of firms which are in the equilibrium size is due to random shocks. Lazarova et al. (2003) proposed equation 5.3, which is the difference between the size of firm *i* and the size of firm *j*:

$$\Delta d_{ijt} \equiv \left(\log S_{i,t} - \log S_{j,t}\right) \equiv \beta d_{ijt-1} + \left(\varepsilon_{i,t} - \varepsilon_{j,t}\right) \qquad (5.3)$$

When there are no differences in the intercept ($\alpha_i = \alpha_j$), equation 5.3 shows whether variations in size are due to differences in size in *t-1*. Firms *i* and *j* will converge in the long run if d_{ijt} is equal to zero when *t* approaches infinity.

The authors found evidence of weak reversion and emphasise two main conclusions: a) the difference between firms is permanent and b) the speed of convergence in traditional models is sensitive to how heterogeneities are handled, which means that heterogeneities in the steady state size or in the speed of convergence can generate biased estimations. They indicated that equation 5.2 is useful for active firms which do not deviate excessively from the equilibrium.

There are three relevant Spanish studies, Fariñas and Moreno (2000), Correa et al. (2003) and Calvo (2006). Fariñas and Moreno (2000) analysed the growth of 2188 Spanish manufacturing firms between 1990 and 1995 using non-parametric methods[12]. Their estimations of firm growth for all firms depending on size and age show that size has a negative impact on growth among surviving firms. Consequently, Gibrat's Law is rejected.

[12] Their source of information is the *Encuesta sobre Estrategias Empresariales*.

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Fariñas and Moreno (2000) classified firms in groups of sizes[13], which means that each firm is classified in one group, and estimated growth for the whole group. They assumed that firms belonging to a group will have particular characteristics that will determine their future growth. However, firms were classified in a group depending on their initial size without taking into account the possibility that they can change to a different group with different characteristics. To avoid mean-reversion bias due to the fact that they can change group, they introduced cross-boundary dummies to control for firms that change groups. Their results show that reversion to the mean does not explain the negative relationship between firm growth and the size of surviving firms. They also show that the growth rates of smaller surviving firms diminish abruptly in the long run. However, they admitted that "*the relationship between size and growth is affected by additional factors other than simply the tendency to the mean size*". Their main contributions are the fact that that theirs is one of the few studies to analyse Spanish data, and their non-parametric approach that relates a firm's age and size with the variance in size and probabilities of failure.

Correa et al. (2003) estimated firm growth in the Canary Islands with data from the *Commercial Performance Information Bureau*[14] of the University of La Laguna between 1990 and 1996. They studied firm growth using several measures (assets, added value and incomes). Their results show a positive impact of insularity[15] on firm growth, while age is not significant. Moreover, their results reject Gibrat's Law since small firms grow faster than large ones.

[13] In Fariñas and Moreno (2000), firms are classified by groups depending on the initial number of employees. This method can create problems because changes in size will be detected when firms change group, while changes within a group are not noticed.
[14] Their data base includes all firms belonging to non-financial sectors.
[15] Because of the characteristics of the Canary Islands, firm growth is higher there than in the rest of Spain.

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Recently, Calvo (2006) found a negative relationship between firm size and growth among Spanish manufacturing firms from the *Encuesta sobre Estrategias Empresariales* between 1990 and 2000. He applied a Heckman's equation and found that product and process innovation has a positive impact on firm growth and survival. Furthermore, there is a negative relationship between firm size and firm growth.

The conclusions from this literature are that factors other than the initial size of a firm determine its growth. In our empirical specifications we therefore include other explanatory variables such as location, external activity and the firm's legal status. The main objective is that all these variables include other factors that explain firm growth which are not captured by the firm size.

5.4. METHODOLOGY AND EMPIRICAL ESTIMATION

This section aims to provide empirical evidence about the differences between firms in the manufacturing and service sectors. In particular, we would like to know whether the smaller average size of firms in the service sector leads to different growth dynamics. Our aim, therefore, is to measure differences in firm growth between Spanish firms in the two sectors.

Our starting point is that the assumption that the pattern of firm growth depends on the industrial sector. This means that there are differences between the growth process of firms in the service sector and that of firms in the manufacturing sector. Manufacturing activities have certain requirements that affect growth. In addition, the individual decisions of an entrepreneur can also affect firm behaviour.

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5.4.1. Data

The SABI database provides information about Spanish and Portuguese firms that present their accounts to the Business Register. This data base contains information on more than 500,000 Spanish firms and 50,000 Portuguese firms since 1994. It covers more than 95% of Spanish firms that present their accounts to the Business Register.

This database has several advantages. First, it covers a large number of firms and contains detailed information on a wide range of firm characteristics. Second, it also contains information on the same firms over a relatively long period of time (1991-2003[16]) and enables us to study firm growth over the medium term. However, these data are not representative of all Spanish firms because the smallest firms are absent. From this database we selected an estimating subsample helping order to overcome problems regarding the excessive size of the data and missing data.

One of the aims of this study is to investigate differences in firm growth between firms in the manufacturing sector and those in the service sector. As a first step, we summarise these key variables separately within each sector (Tables 5.1 and 5.2).

In Table 5.1 about 20% of the observations relate to *Metal products*. This sector also has one of the smallest average firm sizes (23 employees) together with *Textile and leather clothes*, *Wood and cork* and *Furniture*. The relationship between the number of active firms in an industry and the firm size necessary to be efficient is well-known in the literature (Segarra et al., 2002). If a firm needs a high number of employees to

[16] Because of a lack of information for the beginning or the end of the sample, we worked only with firms covered in the period 1994-2002.

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enter the market in a particular industry, there are high barriers to entry and so there will be a low number of active firms. In our case, most firms are concentrated in the aforementioned sectors and their average firm size is relatively small, which indicates that these sectors have low barriers to entry.

Table 5.1. Average value by manufacturing industry.

