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Mercedes Teruel Carrizosa
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CHAPTER 4

THE PERSISTENCE OF FIRM GROWTH

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CHAPTER 4

THE PERSISTENCE OF FIRM GROWTH

"*Success breeds success and failure breeds failure*".
Ginsberg and Baum (1994)

4.1. INTRODUCTION

Our experience shows that every day firms with different trajectories coexist in the market. While some firms seem to have been born under a lucky star, others are doomed to failure from their first day. This diversity of trajectories increase competition and makes the market efficient.

Economic literature has analysed the relationship between firm size and firm growth in depth. However, as the analyses of firm growth and size have had a static perspective, dynamic questions may remain unanswered. For example, are firms that grew in the past still growing? Or is there no pattern that relates past growth to future growth? Do different patterns appear when we analyse different industries? The starting point for analysing persistence is Chesher's (1979) model, which is based on Gibrat's (1931) Law. The main aim of this chapter is to analyse the persistence of firm growth by assuming that there is a relationship between past and future growth patterns.

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The focus on the persistence of firm growth is due to the impact on the labour market. Not only is it crucial to know whether small firms create more employment. It is also important to determine whether firms that grew in the past are more likely to grow in the future.

Obviously, the analysis of persistence is extremely important for policy makers. Wagner (1992) states that knowing the existence of persistence on firm growth is necessary for applying correct policies. For example, in times of recession unemployment increases. To maintain macroeconomic stability as much as possible, governments will propose expansive policies, such as subsidies to firms. However, it is important to know which firms will grow faster and help to end the recession.

Managers are also interested in the characteristics of firms in order to increase their growth rates. A firm's resources are limited, so when a firm decides to invest it usually has several alternatives. If, for example, a firm has two projects in two alternative plants, the firm's managers need to consider the persistence of firm growth in order to make full use of internal economies.

It is therefore crucial to analyse which factors determine a higher propensity to grow in order to ascertain whether past growth rates or age affect persistence. The main aim is for policy makers and managers to have some idea about whether it is worth investing in the firm.

Several Spanish contributions have anlaysed this field (Suárez, 1977; Pisón, 1983; Correa, 1999). All these studies have limited their scope to one Spanish region or to a small sample. Suárez (1977), for example, analysed a sample of 46 surviving Spanish firms between 1962 and 1972. Pisón (1983) analysed the presence of a serial correlation between past and future growth rates of 18 surviving firms in Galicia. There have been

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other studies of Spanish firm growth (Fariñas and Moreno, 2000; Peña, 2004; Calvo, 2006) but these have not analysed the relationship between past and future growth. Our aim, therefore, is to fill this gap in the recent literature.

This chapter has three main objectives. First we analyse a larger sample of firms located in Spain and identify their characteristics in the medium term. The *Sistema de Análisis de Balances Ibéricos* presents individual information about Spanish firms. It contains a large number of variables and covers the whole country.

In the last ten years much effort has been made in both the private and public sectors to provide better data bases. Our data base therefore includes both the manufacturing and service sectors. As few contributions in the international empirical literature have analysed the service sector (Audretsch et al., 2004), our second objective is to include this sector in our analysis.

Finally, a firm's recent evolution can condition its future trajectory. In other words, although we are interested in analysing the relationship between past growth and future growth, we may also be interested in the differences between firms that grew continuously in the past and those that behaved differently. In our third objective, therefore, we analyse the impact of different trajectories on persistence.

Our first result is that the relationship between past and future growth rates is positive, which is in agreement with recent studies by Oliveira and Fortunato (2005). Second, there appear to be clear differences between the manufacturing and the service sectors. Third, a firm's history is important for ascertaining its future; in other words, firms that were successful in the past will experience higher growth rates.

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This chapter is organised as follows. In section 4.2 we summarize the empirical literature on the persistence of firm growth. In section 4.3 we describe Chesher's theoretical model. In section 4.4 we present the data base and data description. In section 4.5 we describe how we estimated the persistence of firm growth and show our results for the Spanish manufacturing industry. Finally, in section 4.6 we report our main conclusions.

4.2. EMPIRICAL EVIDENCE

Gibrat's Law has been widely studied. One limitation of most studies is that they only consider the relation between firm growth and the initial firm size, thus ignoring any effect past growth might have on future growth (Oliveira and Fortunato, 2005).

The first empirical analysis of firm growth persistence was studied by Singh and Whittington (1975). These authors reported that the degree of persistence is likely to be greater over shorter periods of time and may disappear after more than 6 years. Chesher (1979) developed the analytical expression of persistence of firm growth. The persistence of firm growth is related to the temporal interrelationship between firm growth rates.

Why, though, does persistence occur? Ijiri and Simon (1977) pointed out that "*in studying business firm growth, we often encounter cases where a firm suddenly acquires an impetus for growth. Perhaps by innovating in production or marketing processes, or perhaps as an effect of new management staffs or techniques, the firm grows much more rapidly*

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than the other firms in the industry"[1]. Moreover, the evolutionary approach suggests that the growth of successful firms should persist over time, so there should be a positive serial correlation of growth between consecutive periods. Finally, older firms should have a faster average growth than younger companies (Hart, 2000).

Formally, Gibrat's Law can be derived from Chesher's model. The basic difference between these models is the static-dynamic dimension. In Gibrat's model, firm growth rate depends on a static variable such as size, while in Cheshers' model it depends on past rates. Chesher's model, therefore, emphasises the dynamic perspective in order to explain the firm growth process.

The empirical literature on the persistence of firm growth covers a wide range of regions, industries and periods (see Annex III for a review of the literature). It is therefore difficult to compare our results with those of other studies. In this section we will present our main results and make a special reference to other Spanish contributions.

The international literature contains conflicting results. Some empirical evidence e.g. the studies by Singh and Whittington (1975), Kumar (1985), Contini and Revelli (1989) and Wagner (1992, 1994), has confirmed the presence of growth persistence i.e. firms that grew in the past will also grow in the future.

Other authors, however, e.g. Dunne and Hughes (1994), Almus and Nerlinger (2000) and Vennet (2001), observed a non-significant

[1] Ijiri and Simon (1977) stated that a firm that grows more than the average "is likely to grow more rapidly than the average again this year as a result of the carry-over effects of an innovation that occurred in a previous year on operations in subsequent periods".

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relationship between growths in different periods, which means that firm growths are not serially correlated.

Authors who have analysed growth persistence have usually introduced several explanatory variables. Wagner (1994)[2], for example, showed that macroeconomic conditions during entry do not influence future evolution and that industrial characteristics are not terribly important. The results of that study do not show any evidence of growth persistence.

Vennet (2001) introduced variables such as macroeconomic growth, bank operational efficiency, the quality of credit and capitalization, and observed that between 1985 and 1989 there was a convergence of the bank size, but that between 1990 and 1994 there was a proportional growth of all banks.

The main contribution of growth persistence models is the introduction of dynamic firm evolution. In other words, if we want to know how a firm will grow in the future, we must observe both its current growth and its past growth.

One of the main problems in the literature is the fact that there are no studies of differences between industries. In fact, the service sector has largely been ignored, because of either lack of data or lack of interest. Recent authors such as Piergiovanni et al. (2002), Audretsch et al. (2004) and Oliveira and Fortunato (2005) have tried to fill this gap in the literature. Specifically, Piergiovanni et al. (2002) also analysed the persistence of firm growth. Their main contribution is an analysis of Italian services and a comparison of manufacturing and service sectors.

[2] This author remembers the *Brown-Hamilton-Medoff Warning*: "*Do not judge firms by their size alone*!".

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Audretsch et al. (2004) analysed Dutch service industries[3] using two approaches: Gibrat's Law (from a static perspective) and the persistence of firm growth (from a dynamic perspective). Their results show that there is heterogeneity of results between service subsectors and, more importantly, that "*industry dynamics in small scale services might not simply mirror that in manufacturing, with Gibrat's Law more likely to be confirmed in the former than in the latter*". The reason for this statement is that "*the structure of these services may be inherently different from manufacturing*". In this sense, "*new entrants are typically under pressure to grow to avoid being confronted by a greater likelihood of failure in manufacturing, but the absence of growth in the services does not apparently threaten the viability of the firm*".

More recently, Oliveira and Fortunato (2005) analysed the persistence of firm growth among Portuguese service and manufacturing industries. Their results show that the effect of innovation on firm growth is positive, the effect of past size on firm growth is negative and the effect of past growth rates is positive. This means that successful firms will exhibit higher growth rates in the future than those firms which did not exhibit positive growth rates.

Several contributions have provided Spanish evidence with regard to the growth of manufacturing firms (Peña, 2004; Fariñas and Moreno, 2000; Correa, 1999; and Pisón, 1983). As far as I am aware, there is only one study of persistence (Suárez Suárez, 1976). Also, there is a lack of studies related to the service industries[4].

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[3] Audretsch et al. (2004) analysed small scale services such as restaurants, cafeterias, cafes, hotels and camp sites.

[4] There are some exceptions such as Villacorta and Ballina (2002) who analysed the Spanish hotel firm growth but not persistence.

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4.3. CHESHER'S MODEL

The persistence of firm growth has been widely analysed in the empirical literature. However, there is a lack of knowledge in the Spanish framework, especially with regard to the service industries.

In this section we present Chesher's (1979) formulation and its relationship with Gibrat's Law. We also present the hypothesis used to estimate Gibrat's Law and the persistence of firm growth.

Gibrat's Law shows that the relationship between firm size and firm growth is lognormal. It postulates that the proportionate growth of surviving firms is random and hence independent of previous success or failure. However, it seems reasonable that a firm's past evolution exerts some kind of impact on its future evolution.

To deal with this issue, the literature has evolved from the initial Law of Proportionate Effects, or Gibrat's Law, and focused on the persistence of firm growth. The main idea thus addressed is that future firm growth may be influenced more by past growth rates than by past firm size. This approach highlights past behaviour as another factor in addition to initial firm size.

Singh and Whittington (1975) began their analysis of growth persistence by introducing past growth into the initial Gibrat's Law. Their results showed that firm size had less impact than past growth. However, the analytical description of growth persistence was developed by Chesher's seminal work in 1979. Chesher suggested that Gibrat's Law may not be accomplished if there is a serial correlation between error terms and introduced another equation in which the error term was serially correlated. The following equations determine this relationship:

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$$y_{i,t} = \beta \quad y_{i,t-1} + u_{i,t}$$
$$u_{i,t} = \gamma \quad u_{i,t-1} + \eta_{i,t} \tag{4.1}$$

where y_i is the size of firm "*i*", β is the impact of firm size "*i*" in the period "*t-1*" and is the parameter to be estimated, $\eta_{i,t}$ is a white noise, γ has a value of between 0 and 1 and belongs to the transmission of luck or success from "*t-1*" to the following period, and $u_{i,t-1}$ is an error term. When γ is closer to 1, the reiteration of past situations is more important. If we substitute the last two equations until the initial period, we obtain the following equation:

$$y_{i,t} = \beta^t y_{i,0} + \gamma \sum_{\tau=1}^{t} \beta^{t-\tau} u_{i,\tau-1} + \sum_{\tau=1}^{t} \beta^{t-\tau} \eta_{i,\tau} \tag{4.2}$$

Equation 4.2 is still lognormal because u and η are normal. Therefore, for any β, the higher γ is, the faster size inequalities will increase. However, when β is less than 1 no result is predominant to any γ so we cannot know in advance the effect on size inequalities. Consequently, Gibrat's Law is valid if the estimation of equation 4.2 has a value of 1 for $\hat{\beta}$. This means that the growth of firms is not determined by size. If $\hat{\beta}$ is smaller (larger) than 1, then small (large) firms have a higher growth potential, which indicates a correlation between growth and size. However, β will be consistently estimated if the error terms $u_{i,t}$ are distributed independently over time (Chesher, 1979).

Chesher's main conclusion is that a serial correlation between error terms in the equation produces a dependence between the past size ($y_{i,t-1}$) and the error terms ($u_{i,t}$). The main consequence is that if the disturbances ($u_{i,t}$) are serially correlated, the firm growth rate in one

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period depends on the growth rate in the preceding period. Consequently, Gibrat's Law may be rejected even when the parameter β is around 1. Since Chesher's (1979) contribution, growth persistence has been studied in greater depth.

Growth persistence in one period with respect to another may produce serial correlation. Moreover, this serial correlation produces inconsistent estimators with ordinary least squares. The previous results, for example, would be biased downward, so small firms would grow at a higher rate (Dunne and Hughes, 1994).