	Observ.	Workers	Income p.w.	Added value p. w.	Sales p.w.	Age
Food and beverages	40280	33.66 (319.30)	145.32 (350.10)	24.43 (64.35)	142.98 (348.23)	12.80 (12.18)
Textile and leather clothes	41484	22.10 (63.59)	88.08 (179.65)	17.97 (27.74)	87.43 (178.91)	9.01 (7.88)
Wood and cork	16220	17.64 (117.70)	72.12 (247.23)	19.20 (87.81)	71.65 (245.76)	9.01 (7.88)
Paper products and media	37617	21.23 (97.25)	79.57 (149.09)	24.35 (32.76)	78.49 (147.42)	9.79 (9.84)
Chemical manufactures	11493	58.34 (233.27)	135.69 (272.83)	33.99 (70.72)	133.59 (267.36)	16.01 (15.04)
Rubber and plastic products	14350	35.19 (324.18)	92.05 (202.91)	26.86 (86.38)	91.38 (201.86)	11.64 (9.69)
Other non-metallic products	19775	35.50 (247.42)	90.64 (165.77)	26.49 (52.30)	90.02 (165.32)	11.67 (10.73)
Metal products	62648	22.92 (176.16)	70.94 (167.03)	22.88 (22.74)	70.50 (166.50)	9.84 (9.23)
Machinery and equipment	18822	28.76 (117.27)	86.65 (95.50)	26.30 (37.44)	85.76 (94.63)	11.80 (10.23)
Electric and optic apparatus	12522	48.77 (321.71)	99.18 (467.54)	25.82 (33.78)	96.77 (347.21)	11.19 (10.53)
Transport equipment	7194	124.24 (629.47)	106.24 (269.10)	27.42 (43.31)	104.97 (268.72)	12.83 (13.02)
Furniture	22858	17.45 (46.17)	62.83 (220.03)	18.45 (82.02)	62.42 (220.09)	8.99 (7.89)

Source: author's own.

On average, firms in the *Food products and beverages* and *Chemical manufactures* sectors have a higher income per worker than the other sectors. The pattern for sales per worker is identical to income per worker and the values are similar. Firms in the *Chemical manufactures* sector have the highest average added value per worker, at 34,000 euros,

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while *Textile and leather clothes*, *Wood and cork* and *Furniture* have the lowest values.

The final column in Table 5.1 shows that the *Chemical manufactures* sector has the oldest firms (16 years on average). *Furniture* and *Wood and cork* have the youngest firms (9 years on average).

Table 5.2 focuses on the statistics for firms in the service sector and shows that the majority of firms are in *Motor vehicles* (28%), *Hotels and restaurants* (22%) and *Transport* (27%). Relatively few firms are in the *Research and development* sector (0.5%). In terms of the number of employees, the largest firms are in *Telecommunications* (with 122 employees) and the smallest ones are in *Motor vehicles* and *Wholesale trade* (with 13 and 10 employees, respectively).

As in the manufacturing sectors, operating revenue has the same pattern as sales, which means that firms performing well in one domain also perform well in the other.

If we compare revenue per worker, firms in *Motor vehicles* and *Wholesale trade* have the highest average value (between 150,000 and 250,000 euros per worker), while firms in the *Hotels and restaurants* sectors have the lowest. These results are common and to be expected, since, being labour-intensive sectors, they are typically the ones with the lowest added value per worker. As expected, firms in the *Finances and Renting* sectors have the highest values in terms of added value per worker, while those in *Telecommunications* add on average a value of five thousand euros per worker. Finally, the youngest firms are found in *Telecommunications*. Again, this is to be expected as this sector has become more competitive in the last ten years.

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Table 5.2. Average values by service industry.

	Observ.	Workers	Revenue per worker	Added value per worker	Sales per worker	Age
Motor vehicles	79167	13.43 (64.39)	163.43 (371.80)	20.76 (37.90)	160.61 (369.64)	10.75 (8.32)
Wholesale trade	17713	10.85 (50.55)	253.68 (1727.88)	27.05 (47.24)	251.54 (1712.19)	9.00 (8.32)
Hotels and restaurants	61967	27.63 (244.14)	49.14 (185.05)	19.53 (113.03)	47.17 (167.67)	8.34 (8.12)
Transport	75176	26.99 (479.21)	137.34 (369.19)	28.21 (74.07)	135.19 (358.48)	9.85 (10.10)
Telecommunications	6049	121.61 (1598.48)	93.62 (238.64)	4.59 (477.89)	90.34 (236.20)	5.74 (6.06)
Finances	8895	37.24 (485.19)	115.29 (1108.93)	85.42 (950.95)	118.64 (1153.52)	8.58 (8.03)
Renting	10659	12.71 (33.94)	136.34 (837.50)	69.61 (876.47)	132.26 (841.79)	7.98 (7.08)
Computer activities	18349	30.36 (205.91)	89.45 (225.12)	22.26 (105.45)	87.45 (224.34)	5.90 (5.34)
R&D	1316	49.75 (264.66)	89.86 (159.91)	33.48 (78.71)	79.56 (160.24)	8.16 (7.42)

Source: author's own.

In general a comparison of the firms in the manufacturing and service sectors indicates that those in the service sectors are smaller (in terms of number of employees) and younger. However they have better performance in terms of income per worker, added value per worker and sales per worker. The final conclusion we draw from these descriptive tables is that manufacturing and service sector firms are very different, which may suggest that they enjoy different rates of growth. Our aim in the remainder of this study is to analyse differences in the post-entry performance of firms in each sector.

5.4.2. Econometric methodology

As discussed previously, several econometric methods have been used to test Gibrat's Law. The first attempts used a cross-section regression. However, if unobserved factors (such as managerial attitude) affect firm growth rates, and these are positively correlated with firm size and are

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not controlled for in regressions using cross section data, the estimated coefficients on the firm size variable will be biased upwards.

In this sense, panel data can be used to control for time-invariant unobserved heterogeneity (Baltagi, 1995). The standard methods of panel estimation are fixed effects or random effects. The main difference between these two techniques is the information used to calculate the coefficients. The fixed-effects estimates are calculated from differences within each firm across time. However, as Cefis et al. (2002) pointed out, this approach forces the parameters to be identical across firms. If firms are heterogeneous, the fixed-effects estimates can be biased. Neglecting heterogeneous coefficients in dynamic models creates correlation between the regressors and the error term and causes serially correlated disturbances (Pesaran and Smith, 1995; Hsiao et al., 1986).

The random-effects estimates are more efficient, since they incorporate information across individual firms as well as across periods. The major drawback with random effects is that they are consistent only if the firm-specific effects are uncorrelated with the other explanatory variables. We applied a Hausman test to evaluate this independence assumption. Therefore, the fixed effects model is consistent. However, the application of the Fixed Effects model has several shortcomings:

1. variables with non-individual dimension disappear from the analysis,
2. we may not be interested in a Random Effects model in order to extrapolate the data, and
3. Nickell (1981) states that the Fixed Effects model may have a downward bias.

Nickell (1981) reported that introducing the lagged dependent variable in a Fixed Effects model implies a large and negative bias on the estimated

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coefficient of the lagged dependent variable. And more importantly, the smaller the time period of the database, the larger is the bias. This is highly important since microeconomics panels are characterised by a larger number of observations compared to the number of periods. Moreover, the bias does not tend to zero when the real value of the coefficient of the lagged value (ρ) tends to zero.

5.4.3. Estimation

The estimation of Gibrat's Law (equation 5.1) assumes that the behaviour of all firms is identical, which in our case assumes that firm growth is identical for firms in the manufacturing and service sectors. This assumption does not match the empirical evidence. Audretsch et al. (2004) showed that the behaviour of firms in the manufacturing sector is different from the behaviour of firms in the service sector.

For this reason, we introduced two lagged size variables: the first one identifies the lagged size of firms in manufacturing (and taking a value equal to 0 for firms in the service sector) and the other represents the impact of the lagged size of firms in services (taking a value equal to 0 for firms in the manufacturing sector). Our main equation therefore takes the following form:

$$\Delta \log S_{i,t} = \alpha_i + \beta_{i,MANUF} \log Size_{iMANUF,t-1} + \beta_{i,SERV} \log Size_{iSERV,t-1} + \varepsilon_{i,t} \quad (5.4)$$

Equation 5.4 will also include other variables, which are classified in the four groups shown in Table 5.3.

The explanatory variables are divided into four groups. The first group contains individual characteristics such as the lagged size of the firm and

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its age. The coefficients on the lagged size variables for firms in manufacturing and services ($Size_{iManuf,t-1}$ and $Size_{iServ,t-1}$) will determine whether or not Gibrat's Law is accepted. In particular, a value equal to 0 will accept Gibrat's Law, which means that firm growth does not depend on the initial size of the firm. Age and its quadratic value (*Age* and *Age2*) are often introduced in the literature, since they show how firm growth responds to each life cycle of the firm. While the variable *Age* represents how the firm evolves over time, *Age2* expresses how the maturity process affects the growth of the firm. These variables are closely related to the Theory of Learning (Jovanovic, 1982), which states that the youngest surviving firms will have a higher growth rate.

Table 5.3. Description of variables

Variable	Description
	Individual characteristics
$Size_{iManuf,t-1}$	Logarithm of the size from the previous period only for manufacturing (value 0 for services)
$Size_{iServ,t-1}$	Logarithm of the size from the previous period only for services (value 0 for manufacturing)
Age	Logarithm of the age
Age2	Logarithm of the age squared
	External activity
Exp	Dummy identifying whether the firm exports
Imp	Dummy identifying whether the firm imports
ExpImp	Dummy identifying whether the firm both exports and imports
	Internal organization and legal status
Holding	Dummy identifying firms with consolidated and unconsolidated accounts
Legal status	Dummy identifying joint stock company
Others	Dummy identifying whether the firm is not a joint stock company or a limited liability company
	Territorial variables
AR1…AR19[a]	Dummies identifying firm location in one of the Spanish autonomous regions

Source: author's own.

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The second group of variables measures the firm's external activity. Dummy variables identify firms that export or import products and firms that do both (*Exp*, *Imp* and *ExpImp*), and examine their impact on firm growth trends.

The third group measures the firm's internal organization and legal status. The *Holding* variable measures whether the firm has consolidated and unconsolidated accounts relative to those firms with unconsolidated accounts. Also, limited liability firms are compared with joint stock companies (*Legal status*) and other legal status (*Others*).

Finally, the fourth group captures the effect of firm location. In particular, we introduce dummies identifying the location of the firm in one of the 19 Spanish autonomous regions (*AR1…AR19*) in order to determine the advantages and disadvantages of locating in a particular region. There are 19 regions in total and we compare firms in other regions to those in the Autonomous Region of Madrid.

We introduce each group of variables separately to estimate their effect on firm growth. The final group to be introduced is the group of location variables. The final model to be estimated has the following specification:

$$\Delta \log S_{i,t} = \alpha_i + \beta_{1iMANUF} \log Size_{iMANUF,t-1} + \beta_{2iSERV} \log Size_{iSERV,t-1} + \beta_{3i} \log Age_{i,t} + \\ + \beta_{4i} \log Age2_{i,t} + \beta_{5i} \log Exp_i + \beta_{6i} \log \mathrm{Im}\, p_i + \beta_{7i} \log Exp\,\mathrm{Im}\, p_i + \\ + \beta_{8i} Holding_i + \beta_{9i} Legal_i + \beta_{10i} Others_i + \beta_{11i} AR_i + \varepsilon_{i,t} \quad (5.5)$$

The choice of whether to estimate "random" or "fixed" panel data is made through the Hausman test (see Tables 5.4, 5.6 and 5.7). The Hausman test accepts the hypothesis that the coefficients in the fixed and random

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effects models are similar for the different specifications, so we only present results of the random effects estimation. The panel data estimation has been used frequently in the literature. Recently, authors such as Resende (2004), Goddard et al. (2002) and Chen and Lu (2003) used panel data regression to estimate the post-entry performance of firms. The introduction of dummy variables is needed to analyse certain behaviours. Therefore we estimate our equations with random effects panel data.

5.4.4. Results

The results of the econometric estimations are presented in Table 5.4. Each column presents the results of introducing a further set of covariates, with specification 6 being the most complete. These results show that Gibrat's Law is rejected since the coefficients on the lagged size variables are statistically significant for firms in both manufacturing and services ($Size_{iManuf,t-1}$ and $Size_{iServ,t-1}$). Moreover, the coefficients are negative, which implies that larger firms in the initial period grow less than smaller ones.

This result is consistent with the Jovanovic's (1982) model because there is bounded efficiency. This means that there is a range of sizes in which firms can produce at efficient levels[17].

Secondly, age does not have a clear or consistent pattern. Though significant in nearly all cases, the sign varies across specifications. In general, however, growth declines with age but the rate of decline gets lower over time. The negative sign from the variable *Age* generates a decrease in the firm growth and indicates diminishing returns to

17 The large number of firms in our database, the fact that we do not classify firms by groups of size and the fact that we do not have a short panel implies that our panel does not suffer from the mean-reversion tendency.

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learning. The positive sign in the variable *Age2* is due to the fact that firms surviving for such a long time may have strategies or characteristics that enhance their probability to survive and grow.