In general, the Chesher's model determines the relationship between a firm's current growth and its past growth. If we insert equations 4.1 and express firm size in logarithms, we obtain the following expression:

$$z_{i,t} = \beta \quad z_{i,t-1} + u_{i,t}$$

$$u_{i,t} = \gamma \quad u_{i,t-1} + \eta_{i,t}$$

where $z_{i,t}$ is the logarithm of firm growth belonging to firm "*i*" between "*t*" and "*t-1*", and $z_{i,t-1}$ and $z_{i,t-2}$ would be equivalent to the two previous periods ("*t-1*" and "*t-2*", and "*t-2*" and "*t-3*").

$$z_{i,t} = \beta \quad z_{i,t-1} + \quad \gamma \quad u_{i,t-1} + \eta_{i,t} \qquad (4.3)$$

If:

$$z_{i,t} = \beta \quad z_{i,t-1} + u_{i,t}$$

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by isolating the error term $u_{i,t}$:

$$u_i(t) = z_i(t) - \beta \ z_i(t-1) \tag{4.4}$$

and substituting 4.4 in 4.3 we obtain:

$$z_{i,t} = \beta \ z_{i,t-1} + \gamma \left(z_{i,t-1} - \beta \ z_{i,t-2} \right) + \eta_{i,t}$$

Finally;

$$z_{i,t} = \gamma_1 z_{i,t-1} + \gamma_2 z_{i,t-2} + \eta_{i,t} \tag{4.5}$$

where,

$$\begin{aligned} \gamma_1 &= \beta + \gamma \\ \gamma_2 &= -\beta * \gamma \end{aligned} \tag{4.6}$$

The resulting quadratic equation from 4.6 has the following solutions (Almus and Nerlinger, 2000):

$$\left(\hat{\beta}, \hat{\rho}\right) = \frac{1}{2} \left\{ \hat{\gamma}_1 \pm \left(\hat{\gamma}_1^2 + 4\hat{\gamma}_2 \right)^{1/2} \right\}$$

Using the estimated parameters, the validity of Gibrat's Law can then be tested with the data. We found a relationship between Chesher's equation and Gibrat's Law in the coefficients $z_{i,t-1}$ and $z_{i,t-2}$ of equation 4.5. Specifically, Gibrat's Law postulates that β has a value of 1 and γ has a value of 0. This means:

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$\hat{\beta} = 1,$ *i.e. firm growth is independent of size and if*

$\hat{\rho} = 0,$ *ie. the error terms do not follow a first-order autoregressive process*

Consequently, the null hypothesis when testing the presence of Gibrat's Law is as follows:

$$H_0 : \begin{pmatrix} \hat{\gamma}_1 & \hat{\gamma}_2 \end{pmatrix} = \begin{pmatrix} 1 & 0 \end{pmatrix}$$
$$H_1 : \begin{pmatrix} \hat{\gamma}_1 & \hat{\gamma}_2 \end{pmatrix} \neq \begin{pmatrix} 1 & 0 \end{pmatrix}$$

The main objectives are to determine (i) whether firm growth persistence exists; (ii) if it does, whether it is positive or negative; and (iii) what the implications for Gibrat's Law are.

4.4. DATA DESCRIPTION

Having presented the theoretical model, in this section we will briefly present our database, describe the method we used to select our sample of Spanish firms between 1994 and 2002, and highlight the differences between the manufacturing and service industries.

4.4.1. The data base

The data source we used in this study is the SABI data base, which compiles information from the Mercantile Registry and provides individual information about Spanish firms in various sectors. Spanish companies with an annual turnover of over 6 million euros are obliged to present their annual accounts to the Mercantile Registry. Our date base

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therefore contains practically every Spanish firm. The data base provides annual observations from 1994 to 2002. Although this means that we will have biased data up towards, 95% of Spanish firms are represented in this database.

Data pre-treatment was as follows. First we incorporated all the firms in the manufacturing and service industries that were still active in 2003. We used data on the two-digit level industries. This database groups firms in accordance with the CNAE-93 (*National Classification of Economic Activities*) with two digits. The codes for manufacturing industries range from 15 to 36 and the codes for service industries range from 50 to 74. In some of these sectors the number of firms is negligible because of the high barriers to entry (e.g. sector 16 (tobacco) and sector 23 (petroleum)). We have therefore excluded them in order to avoid biased results. Also, to avoid long tables of different industries, we have classified the industries in accordance with the NACE-CLIO (R-25) classification[5].

Note that, to avoid bias caused by firms that failed during the studied period, our data base only includes surviving firms. We therefore include firms created before 1999[6], regardless of whether they were created before or after 1994 (our first year of observation). Our data are therefore organised in an unbalanced panel.

Some of the observations have been omitted, mainly because of lack of information on some of the chosen variables. For example, as a considerable number of firms in the database provide no information about the number of employees or the year they were set up, we were

[5] To observe the equivalences between the two classifications, see Annex I.
[6] Obviously we need at least four observations of a firm to estimate three growth rates over three years (we must estimate z_{it}, z_{it-1} and z_{it-2}).

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forced to leave them out of our analysis. Other observations have also been left out because of their extraordinary growth performance.

In short, the number of surviving firms observed between 1994 and 2002 is 42,280 (27,038 firms in the manufacturing sector and 15,242 firms in the service sector). As we analyse firm growth rates over two years, we will have eight observations for each firm.

4.4.2. Data description

In this subsection, we focus on the relationship between the different firm growth rates. Specifically, we will show the evolution of the number of employees in each firm during the period of analysis (1994-2002) and the growth rate between "t" and "t-1" (gworkers), the growth rate between "t-1" and "t-2" (L1gworkers) and "t-2" and "t-3" (L2gworkers). Obviously, this process of creating panel data with different lags will lose some of the firms we had previously selected. That means that while our original database included firms with at least two observations, we now need information from at least four periods of time.

Variable	Description
Workers	Number of employees
Growth	Difference in the logarithmic number of employees between two consecutive periods
Growth t-1	Lagged value of the difference in the logarithmic number of employees between two consecutive periods.
Growth t-2	Two lagged periods of the value of the difference in the logarithmic number of employees between two consecutive periods.

Table 4.1 shows the averages and standard deviations for the whole database, the manufacturing sector and the services sector. The mean

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average number of employees for the whole database is 27. The difference between manufacturing and services is just five employees (the average number of employees in the manufacturing and service industries is 30 and 25, respectively).