Table 5.4. Determinants of firm growth for the whole data base (GLS random effects model)

	Specification1	Specification2	Specification3	Specification4	Specification5	Specification6[a]
$Size_{t-1}$ Manuf	-0.1624	-0.1800	-0.1826	-0.1895	-0.2045	-0.2061
	(0.0009)*	(0.0010)*	(0.0010)*	(0.0010)*	(0.0010)*	(0.0010)*
$Size_{t-1}$ Serv	-0.1511	-0.1709	-0.1874	-0.1937	-0.2045	-0.2061
	(0.0008)*	(0.0009)*	(0.0010)*	(0.0010)*	(0.0010)*	(0.0010)*
Age		0.0053	-0.0004	0.0003	-0.0034	-0.0034
		(0.0001)*	(0.0002)***	(0.0002)	(0.0002)*	(0.0002)*
Age2			0.0001	0.0001	0.0001	0.0001
			(0.00001)*	(0.00001)*	(0.00001)*	(0.00001)*
Exp			0.0698	0.0694	0.04310	0.0428
			(0.0045)*	(0.0045)*	(0.0044)*	(0.0045)*
Imp			0.0841	0.0873	0.0565	0.0548
			(0.0050)*	(0.0038)*	(0.0050)*	(0.0050)*
ExpImp			0.2306	0.2236	0.1841	0.1841
			(0.0038)*	(0.0038)*	(0.0038)*	(0.0038)*
Holding				0.7273	0.7187	0.7222
				(0.0168)*	(0.0168)*	(0.0168)*
Legal status					0.1793	0.1816
					(0.0026)*	(0.0027)*
Others					-0.0127	-0.0068
					(0.0102)	(0.0102)
Constant	0.3823	0.3683	0.3995	0.4072	0.4237	0.4226
	(0.0019)*	(0.0019)*	(0.0022)*	(0.0022)*	(0.0022)*	(0.0033)*
R^2	0.4251	0.4438	0.4367	0.4401	0.4397	0.4404
N	414,123	414,123	414,123	414,123	414,123	414,123
Hausman	163938.98	179651.08	185926.65	186199.43	185529.74	186197.70
test	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Standard deviation in brackets.
[a] This equation includes location variables (see Table 5.9).
* significant at 1%, ** significant at 5% and *** significant at 10%.

With regard to the external activity of the firm, we can see that firms that import or export have significantly higher growth rates than those that do neither. Pfaffermayr (2004), Wagner (2001) and Voulgaris et al. (2003) confirmed that there is a positive relationship between exports and the firm growth process. Delgado et al. (2002) obtained similar results for Spanish manufacturing firms. Moreover, we find an additional growth premium associated with having both imports and exports—the coefficient on the *Expimp* variable is also positive and significant.

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Consequently, firms that participate in other markets by buying or selling products can reach higher growth rates. We suppose that these firms must have a larger level of efficiency to be able to compete in larger international markets.

Firms with consolidated and unconsolidated accounts experience a significantly higher level of growth. This is probably because they belong to multinational firms or holdings with more growth capacity and diversify their investments. This diversification gives the firm an opportunity to increase its growth capacity without having to take as many risks as a small firm. In this context, Delmar and Davidsson (1998) did not find a clear pattern between group affiliation and firm growth.[18]

Finally, we find that joint stock companies enjoy significantly higher levels of growth than limited liability companies. The coefficient on the variable *Others* (which represents general partnership, limited partnership, cooperatives and associations) has a negative impact, though this is not significant. These results are consistent with Niefert's (2005) results, which showed that limited liability and joint-stock companies enjoy greater firm growth than other firms.

Table 5.5. Coefficient test: Manufacturing vs. Services

	Specification1	Specification2	Specification3	Specification4	Specification5	Specification6[a]
χ^2	177.31 (0.0000)	109.62 (0.0000)	29.64 (0.0000)	22.36 (0.0000)	0.60 (0.4380)	0.00 (0.9482)

[a] This equation includes territorial variables.

These results indicate that Gibrat's Law should be rejected for Spanish firms. We find that firm growth in terms of number of employees depends on firm size in the initial period. However, we are also interested in determining whether patterns of growth differ between

[18] Delmar and Davidsson (1998) estimated a model for high-firm growth. Our results may therefore be different because the characteristics of high-growth firms may be significantly different in comparison with other firms.

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firms in the manufacturing and service sectors. We do this initially by testing whether the coefficients on the lagged size variable for each sector are equal. Table 5.5 presents the results of chi-squared tests for equality of coefficients. This shows that in the basic model (which only introduces the lagged size) and the extensions with variables such as age, quadratic age and external activity, the coefficients on the lagged firm size differ between manufacturing and services. However, this difference disappears in the more complete models that include legal status and the location variables. These findings suggest two things—firstly that, all else equal, firms in manufacturing and service sectors have the same levels of growth and, secondly, that a large proportion of the difference between growth in the two sectors is explained by the location variables.

However, this specification forces the coefficients on the other covariates to be equal for firms in the two sectors, which may not be realistic—there is no reason why we should expect the impact of exporting goods and products to have the same impact on growth for a firm in the manufacturing sector as for a firm in the service sector. To overcome this, we estimate the same equations for manufacturing and services separately, since estimating manufacturing and services jointly can introduce bias.

The results for manufacturing firms are shown in Table 5.6 and those for services are shown in Table 5.7. We will not describe the coefficients obtained in both estimations in detail, since they agree with the previous estimation. Instead we focus on differences between the two sectors.

If we compare the coefficients on the initial size variable ($Size_{it-1}$) in the two tables, we can see that the coefficient is larger for firms in manufacturing (between -0'18 and -0'27) than for those in services (a negative impact of 0'13 and 0'15). These results match our expectations

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since the minimum efficient size of the service sector is smaller than it is for the manufacturing sector (Audretsch et al., 2004). Consequently, convergence is reached more quickly in the service sector than in the manufacturing sector. Another explanation for this difference is that in the service sector we can find a larger range of firm sizes operating efficiently. For example, in rural areas large chains of hotels may coexist with small hostels. This wider range of efficient sizes means that firms do not need to increase in size in order to reach an efficient scale.

Table 5.6. Determinants of firm growth for manufacturing (GLS random effects model)

	Specification1	Specification2	Specification3	Specification4	Specification5	Specification6[a]
$Size_{t-1}$	-0.1863 (0.0011)*	-0.1285 (0.0011)*	-0.2414 (0.0013)*	-0.2501 (0.0013)*	-0.2676 (0.0013)*	-0.2697 (0.0013)*
Age		0.0053 (0.0001)*	-0.0029 (0.0003)*	0.0040 (0.0003)*	-0.0003 (0.0003)	-0.0003 (0.0002)
Age2			0.0001 (0.00001)*	0.00004 (0.00001)*	0.0001 (0.00001)*	0.0001 (0.00001)*
Exp			0.0644 (0.0052)*	0.0657 (0.0052)*	0.0306 (0.0052)*	0.0303 (0.0052)*
Imp			0.0917 (0.0065)*	0.0961 (0.0065)*	0.0538 (0.0065)*	0.0533 (0.0065)*
ExpImp			0.2841 (0.0046)*	0.2790 (0.0046)*	0.2249 (0.0046)*	0.2267 (0.0047)*
Holding				0.8775 (0.0223)*	0.8648 (0.0222)*	0.8725 (0.0222)*
Legal status					0.2352 (0.0038)*	0.2420 (0.0038)*
Others					-0.0547 (0.0126)	-0.0533 (0.0128)*
Constant	0.4781 (0.0028)*	0.4620 (0.0029)*	0.5000 (0.0032)*	0.5108 (0.0032)*	0.5352 (0.0032)*	0.5132 (0.0050)*
R^2	0.4414	0.4667	0.4653	0.4700	0.4766	0.4779
N	235,056	235,056	235,056	235,056	235,056	235,056
Hausman test	103674.07 (0.0000)	116160.69 (0.0000)	123100.04 (0.0000)	123980.08 (0.0000)	124558.95 (0.0000)	125315.47 (0.0000)