Table 4.1. Average and standard deviation

		Whole database	Manufacturing	Services
Workers	*Mean*	27.26	29.86	25.34
	Std. Dev.	305.42	219.36	390.00
Growth	*Mean*	0.0616	0.0604	0.0628
	Std. Dev.	0.4498	0.4501	0.4536
Growth t-1	*Mean*	0.0755	0.0703	0.0838
	Std. Dev.	0.4457	0.4499	0.4440
Growth t-2	*Mean*	0.0851	0.0780	0.100
	Std. Dev.	0.4522	0.4600	0.4427

Source: author's own from SABI database.

The main difference, however, is in the standard deviation. Obviously, the heterogeneity of service industries is higher than that of manufacturing indistries. For example, though it is difficult to find a manufacturing firm with just one employee, microfirms are common in the service industries. Conversely, some service industries are characterised by the presence of monopolies or oligopolies, with huge firms sharing the market. Examples of such industries are the financial market and former public monopolies such as the phone service and the energy industry. This heterogeneity is reflected in the higher standard deviation for the service industry.

We observed that the average firm growth rates have been decreasing in the last few years. This means that, in general, firms grew in the past more than they have done in recent years. This pattern is more clearly observed in service industries, where the difference between the averages

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is larger than in manufacturing. The literature has highlighted the differences in sunk costs. This greater variability in the evolution of service firms may be a reflection of a firm's ability to make and un-make an investment.

Table 4.2. Correlation between different growth rates.

	Whole database		
	Growth	*Growth t-1*	*Growth t-2*
Growth	1.0000		
Growth t-1	-0.2458	1.0000	
Growth t-2	-0.0064	-0.2217	1.0000
	Manufacturing		
	Growth	*Growth t-1*	*Growth t-2*
Growth	1.0000		
Growth t-1	-0.2883	1.0000	
Growth t-2	-0.0062	-0.2707	1.0000
	Services		
	Growth	*Growth t-1*	*Growth t-2*
Growth	1.0000		
Growth t-1	-0.1718	1.0000	
Growth t-2	-0.0056	-0.1211	1.0000

Source: author's own from SABI database.

Table 4.2 shows the correlation between growth rates for three different periods. Firstly, we can see that there is a negative relationship between the growth rate of one period and the growth rate of the previous one. However, as it is close to 0, this relationship is not a strong one. Secondly, the relationship is weaker among service industries, so service industries do not present a clear structure of dependence between sectors.

4.5. METHODOLOGY AND ESTIMATIONS

In this section we present the econometric methodology for estimating the persistence of firm growth. We then show the results obtained for

Spanish firms between 1994 and 2002 and, finally, present several extensions to the initial model, such as the learning process, the consideration of individual industries and past firm behaviour.

4.5.1. Econometric methodology

The methods used to estimate the persistence of firm growth have evolved over time. Initially, authors such as González and Correa (1998), Dunne and Hughes (1994), Kumar (1985) and Singh and Whittington (1975) applied Ordinary Least Squares (OLS). However, in the presence of dynamic models, the pooled OLS estimator is inconsistent and biased upwards. Recent studies, such as Vennet (2001), have introduced panel data estimations with Generalised Least Squares estimations.

Recent advances in methods for testing panel data have created opportunities for incorporating short panel data into empirical tests of the Law of Proportional Effects. Specifically, to estimate these dynamic regression models using panels containing a large number of firms and a low number of time periods, we used a Generalised Method of Moments (GMM)[7] estimator developed by Arellano and Bover (1990, 1991). GMM is based on analysing the distribution of the diverse moments that characterise a variable. Thus, taking advantage of the characteristics of the moments of a variable, GMM estimates the first moment characteristics of the moment.

[7] Arellano and Bond (1991) derived a Generalized Method of Moments estimator using lagged levels of the dependent variables, the predetermined variables and differences in the strictly exogenous variables. Our estimator is known as the ″Arellano–Bond″ dynamic panel data estimator. This method assumes that there is no autocorrelation in the temporal random errors.

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This estimator controls for the presence of unobserved firm-specific effects and for the endogeneity of the current-dated explanatory variables. GMM has made it possible to analyse short panel data, which are characteristic of microeconomics panel. Del Monte and Papagni (2003) and Oliveira and Fortunato (2005), for example, used GMM to estimate the persistence of firm growth.

The following equation is our starting point since it considers the relationship between the past and initial firm growth rates using the GMM estimator:

$$z_{i,t} = \gamma_1 z_{i,t-1} + \gamma_2 z_{i,t-2} + \beta_i X + \eta_{i,t} \quad (4.7)$$

where $z_{i,t}$ represents the firm growth of firm "i" between period "t" and period "t-1", measured as the difference in the logarithmic number of employees, $z_{i,t-1}$ and $z_{i,t-2}$ would be identically defined, γ_1 and γ_2 are the parameters we are interested in estimating by measuring the impact of past firm growth ($z_{i,t-1}$ and $z_{i,t-2}$), X is a vector of exogenous variables, β_i *are* the parameters that indicate the impact of those exogenous variables on firm growth and $\eta_{i,t}$ is a disturbance that measures the impact of past firm growth on future performance. Also,

$$\gamma_1 = \beta + \gamma$$
$$\gamma_2 = -\beta * \gamma$$

where β is the impact of the firm size "*i*" from period "*t-1*" to the period "*t*" and γ is the parameter that determines the transmission of luck or success between one period and the previous one.

This study analyses the persistence of firm growth based on Oliveira and Fortunato (2005). The hypotheses to examine relate to the relationship between past growth rates and current growth rates, individual sectors

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and age. Our data base provides individual information at the business level for 179,318 observations from 59,459 Spanish firms belonging to the manufacturing and service industries.

4.5.2. Estimation of Chesher's equation

The persistence of firm growth refers to the relationship between intertemporal firm growths. Most empirical evidence shows that there is no persistence of growth (Acs and Audretsch, 1990; Dunne and Hughes, 1994). Chesher (1979), Kumar (1985); Wagner (1992) and Tschoegl (1996) also found no positive relation. Oliveira and Fortunato (2005) observed a positive growth persistence, while a smaller number of researchers have found evidence of a negative growth persistence (Contini and Revelli, 1989; Almus and Nerlinger, 2000; Goddard et al. 2002).

Positive growth persistence means that firms that grew in the past are more likely to grow in the future. This seems to be a sensible statement: firms that grew in the past usually continue to grow in the future since determinants that cause a higher growth do not usually disappear in the short term. The limit to this process of positive growth rates is the equilibrium firm size. Conversely, firms with a negative behaviour in the past often tend to decrease in size. These firms will decrease in size until they adjust or fail.

Consequently, our first estimation is:

$$z_{i,t} = \gamma_1 z_{i,t-1} + \gamma_2 z_{i,t-2} + \beta_1 \log(S_{i,t-1}) + \eta_{i,t} \qquad \text{(Estimation 4.1)}$$

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where $z_{i,t}$ represents the growth of firm "i" between period "t" and "t-1" measured as the difference in the logarithmic number of employees, $z_{i,t-1}$ and $z_{i,t-2}$ would be identically defined, γ_1 and γ_2 are the parameters we are interested in estimating by measuring the impact of past firm growth ($z_{i,t-1}$ and $z_{i,t-2}$), $log(S_{i,t-1})$ is the logarithmic firm size in the previous period, β1 is the parameter that measures the impact of the previous size on the current firm growth rate, and $\eta_{i,t}$ is a disturbance that measures the impact of past firm growth on future performance.

Table 4.3 presents the results of Estimation 4.1. We first estimated this equation for the whole pool of firms regardless of which sector each firm belongs to. We then estimated manufacturing firms separately from the service sectors and finally estimated the service sectors.

Table 4.3. The persistence of firm growth estimated with Generalized Method of Moments.

	Whole database	Manufacturing	Services
Growth t-1	0.0695 (0.0029)*	0.0851 (0.0033)*	0.0372 (0.0057)*
Growth t-2	0.0145 (0.0019)*	0.0232 (0.0021)*	-0.0034 (0.0040)
S_{t-1}	-1.2473 (0.0039)*	-1.2630 (0.0046)*	-1.2156 (0.0072)*
Coefficient	0.0357 (0.0006)*	0.0350 (0.0007)*	0.0372 (0.0013)*
Chi2	201041.30 (0.000)	150649.64 (0.000)	55264.57 (0.000)
Sargan Test	292.76 (0.000)	412.09 (0.000)	82.97 (0. 000)
Arellano-Bond test order 2	2.00 (0.0451)	1.45 (0.1470)	1.06 (0.2913)
Observations	119859	81147	38712
Firms	42280	27038	15242

Standard deviation in brackets. Sargan is a test of the overidentifying restrictions. Arellano-Bond test order 1 and test order 2 are tests for first-order and second–order serial correlation in the first differenced residual, asymptotically distributed as N(0, 1) under the nullity of no serial correlation. The p-value of Sargan's test for overidentifying restrictions and m2 test are reported in square brackets.
** significant at 1%, ** significant at 5% and *** significant at 10%.*

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With regard to past growth rates, there appears to be a positive relationship between past and current firm growth behaviour. In other words, firms that experienced a positive growth in the previous period will experience a positive impact on its current growth. However, this effect diminishes when we analyse firm growth from the two previous periods.

Persistence seems to have more effect among manufacturing industries than among service industries. For example, the value of previous growth (*Growth t-1*) is 0.0851 in manufacturing and 0.0372 in the service sector. There is therefore consistent evidence of positive serial correlation: in other words, firms with above average growth in one period will experience above average growth in the next. These results are consistent with those of Oliveira and Fortunato (2005) but they are not conclusive. Acs and Audretsch (1990) and Dunne and Hughes (1994) found no evidence of persistence. Some authors (e.g. Chesher, 1979; Kumar, 1985; Wagner, 1992; Tschoegl, 1996) found no evidence of positive persistence, while others (Contini and Revelli, 1989; Almus and Nerlinger, 2000; Goddard et al. 2002) found evidence of negative persistence.

As we showed in the previous chapter, Gibrat's Law is not satisfied since the coefficient of the lagged value of the logarithmic size is negative. Small firms therefore tend to grow more rapidly than large firms. Moreover, the values for the manufacturing and service industries are quite similar.

However, to ascertain whether Gibrat's Law is in operation, both β and ρ must be rejected. According to the Wald joint significance test, the null

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hypothesis regarding the nullity of coefficient is rejected at the 1% level of significance, so Gibrat's Law does not hold.

Finally, the Arellano-Bond test of second-order serial correlation of residuals shows the consistency of the GMM estimator. The null hypothesis in this test determines the presence of serial correlation among residuals. Our results show that this test rejects the null hypothesis, so there is an absence of serial correlation. However, when the whole database is analysed (manufacturing and service industries), the test accepts the null hypothesis. Separating the two industries leads to acceptance of the test, so the results obtained with separate industries are more consistent.

4.5.3. The learning process in the persistence of firm growth

According to the learning models, experience in the market is crucial to later performance since it provides information about a firm's efficiency. Estimation 4.2 therefore introduces variables related to the age of the firm. Here, age is the number of years between the year of creation and the current year.

$$z_{i,t} = \gamma_1 z_{i,t-1} + \gamma_2 z_{i,t-2} + \beta_1 \log(S_{i,t-1}) + \beta_2 \log\left(Age_{i,t-1}\right) + \beta_3 \log(Age^2) + \eta_{i,t}$$

(Estimation 4.2)

where $z_{i,t}$ represents the growth of firm "i" between period "t" and period "t-1", measured as the difference in the logarithmic number of employees, $z_{i,t-1}$ and $z_{i,t-2}$ would be identically defined, γ_1 and γ_2 are the parameters we are interested in estimating by measuring the impact of past firm growth ($z_{i,t-1}$ and $z_{i,t-2}$), $log(S_{i,t-1})$ is the logarithmic firm size in the

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previous period, β_1 is the parameter that measures the impact of previous size on the current firm growth rate, $log(A_{i,t-1})$ and $log(A^2_{i,t-1})$ are the logarithm of firm age and its quadratic value, β_2 and β_3 are the parameters that measure the impact of experience on current firm growth and $\eta_{i,t}$ is a disturbance that measures the impact of past firm growth on future performance.

Table 4.4 shows the results of Estimation 4.2. First, there is a high increase in the impact of the previous growth (*Growth t-1*) of service industries (from 0.0372 to 0.0503). However, the value for *Growth t-2* is non-significant for the service industries.