Standard deviation in brackets.
[a] This equation includes territorial variables (see Table 5.9).
* significant at 1%, ** significant at 5% and *** significant at 10%.

Another characteristic is that the logarithmic lagged value of the coefficient on initial size gets larger when new variables are introduced in the regressions with manufacturing firms, while the coefficient is quite stable for services. Moreover, this difference between the manufacturing

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and service sectors is much larger when the location variables are included. Consequently, these results are consistent with Audretsch and Dohse (2004) and Hoogstra and Dijk (2004).

Table 5.7. Determinants of firm growth for services (GLS random effects model)

	Specification1	Specification2	Specification3	Specification4	Specification5	Specification6[a]
Size$_{t-1}$	-0.1285	-0.1325	-0.1323	-0.1368	-0.1455	-0.1469
	(0.0011)*	(0.0012)*	(0.0012)*	(0.0012)*	(0.0012)*	(0.0012)*
Age		0.0012	-0.0038	-0.0034	-0.0064	-0.0063
		(0.0002)*	(0.0003)*	(0.0003)*	(0.0003)*	(0.0003)*
Age2			0.0001	0.0001	0.0001	0.0001
			(0.00001)*	(0.00001)*	(0.00001)*	(0.00001)*
Exp			0.0949	0.0894	0.0662	0.0654
			(0.0080)*	(0.0104)*	(0.0104)*	(0.0104)*
Imp			0.0664	0.0681	0.0471	0.0437
			(0.0080)*	(0.0080)*	(0.0080)*	(0.0080)*
ExpImp			0.0989	0.0875	0.0610	0.0584
			(0.0073)*	(0.0073)*	(0.0073)*	(0.0073)*
Holding				0.5660	0.5585	0.5560
				(0.0256)*	(0.0254)*	(0.0254)*
Legal status					0.1283	0.1250
					(0.0036)*	(0.0037)*
Others					0.0448	0.0494
					(0.0176)*	(0.0176)
Constant	0.3007	0.2974	0.3193	0.3246	0.3347	0.3534
	(0.0025)*	(0.0026)*	(0.0029)*	(0.0029)*	(0.0029)*	(0.0042)*
R^2	0.4041	0.4077	0.3949	0.3962	0.3860	0.3868
N	179,067	179,067	179,067	179,067	179,067	179,067
Hausman	59253.82	62458.86	62827.37	62322.54	61064.43	60915.12
test	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Standard deviation in brackets.
[a] This equation includes territorial variables (see Table 5.9).
* significant at 1%, ** significant at 5% and *** significant at 10%.

Again, we are interested to see whether we can accept the hypothesis that firm growth in the two sectors is the same. To do so, we estimate chi-squared tests for equality of coefficients. The results of these estimations are shown in Table 5.8. If the other covariates have similar effects in both types of industry, these test statistics should be similar to those in Table 5.5.

These results indicate that, for the first 4 specifications, the results are the same as before—we reject the hypothesis of equal coefficients, which

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indicates that the impact of firm size on growth is different in each sector. However, the results for specifications 5 and 6 are different than before. In this case we also reject the hypothesis of equal coefficients, which reinforces our earlier suggestion that firm location plays an important role in determining differences in firm growth between the two sectors. We will return to this point later.

Table 5.8. Coefficient test: Manufacturing vs. Services

	Specification1	Specification2	Specification3	Specification4	Specification5	Specification6[a]
χ^2	2714.04	5456.85	8231.68	8644.58	9667.46	9903.68
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0013)

[a] This equation includes territorial variables.

Table 5.6 also shows that in manufacturing the coefficients on age do not have a clear pattern but that in services negative coefficients predominate (Table 5.7). This may be because firms in the service sector are more affected by the learning process and have higher levels of competitiveness. It may also be because the minimum efficient size is smaller in services than it is in manufacturing, so these firms achieve their optimal size to be competitive in the market more quickly (Piergiovanni et al., 2002). The negative coefficients in the model for services agree with the Jovanovic's (1982) Learning Theory, which states that the older the firm is the lower growth it achieves. However, our main focus is not on the differences in growth between the youngest and the oldest firms, which could be a potential avenue for further research[19].

It is worth noting that firms in manufacturing yield a higher coefficient on the dummy variable that identifies exports and imports. This may be because manufacturing firms that are able to compete internationally have more capacity to grow, while firms in the service sectors find it is easier to expand their markets internationally without increasing in size.

[19] Fariñas and Moreno (2000) found that firm size and age had a negative effect on the growth of firms in Spanish manufacturing.

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Table 5.9. Impact of territorial variables (Region of reference: Madrid)

	WHOLE DATA BASE	MANUFACTURING	SERVICES
AR1-ANDALUSIA	-0.0066	0.0091	-0.0198
	(0.0040)***	(0.0062)	(0.0051)*
AR2–ARAGON	-0.0077	0.0253	-0.0389
	(0.0053)	(0.0077)	(0.0073)*
AR3–ASTURIAS	-0.0064	0.0409	-0.0320
	(0.0070)	(0.0112)*	(0.0087)*
AR4–BALEARIC ISLANDS	0.0183	0.0268	0.0096
	(0.0067)*	(0.0129)**	(0.0076)
AR5– CANARY ISLANDS	0.0913	0.1545	0.0501
	(0.0081)*	(0.0157)*	(0.0091)*
AR6–CANTABRIA	0.0662	0.1541	0.0060
	(0.0134)*	(0.0195)*	(0.0183)
AR7–CASTILE LA MANCHA	-0.0167	-0.0202	-0.0531
	(0.0055)*	(0.0077)*	(0.0079)*
AR8– CASTILE LEON	-0.0181	0.0139	-0.0458
	(0.0052)*	(0.0077)***	(0.0068)*
AR9–CATALONIA	-0.0053	0.0020	-0.0161
	(0.0034)	(0.0050)	(0.0045)*
AR10–CEUTA	-0.0244	0.0174	-0.0163
	(0.0587)	(0.1417)	(0.0612)
AR11-VALENCIA	0.0107	0.0425	-0.0242
	(0.0039)*	(0.0057)*	(0.0054)*
AR12–EXTREMADURA	-0.0263	0.0156	-0.0584
	(0.0101)*	(0.0149)	(0.0136)*
AR13–GALICIA	0.0314	0.0894	-0.0174
	(0.0055)*	(0.0081)*	(0.0073)**
AR15–MELILLA	-0.0931	-0.1995	-0.0512
	(0.0531)***	(0.1413)	(0.0543)
AR16–MURCIA	0.0298	0.0640	-0.0061
	(0.0069)*	(0.0096)*	(0.0098)
AR17–NAVARRE	0.0397	0.0872	-0.0198
	(0.0081)*	(0.0109)*	(0.0121)***
AR18–BASQUE COUNTRY	0.0165	0.0439	-0.0165
	(0.0051)*	(0.0072)*	(0.0073)**
AR19–RIOJA	-0.0053	-0.0090	0.0003
	(0.0105)	(0.0130)	(0.0189)
R^2	0.4251	0.4779	0.3868
N	414,123	235,056	179,067

Standard deviation in brackets.
* significant at 1%, ** significant at 5% and *** significant at 10%.

Having consolidated and unconsolidated accounts (*Holding*) has a larger impact on the growth of firms in the service sector it does on firms in the manufacturing sector. This may be because the effect of belonging to a corporation of firms may be bigger in services than in manufacturing since the volatility of incomes in the service sector is higher. Consequently, being in a larger corporation may stabilise growth.

The tables also indicates that joint stock companies enjoy greater firm growth in the manufacturing sector than in the service sector. However, firms with other legal forms (general partnership, limited partnership, cooperatives and associations) experience lower growth in manufacturing and higher growth in services.

Because of the importance of the location variables for estimating the differences in firm growth between the manufacturing and service sectors, Table 5.9 shows the coefficients obtained in the estimation of specification 6 in Tables 5.4, 5.6 and 5.7. The aim is to examine the different impacts of the geographical location of firms on the firm growth process.

Firms in the service sector may rely more on economies of agglomeration than on economies of scale, and location is a critical consideration in both sourcing and marketing. A central location in a major commercial capital may be crucial to accessing labour skills, information sources and client bases. Technological advantages that can be easily imitated and rapidly diffused are less important in the service sector than in manufacturing. We should therefore expect location to have different impacts on firm growth in each sector.

Concerning to the R^2 coefficient, it is lower in the service estimation than in the manufacturing estimations. Furthermore, it is worth noting that the R^2 slightly diminishes when the location variables are included in the model for service sectors. This may indicate that such regional classifications are less suitable for firms in the service sector than for firms in the manufacturing sector[20].

Secondly, we should remember that our region of reference is Madrid and that all our comparisons are therefore relative to this Spanish region. Most location variables have a positive impact in the specification for manufacturing firms and a negative impact for services. Moreover, the impacts are bigger in the manufacturing sector than in the service sector. This indicates that manufacturing firms in Madrid enjoy a lower growth than those elsewhere in Spain, while service sector firms in Madrid enjoy a relatively high growth. One explanation for these results may be that firms locate where they can obtain higher expected profits. Madrid is the location for most government services and is an important city in terms of influence. In which regions do firms enjoy the highest growth? In the pooled specification, regions with positive coefficients are the Balearic Islands, the Canary Islands (in agreement with Correa et al., 2003), Cantabria, Valencia, Galicia, Murcia, Navarre and the Basque Country. The largest impact is found in the Canary islands. As Correa et al. (2003) concluded, the insularity of the Canary Islands can be highly significant in achieving higher growth. In contrast, firms located in Melilla have the lowest growth, with an estimated coefficient of -0.0931.

However, a clearer picture of what is happening can be obtained by examining the impact of location on the growth of firms in manufacturing and services separately. In the manufacturing sector, the regions which have a positive impact on firm growth in relation to Madrid are Andalusia, Aragon, Asturias, the Balearic Islands, the Canary Islands, Cantabria, Castile Leon, Catalonia, Ceuta, Valencia, Galicia, Extremadura, Galicia, Murcia, Navarre and the Basque

[20] Arauzo and Teruel (2005) presented an alternative way to measure the regional impact through city size rather than location in a particular region. This could be a future line of research for this study.

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Country. However, only the impacts for Asturias, the Balearic Islands, the Canary Islands, Cantabria, Castile Leon, Valencia, Galicia, Murcia, Navarre and the Basque Country are statistically significant. Nevertheless, manufacturing firms in most regions enjoy a higher growth than in Madrid.

The location variables have a very different impact on firm growth in the service sector. In particular, only the coefficients on the Balearic Islands, the Canary Islands, Cantabria and Rioja are positive, and of these only the one for the Canary Islands is statistically significant. Castile la Mancha and Extremadura have negative impacts on firm growth in the service sector.

To sum up, the impact of location on firm growth depends on which sector we are analysing. These different impacts may be due to the fact that different regions specialize in different economic activities. While regions can exert a considerable positive influence in manufacturing, they have a negative impact in services. For example, some regions have a labour market that is specialized in one sector and it is likely that fast-growing firms are located in that sector.

5.5. A FORECAST OF FUTURE FIRM SIZE

Over time, the greater economic integration in the world is reflected by an intensification in international trade. The flows between firms from different countries have expanded exponentially in the last few decades. This increase in international trade may have an impact on the evolution of firms and their volatility may increase or decrease.

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In this section we will expand Gibrat's Law using a large database for the Spanish context. We will also extend previous studies by investigating the relationship between firm size and export-import profile using predictive techniques to identify the importance of external activity on the speed of firm growth.

In this section we analyse the relationship between firm growth and the speed of convergence towards a firm size. First we present the strategy for forecasting firm size. Then we present the estimations of Gibrat's Law for each subgroup of firms. Finally, we show the forecast of future firm size.

5.5.1. Estimation of the coefficients

The previous sections analysed the differences in the relationship between the manufacturing and service industries. However, it may be interesting to explore the capacity of firm growth depending on the firm's external activity and its impact on future firm size.

The literature indicates several reasons why firm size may be positively related to export activity. For example, Wagner (1995) noted that the most important economic factors that positively affect the relationship between firm size and exports are the existence of economies of scale in production, a fuller utilization of managers, the opportunity to raise finance at a lower cost, having a marketing and sales department, and a higher capacity for taking risks due to internal diversification.