Table 4.4. The persistence of firm growth and the learning process estimated with Generalized Method of Moments.

	Whole database	Manufacturing	Services
Growth t-1	0.0765 (0.0029)*	0.0894 (0.0034)*	0.0503 (0.0058)*
Growth t-2	0.0194 (0.0019)*	0.0265 (0.0022)*	0.0048 (0.0041)
S_{t-1}	-1.2553 (0.0040)*	-1.2674 (0.0046)*	-1.2320 (0.0073)*
Age	0.0534 (0.0010)*	-	0.0636 (0.0022)*
Age2	-0.0006 (0.00003)*	-0.0004 (0.00003)*	-0.0010 (0.0001)*
Coefficient	-	0.0486 (0.0012)*	-
Chi2	203659.06 (0.000)	150863.45 (0.000)	55997.69 (0.000)
Sargan Test	363.10 (0.0000)	497.86 (0.0000)	85.97 (0.0000)
Arellano-Bond test order 2	2.26 (0.0240)	1.57 (0.1173)	1.36 (0.1751)
Observations	119859	81147	38712
Firms	42280	27038	15242

Standard deviation in brackets. Sargan is a test of the overidentifying restrictions. Arellano-Bond test order 1 and test order 2 are tests for first-order and second–order serial correlation in the first differenced residual, asymptotically distributed as N(0, 1) under the nullity of no serial correlation. The p-value of Sargan's test for overidentifying restrictions and m2 test are reported in square brackets.
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Therefore, growth persistence dissolves over time. The first lagged growth rate has an impact on firm growth but the effect of growth rate is smaller when growth from two previous periods is analysed.

Moreover, this effect is the same for both types of industry. This means that the variables have similar coefficients, though the coefficients of the service industries are smaller (especially the effect of the growth rate from two previous periods).

The learning process appears to have a double effect. On the one hand, there is a learning process for young firms (there is a positive coefficient for the variable *Age*). On the other hand, there is also an unlearning process since the quadratic age has a negative impact on firm growth. In other words, older firms have a negative effect on the firm growth rate. However, the combined effect of the two variables is positive since the learning process is greater than the unlearning process.

4.5.4. The evolution of industries

The individual characteristics of an industry can create specific dynamics on firm growth. In this section we will analyse the evolution of growth persistence for individual sectors in the manufacturing and service sectors. The results of Estimation 4.1 for each sector are shown in Table 4.5 (for manufacturing) and in Table 4.6 (for services).

In the manufacturing sector, our results show that:

- *Rubber and plastic goods* (0.1411), *Textile and leather clothes* (0.1134) and *Furniture* (0.1013) have the higher positive impact. In other words, firms in these industries grow more than the average thanks to the transmission of luck from the first period.

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Table 4.5. The persistence of firm growth in manufacturing industries estimated with GMM.

	Coefficients				*Tests*			*Observations*	
	Growth t-1	*Growth t-2*	Size	constant	Wald test	Sargan test	Test order 2	Obs.	Firms
Food and beverages	0.0535 (0.0063)*	0.0193 (0.0036)*	-1.1321 (0.0095)*	0.0329 (0.0020)*	41705.63 (0.000)	269.20 (0.0000)	3.75 (0.0000)	9449	3426
Textile and leather clothes	0.1134 (0.0099)*	0.0501 (0.0067)*	-1.3178 (0.0130)*	0.0156 (0.0019)*	17965.67 (0.000)	45.40 (0.0148)	-0.06 (0.9511)	11704	3773
Wood and cork	0.0748 (0.0191)*	0.0201 (0.0131)	-1.2643 (0.0257)*	0.0164 (0.0036)*	4847.54 (0.000)	101.08 (0.0000)	-0.91 (0.3627)	3338	1248
Paper products and media	0.0487 (0.0106)*	-0.0064 (0.0076)	-1.2828 (0.0137)*	0.0294 (0.0017)*	16700.03 (0.000)	39.76 (0.0539)	-1.03 (0.3031)	10664	3402
Chemical manufactures	0.0389 (0.0165)**	0.0080 (0.0112)	-1.1984 (0.0206)*	0.0381 (0.0028)*	5679.82 (0.000)	46.35 (0.0117)	1.21 (0.2258)	3735	1111
Rubber and plastic goods	0.1411 (0.0155)*	0.0215 (0.0105)**	-1.4171 (0.0209)*	0.0524 (0.0029)*	8135.24 (0.000)	67.21 (0.0000)	-3.50 (0.0005)	4395	1390
Other non-metallic prod.	0.0536 (0.0130)*	-0.0114 (0.0095)	-1.2722 (0.0183)*	0.0438 (0.0024)*	8072.72 (0.000)	35.77 (0.1204)	1.02 (0.3091)	5225	1733
Metal products	0.0911 (0.0084)*	0.0136 (0.0059)**	-1.3553 (0.0114)*	0.0484 (0.0016)*	25643.31 (0.000)	125.84 (0.0000)	-0.05 (0.9578)	16419	5563
Machinery and equipment	0.0308 (0.0130)**	-0.0052 (0.0089)	-1.2336 (0.0174)*	0.0425 (0.0023)*	8982.45 (0.000)	69.55 (0.0000)	0.09 (0.9321)	5659	1781
Electric and optic devices	-0.0064 (0.0171)	-0.0188 (0.0117)	-1.1305 (0.0214)*	0.0421 (0.0032)*	5025.25 (0.000)	23.19 (0.6746)	-0.05 (0.9596)	3609	1155
Transport equipment	0.0315 (0.0207)	-0.0314 (0.0150)**	-1.1006 (0.0281)*	0.0224 (0.0038)*	2367.42 (0.000)	42.49 (0.0295)	-2.36 (0.0181)	2135	671
Furniture	0.1013 (0.0160)*	0.0286 (0.0107)*	-1.2832 (0.0212)*	0.0190 (0.0030)*	6661.63 (0.000)	78.71 (0.0000)	-3.63 (0.0003)	4815	1785

Standard deviation in brackets. Sargan is a test of the overidentifying restrictions. Arellano-Bond test order 1 and test order 2 are tests for first-order and second–order serial correlation in the first differenced residual, asymptotically distributed as N(0, 1) under the nullity of no serial correlation. The p-value of Sargan's test for overidentifying restrictions and m2 test are reported in square brackets.
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Table 4.6. The persistence of firm growth in (?) the service sector estimated with Generalized Method of Moments.