The relationship between firm growth and the export-import relationship has not been explored so thoroughly. However, Pfaffermayr (2004), Voulgaris et al. (2003), Wagner (2001) and Bernard and Jensen (1999) recently analysed the impact of exports on firm growth and showed that

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there is a significant relationship between firm growth and export-import behaviour. It would seem to be interesting, therefore, to explore this activity and its relationship with the firm growth. Wagner (2001) found an inverse U-shaped relation between the number of employees and the export/sales ratio. However, he also found that the behaviour of individual sectors is also important for correctly determining this relationship.

However, the patterns of the different flows of international trade, i.e. exports, imports, both exports and imports, and neither exports nor imports, have not been analysed. The separate analysis of these different flows is essential for investigating the direction and intensity of their effect.

With this aim, we analysed the relationship between firm growth and firm size and the evolution of the firm size. Will firms grow more rapidly depending on their external activity? If so, will small firms behave differently?

To analyse different firm sizes in the long run, we have applied the following research methodology. First we estimated Gibrat's Law for manufacturing firms depending on external activity and firm size. Then we estimated the speed of convergence of firm size.

The various estimations depending on external activity have been classified as follows:

Classification by international trade relationships.	
Whole database	Firms regardless of their external activity.
Exports	Firms which only export.
Imports	Firms which only import.
Exports and Imports	Firms which import and export simultaneously.
No external activity	Firms which have no external activity.
Any external activity	Firms which have any external activity.

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We should point out that those firms classified as "Any external activity" include firms classified as "Exports", "Imports" and "Exports and Imports". This category therefore includes both directions of the relationship of international trade. We consider that firm size limits the capacity of the firm to export and import and therefore limits its future growth. Thus, firms are classified depending on whether they have more or fewer than 100 employees.

The distinction between size classifications is important. Since their growth is not so constrained by market size and they are able to exploit their economies of scale, there is evidence that large firms are more intensive in international trade (Machado and Mata, 2000; Calof, 1994).

Given these characteristics, we analysed firm growth behaviour depending on firm size and external activity. Equation 5.6 shows that firm size influences future firm growth conditioned to two firm characteristics: firm size and external activity:

$$\Delta \log\left(S_{i,t} \middle| S_{i,t-1}, External \quad activity \right) = \alpha + \beta \log\left(S_{i,t-1} \middle| External \quad activity \right) + \varepsilon_{i,t} \qquad (5.6)$$

Equation 5.6 shows that we obtain different estimated parameters depending on the firm's future evolution. This means that firms belonging to different size groups will present different estimated parameters.

Table 5.10 presents the results of Gibrat's Law obtained by analysing firm size and firm growth. We can see that there is a negative relationship for both variables, which is in agreement with our previous results. Before presenting the forecasted firm size, we will briefly mention the estimated coefficients of Gibrat's Law.

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Table 5.10. Determinants of firm growth for manufacturing firms (GLS random effects model) depending on external activity.

	Whole database	Exports	Imports	Exports and Imports	No external activity	Any external activity
WHOLE FIRMS						
S_{t-1}	-0.1863	-0.3849	-0.3533	-0.3054	-0.2675	-0.2426
	(0.0011)*	(0.0042)*	(0.0055)*	(0.0030)*	(0.0016)*	(0.0021)*
Constant	0.4781	1.0654	0.9429	1.0509	0.5765	0.7592
	(0.0028)*	(0.0134)*	(0.0162)*	(0.0108)*	(0.0035)*	(0.0068)*
R^2	0.4414	0.4982	0.4325	0.4713	0.4533	0.4511
Obs.	235056	25532	14770	41905	152849	82207
Firms	68281	6063	3508	9189	50700	18315
LESS THAN 100 WORKERS						
S_{t-1}	-0.2635	-0.4800	-0.3808	-0.3456	-0.2937	-0.3541
	(0.0013)*	(0.0045)*	(0.0056)*	(0.0035)*	(0.0016)*	(0.0024)*
Constant	0.6087	1.2480	0.9759	1.0403	0.6143	0.9825
	(0.0030)*	(0.0135)*	(0.0158)*	(0.0110)*	(0.0035)*	(0.0074)*
R^2	0.4520	0.5292	0.4479	0.4180	0.4605	0.4535
Obs.	224590	23900	14156	35239	151295	73295
Firms	66683	5798	3420	8073	50417	16918
MORE THAN 100 WORKERS						
S_{t-1}	-0.8560	-0.8141	-0.9048	-0.8343	-0.9122	-0.8367
	(0.0039)*	(0.0100)*	(0.0134)*	(0.0051)*	(0.0098)*	(0.0044)*
Constant	4.6445	4.4374	4.7054	4.5792	4.8143	4.5684
	(0.0232)*	(0.0573)*	(0.0802)*	(0.0304)*	(0.0540)*	(0.0257)*
R^2	0.8626	0.8612	0.9028	0.8532	0.8847	0.8568
Obs.	10318	1601	607	6592	1518	8800
Firms	2623	439	147	1498	539	2084

Standard deviations in brackets.
* Significant at 1%.

When we analysed the effect of firm size on firm growth in the database that includes all firms regardless of their size, we found no important differences between firms with external activity and those without. Specifically, firms without external activity converged at a speed of 0.2675, while firms with any type of external activity converged at a speed of 0.2426. However, when we analysed firms depending on their external activity, we found that firms exporting, firms importing and firms both exporting and importing converged considerably faster

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(between -0.3054 and -0.3849). These values are significantly higher than those of firms without any kind of external activity.

However, the capacity to converge of firms with less than 100 employees is more intense than for the whole database.

When we compared the relationship between firm size and firm growth for firms with more than 100 employees, we found that firms converged more quickly than previous size classifications[21]. Finally, we also found that the explained capacity of the model (ie. R^2 coefficient) is larger for firms with more than 100 workers than for firms with less than 100 workers.

To sum up, external capacity seems to have a heterogeneous influence depending on the firm size group considered. Our forecast will therefore show different patterns depending on the size of the firm.

5.5.2. The speed of convergence

The literature on firm growth has analysed the relationship between firm growth and firm size. However, the speed of convergence of firm sizes has not been analysed. Cefis et al. (2002) applied a Bayesian estimation to determine the speed of convergence. Their results show that larger firms tend to grow faster than smaller firms.

Starting from the model of Gibrat's Law, we analyse the speed of convergence using the following expression:

$$\Delta \ln(S_{i,t}) = \alpha + \beta \ln(S_{i,t-1}) + \varepsilon_{i,t}$$

[21] In fact they grow at double or three times more rapidly than the previous size classifications.