	Coefficients				*Tests*			*Observations*	
	Growth t-1	*Growth t-2*	Size	constant	Wald Chi2	Sargan test	Test order 2	Obs.	Firms
Wholesale trade	0.0475 (0.0159)*	0.0069 (0.0105)	-1.2221 (0.0211)*	0.0367 (0.0030)*	6152.28 (0.000)	23.97 (0.6318)	1.29 (0.1969)	4606	1665
Hotels and restaurants	0.1084 (0.0121)*	0.0299 (0.0083)*	-1.3252 (0.0157)*	0.0119 (0.0028)*	14701.43 (0.000)	76.41 (0.0000)	0.65 (0.5158)	9741	4059
Transport	0.0369 (0.0091)*	0.0008 (0.0064)	-1.2376 (0.0114)*	0.0397 (0.0019)*	23067.83 (0.000)	25.08 (0.5702)	-1.30 (0.1934)	16400	6278
Telecoms.	-0.0284 (0.0319)	-0.0300 (0.0229)	-1.0623 (0.0387)*	0.0790 (0.0099)*	1435.19 (0.000)	61.20 (0.0002)	0.48 (0.6287)	1028	433
Finances	-0.0079 (0.0317)	-0.0558 (0.0236)**	-1.0462 (0.0381)*	0.0283 (0.0071)*	1536.92 (0.000)	31.20 (0.2628)	1.60 (0.1104)	1286	585
Renting	0.0691 (0.0235)*	0.0241 (0.0174)	-1.2036 (0.0287)*	0.0691 (0.0063)*	3136.19 (0.000)	23.18 (0.6754)	2.47 (0.0134)	2037	798
Computer activities	-0.0232 (0.0183)	-0.0340 (0.0137)**	-1.0845 (0.0218)*	0.0605 (0.0054)*	4600.03 (0.000)	77.51 (0.0000)	-0.16 (0.8721)	3333	1318
R&D	0.1954 (0.0673)*	0.0873 (0.0459)*** 	-1.4278 (0.0819)*	0.14239 (0.0173)*	537.56 (0.000)	19.61 (0.8469)	-0.64 (0.5249)	281	106

Standard deviation in brackets. Sargan is a test of the overidentifying restrictions. Arellano-Bond test order 1 and test order 2 are tests for first-order and second–order serial correlation in the first differenced residual, asymptotically distributed as N(0, 1) under the nullity of no serial correlation. The p-value of Sargan's test for overidentifying restrictions and m2 test are reported in square brackets.
** significant at 1%, ** significant at 5% and *** significant at 10%.*

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- *Transport equipment* has a non-significant coefficient for the first lagged growth, but this is not significant. *Electrical and optical devices* has a negative impact but this is not significant.
- For the *Transport equipment* industry, there is a combined effect of one lagged growth (0.0315) and two lagged growth (-0.0314).

In the service sector, our results show that:

- The impact on current firm growth is highest in *R&D*, with a coefficient of 0.1954 for the one lagged growth and a coefficient of 0.0873 for the impact of the two lagged growth. Our results are in concordance with Raymond et al. (2006) who find that there exists a slight positive impact between past sales due to innovation and their future value. Also Cefis (2003) demonstrates that although in general manufacturing firms in UK do no show a strong persistence, those large innovating firms show certain persistence to innovate.
- *Transport* has the lowest values, which means that growth persistence across periods is low in this sector.
- *Finances* presents a negative estimated parameter but the significance level is low.

In summary, these results reveal heterogeneity between sectors. Since each sector shows different trends, each sector should be considered individually when the evolution of firm performance is analysed.

4.5.5. What about the influence of past behaviour?

At any point in time, the history of a firm has a significant effect on the configuration of its internal context through the organizational structure

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and procedures it has chosen in the past and through the experience that its members have acquired in the process (Canals, 2000). The history of a firm therefore has an impact on its future.

Only a few theories, however, have included the role of history in their models. Neoclassical theories, for example, introduced past decisions through the interaction between competitors in the market (Shapiro, 1989). The evolutionary theory (Nelson and Winter, 1982) is based on the routines[8]—the way things are done—that a firm is able to develop over time. The configuration of these routines is influenced by a large number of factors, particularly by how they interact with each other during the firm's evolution.

Clearly, growth may depend on a firm's past evolution. Investment in assets, employees or R&D are closely related to the firm's past evolution and, therefore, to its expectations in the market and the evolution of the industry. Here three factors are important:

- First, present strategic decisions determine a firm's path in the medium term. Managers' decisions, accumulated resources, available capabilities and the external context (interaction with customers, suppliers and competitors) will encourage the firm to take one path or another.
- Second, the path taken by firms with increasing returns[9] tends to consolidate the original decision. However, the fact that the path is reinforced is not unequivocally positive, i.e. a path that is favoured by increasing returns has positive effects for the company until the

[8] Nelson and Winter (1982) stated that the routines and procedures are determined by the organization's formal system (e.g. control mechanisms and compensation systems) and by its informal system (mainly culture).
[9] Increasing returns are an implicit mechanism in some industries by which a firm that is ahead gets further ahead.

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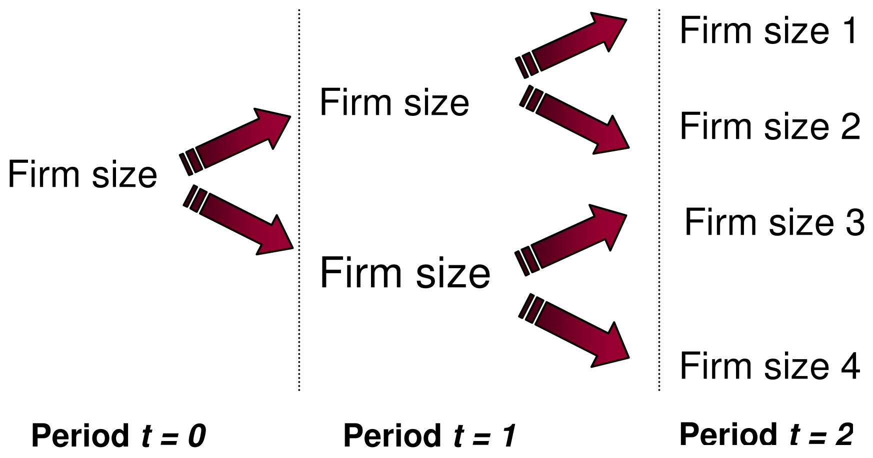
fateful moment is reached when a revolutionary innovation demands new ways of competing and makes the old ones obsolete.

- Third, learning developed by its staff and the knowledge accumulated by this means have a impact on firm growth. Knowledge refers to R&D and the routine or non-routine activities conducted by a firm over time to design which produce or sell its goods or services to its customers.

The picture may therefore be more accurate if we differentiate between different past patterns. As far as we know, no contribution has considered how a firm's past growth shapes its present and may constrain its future. In this section we respond directly to this question.

Let us suppose that the impact of past growth rates on future growth rates depends on their trajectory. For example, a firm that has grown in the last two periods is more likely to grow in the future. Similarly, a firm that is recovering from a decline (through investment or growth of its direct market) may influence its future firm growth.

Graph 4.1. The evolution of a firm depending on its past evolution



Source: own elaboration.

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Graph 4.1 shows four possible trajectories of a firm. In the initial period (*t=0*), the firm may grow positive or negatively. In the following period (*t=1*), the firm size may also grow positively or negatively. Finally, in the period *t=2*, firm size depends on 4 different trajectories:

- Firm size 1 represents the trajectory of a successful firm that has grown in two consecutive periods.
- Firm size 2 represents the trajectory of a firm that grew in the first period but declined in the second.
- Firm size 3 represents the trajectory of a firm that declined in the first period but grew in the second.
- Firm size 4 represents the negative trajectory of a firm in two consecutive periods.

These four alternative trajectories are incorporated in our initial equation through four dummies:

$$z_{i,t} = \gamma_1 z_{i,t-1} + \gamma_2 z_{i,t-2} + \beta_1 \log(S_{i,t-1}) + \beta_2 Dummy1 + \beta_3 Dummy2 + \beta_4 Dummy3 + \\ + \beta_5 Dummy4 + \eta_{i,t}$$

(Estimation 4.3)

where *Dummy1* represents a firm that grew in two consecutive periods, *Dummy2* represents a firm that decreased in two consecutive periods, *Dummy3* represents a firm that decreased in one period but grew in the next, and *Dummy4* represents a firm that grew in one period but decreased in the next.

Table 4.7 shows the results of Estimation 4.3. With regard to Gibrat's Law and the persistence relationship, the results are the same as for the

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previous estimations, though the coefficients of persistence are slightly lower.

Table 4.7. The persistence of firm growth and past history estimated with Generalized Method of Moments.

	Whole database	Manufacturing	Services
Growth t-1	0.0622 (0.0031)*	0.0784 (0.0035)*	0.0276 (0.0062)*
Growth t-2	0.0079 (0.0022)*	0.0172 (0.0024)*	-0.0120 (0.0046)*
S_{t-1}	-1.2504 (0.0039)*	-1.2661 (0.0031)*	-1.2185 (0.0072)*
Dummy 1	0.0245 (0.0028)*	0.0212 (0.0031)*	0.0321 (0.0057)*
Dummy 2	-0.0183 (0.0041)*	-0.0197 (0.0045)*	-0.0156 (0.0085)***
Dummy 3	0.0117 (0.0030)*	0.0099 (0.0033)*	0.0139 (0.0061)**
Dummy 4	0.0072 (0.0028)*	0.0060 (0.0032)***	0.0073 (0.0059)
Coefficient	0.0359 (0.0006)*	0.0352 (0.0007)*	0.0374 (0.0013)*
Wald Chi2	201409.42 (0.000)	150922.31 (0.000)	55369.25 (0.000)
Sargan Test	312.01 (0.000)	435.41 (0.000)	81.90 (0.000)
Arellano-Bond test order 2	2.09 (0.0367)	1.50 (0.1334)	1.11 (0.2666)
Observations	119859	81147	38712
firms	42280	27038	15242

Standard deviation in brackets. Sargan is a test of the overidentifying restrictions. Arellano-Bond test order 1 and test order 2 are tests for first-order and second–order serial correlation in the first differenced residual, asymptotically distributed as N(0, 1) under the nullity of no serial correlation. The p-value of Sargan's test for overidentifying restrictions and m2 test are reported in square brackets.
** significant at 1%, ** significant at 5% and *** significant at 10%.*

The dummies identifying past histories obtained a significant coefficient. Several conclusions can be drawn. First, *Dummy 1* obtained the highest coefficient (0.0245). Second, as expected, *Dummy 2* obtained a negative coefficient. Therefore, firms declining in two consecutive periods will be

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punished in the future, while firms growing in two consecutive periods will have higher growth rates in the future.

4.6. Summary and concluding remarks

In nature a variety of species coexist. Similarly, in the market both efficient and inefficient and large and small firms also coexist. Some firms therefore experience above average growth rates while others follow a continuously declining path.

In the previous chapter we analysed the relationship between firm growth and size following Gibrat's Law. This relationship offers a static perspective since it relates the evolution of a firm with reference to an initial position. In this chapter, on the other hand, we have widened our perspective by linking past changes in size to future growth rates.

One of our aims is to compare different industries and observe how the combination of interdependence and independence affects firm growth (Lotti et al., 1999).

Briefly, our main results are:

- There is evidence of positive persistence across temporal growth rates.
- As expected, there is a strong relationship between the growth rate in one period and the growth rate in the previous one.
- The manufacturing and service industries have similar patterns. However, there is heterogeneity of growth persistence between industries. This heterogeneity should therefore be taken into account in the future.

- Firms with a brilliant history will have above average growth rates in the future. Firms declining in size are more likely to decline in future.

The contributions made in this chapter to the empirical literature are a differentiation between the manufacturing and service sectors with a large sample of Spanish firms and an analysis of persistence based on the past history of firms. This is the most recent study on the persistence of Spanish growth, a field that should not be ignored by the social agents.

It is important to determine the persistence of firm growth for two reasons. Firstly, policy-makers will have a useful tool for deciding which firms most deserve to receive a subsidy. For the sake of efficiency, public agents must know which firms are more likely to increase employment and contribute to economic growth. Secondly, it should help managers to identify businesses that are more likely to grow and thus increase the profitability of their investments.