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Separating the increase of the logarithmic size and inserting beta in an exponential form, we obtain:

$$\ln(S_{i,t}) - \ln(S_{i,t-1}) = \alpha + \ln(S_{i,t-1})^{\beta} + \varepsilon_{i,t}$$

Transforming the difference of the logarithmic sizes as the logarithmic rate of sizes:

$$\ln\left(S_{i,t}/S_{i,t-1}\right) = \alpha + \ln(S_{i,t-1})^{\beta} + \varepsilon_{i,t}$$

Applying the antilogarithms and operating:

$$e^{\ln(S_{i,t}/S_{i,t-1})} = e^{\alpha + \ln(S_{i,t-1})^{\beta} + \varepsilon_{i,t}}$$

$$e^{\ln(S_{i,t}/S_{i,t-1})} = e^{\alpha} e^{\ln(S_{i,t-1})^{\beta}} e^{\varepsilon_{i,t}}$$

$$\frac{S_{i,t}}{S_{i,t-1}} = e^{\alpha} S^{\beta}_{i,t-1_{i,t-1}} e^{\varepsilon_{i,t}}$$

If $e^{\alpha} = A$ and $e^{\varepsilon it} = u_{it}$:[22]

$$\frac{S_{i,t}}{S_{i,t-1}} = A S^{\beta}_{i,t-1_{i,t-1}} u_{i,t}$$

Supposing that changes of firm size have an annual interval, the speed of convergence (δ) would be the following expression:

$\beta = -(1 - e^{-\delta})$ where δ is the speed of convergence.

[22] This is the same expression as that estimated by Ijiri and Simon (1977):

$$\frac{S_{it}}{S_{it-1}} = \alpha S^{\beta-1}_{it-1} e_{it}$$

where S_{it} is the revenue of firm "*i*" in period "*t*", α is a constant driving the growth equation, β is the speed of growth, and e_{it} is the error term.

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$$\delta = -\ln(1+\beta)$$

The speed of convergence (see Table 5.11) will therefore depend on the relationship between firm size and firm growth (β)

- In general the speed of growth is 0.09. However, firms with less than 100 workers grow at a speed of 0.13 and firms with more than 100 workers grow at a speed of 0.84.
- Large firms have a higher speed of convergence than small firms.

Table 5.11. Speed of convergence (delta)

	Whole database	Exports	Imports	Exports and Imports	No external activity	Any external activity
Whole	0.09	0.21	0.19	0.16	0.14	0.12
< 100 workers	0.13	0.28	0.21	0.18	0.15	0.19
> 100 workers	0.84	0.73	1.02	0.78	1.06	0.79

Source: author's own.

- Firms with no external activity tend to converge more slowly (at a speed of 0.14), while firms that export grow at a speed of 0.21.
- Small firms that export have a higher speed of convergence than large firm that export (0.28 and 0.73 respectively).

Machado and Mata (2000) showed that firm size increases with industry growth, patents, exports and economies of scale, and decreased with import intensity and turbulence in the industry. Although their results hold across the whole distribution, the effects of these variables are much greater in absolute value at the larger quantiles than at the smaller quantiles. Thus, they found that industrial attributes such as economies of scale or international trade are more important to the size of the largest firms in the industry than to the size of the smallest.

To sum up, there appear to be differences between firm growth rates, and, more importantly, the speed of convergence differs between groups

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of firms. This suggests that there is not a unique optimum firm size but a multiplicity of equilibria, since initial characteristics and their speed of convergence differ between firms.

The main conclusion is the presence of heterogeneous optimum firm sizes although with different equilibria. Finally, we should emphasize the presence of different impacts of export-import flows on firm size, which demonstrates the complex interactions between small and large firms and their capacity to participate in international trade.

Policy makers should consider these differences when planning their strategies to enhance both firm growth and firm convergence. It appears that subsidies to import-export may have different impacts on the firm growth evolution, with a possible negative impact on the labour market.

Finally, we should highlight some limitations. Firstly, this study ignores flows related to indirect international trade. For example, a firm might not export directly but supply products to a firm which exports. Secondly, we have only considered the evolution of surviving firms. This means that we analysed a cohort of firms that survived in 2002 but did not take into account the dynamics of the model, which, obviously, have an impact on the distribution of firm sizes in the market. Future research should therefore further examine the relationship between firm size and international trade.

5.6. SUMMARY AND CONCLUDING REMARKS

The aim of this study was to examine the relevance of stochastic firm growth theory for Spanish firms. Gibrat's Law states that firm growth is independent of its initial size. Our results reject Gibrat's Law as we find

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that there is a negative relationship between growth and firm size: smaller firms grow faster than larger ones.

Briefly, the main results for manufacturing and services are as follows:

a) Gibrat's Law is rejected in favour of higher growth for small firms. Consequently, there will be a trend of sizes to converge in the industry.
b) Other variables, such as belonging to a group of firms, being a Joint Stock Company or having external activity have a positive effect on firm growth.
c) Locational effects play an important role in explaining differences between firms in manufacturing and services.
d) Internal characteristics such as the international flows may determine the future optimum firm size.

These results contribute to international and Spanish literature in particular by focusing on firms in both the manufacturing and service sectors. Few previous studies have included the service sector (Audretsch et al., 2004). Our aim was to investigate the presence of different sector-specific equilibria in firm growth. In this sense, our results show that there is a significant difference in growth between manufacturing and service sector firms that persists when controlling for other firm-specific characteristics and time-invariant unobserved heterogeneity. However, we also found that the location of the firm plays an important role in explaining different patterns in firm growth between the two sectors.

Our results show how policy makers can affect firm growth. The aim of policy makers is to increase economic activity and employment in certain regions. Subsidies to firms can be a way to achieve this. However, policy makers must consider the efficiency of their programs. This study

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provides clues as to which characteristics indicate potential firm growth. However, they should also remember that such determinants are dynamic and that periodically we should re-analyse the impact of different variables on the firm growth process in order to be sure that the initial incentives and barriers to firm growth remain the same. Finally, we should mention that, as the data base we analysed does not consider small firms, further research is needed.

This study has also highlighted a number of promising lines for future research. Examples are analyses of the persistence of firm growth differences and of the regional characteristics that cause differences in locational externalities. Further research may also explore the differences in firm growth between industries and across regions in greater detail. Here we have been interested in the presence of different equilibria for firms in manufacturing and services, but the picture could be made more complete by analysing other industries. Other studies could focus on the differences in growth patterns by age and initial firm size using different measures of geographical location.