GIBRAT'S LAW AND MARKET SELECTION IN THE RADIO, TV & TELECOMMUNICATIONS EQUIPMENT INDUSTRY*

by
Francesca Lotti
Bank of Italy, Research Department
Enrico Santarelli
University of Bologna, Department of Economics; and Free University of Bozen/Bolzano, School of Economics and Management
Marco Vivarelli
Catholic University of Piacenza, Department of Economic and Social Sciences; ILO, Geneva; and IZA, Bonn

Abstract

According to Gibrat's Law of Proportionate Effect, the growth rate of a given firm is independent of its size at the beginning of the period examined. In contrast to the previous literature on the subject, this paper seeks to test the Law by taking account of both the entry process and the role of survival/failure in reshaping a given population of firms over time. It does so by focusing on the entire population of firms (including newborn ones) in the Italian Radio, TV & Telecommunications equipment industry and tracking them over seven years. Consistently with the previous literature, it finds that - in general - Gibrat's Law is to be rejected, since smaller firms tend to grow faster than their larger counterparts. However, the paper's main finding is that this rejection of Gibrat's Law may be due to market dynamics and selection. In other words, it is due to the entry process and the presence of transient smaller firms. Indeed, whilst it is found that Gibrat's Law has to be rejected over a seven-year period during which both incumbent and newborn firms are considered, for both sub-populations of surviving firms a convergence towards Gibrat-like behavior over time can be detected. Thus, market selection "cleans" the original population of firms and the resulting industrial "core" (mature, larger, well-established and most efficient firms) does not seem to depart from a Gibrat-like pattern of growth.

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Corresponding author:

Enrico Santarelli
Department of Economics
University of Bologna
Strada Maggiore, 45
40125 Bologna
Italy
santarel@spbo.unibo.it

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Introduction

The debate on Gibrat's Law of Proportionate Effect is a rather old one (see, amongst others, the surveys by Sutton, 1997; Geroski, 1999; Lotti *et al*., 2003). A commonly accepted interpretation of the Law formulated by Robert Gibrat (1931) is that the growth rate of a given firm is independent of its size at the beginning of the period examined. In other words, "the probability of a given proportionate change in size during a specified period is the same for all firms in a given industry - regardless of their size at the beginning of the period" (Mansfield, 1962, p. 1031).

From an empirical viewpoint, the Law can be tested in two ways: either by using a sample of firms continuously active during a given period (balanced panel analysis), or by using a population of firms and testing the Law with sample attrition taken into account, since a portion of firms alive at the beginning of the period do not survive until the end of the same period (unbalanced panel analysis).[1] Both approaches have some shortcomings. Tracking only incumbent surviving firms is by definition equivalent to considering only a sub-sample of the firms' population and to neglecting important elements of industrial dynamics, i.e. entries and failures. If Gibrat's Law is not a feature of the best incumbent firms, but a general pattern of industrial dynamics, it should be tested over the entire population of firms in a given time span (with the inclusion of new entries and firms that may exit the market in the subsequent periods). It is probably for this reason that the most recent estimates of the Law[2] have used the second methodology. Yet, neither in this case do most studies specifically consider newborn firms and they deal with the survival/failure phenomenon by taking account only of sample attrition due to exit. Most of previous studies, in fact, pool large incumbents, newborn firms and small transient firms together, although estimates over a given time period are corrected for sample bias.

By contrast, this paper attempts to consider both the entry process and the role of selection mechanisms in reshaping a given population of firms over time. It consequently differs from the previous literature in that it tries 1) to take joint account of both incumbents and newborn firms and 2) to consider the selection process as it occurs both over the entire period and year by year. Repeating the test of Gibrat's Law year by year enables one to consider what happens when the original heterogeneous population is gradually reshaped in favor of larger, most efficient and well-established firms. Indeed, whilst most of the previous literature has found that Gibrat's law must be rejected, since smaller firms tend to grow faster than their larger counterparts, no previous study

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[1] Fotopoulos and Louri (2001) is an example of the first approach, and Goddard, Wilson, and Blandon (2002) of the second.

[2] See for example Becchetti and Trovato (2002), Hesmathi (2001), Fotopoulos and Louri (2001), Almus and Nerlinger (2000), Harhoff *et al*. (1998).

has attempted to determine whether this result is robust once industrial dynamics are taken fully into account. More specifically, in this paper we deal with the Italian Radio, TV & Telecommunications equipment industry in January 1987 (including 122 newborn firms). During the period examined, this industry was a rather mature one in Italy and still lagging behind in the technological revolution brought about by the passage from analog to digital signals.[3] Many small firms in the industry operated in one of its three sub-markets, whereas only a few large multi-product firms competed against each other in all of those sub-markets. Consequently, this study is affected by a certain degree of arbitrariness in its definition of the industry's boundaries which, according to Sutton (1998), is likely to make it impossible to take account of the fact that each industry contains a number of sub-markets *between* which rivalry is less intense than it is *within* each (cf. also Giorgetti, 2003; Roberts and Thompson, 2003). Nonetheless, it is less severely affected by this arbitrariness than are studies which focus on several different industries. Gibrat's Law is tested by using a sample selection procedure (augmented with age) for all firms, incumbent firms and newborn firms respectively, both over the entire period (1987-1994) and year by year. This set of estimates will enable us to answer the following questions:

a) Is Gibrat's Law valid in general (that is for all firms and over the entire period)?
b) Is Gibrat's Law less valid for new entries than for incumbent firms (smaller sub-optimal firms are relatively more common among new entries)?
c) Is there any convergence towards a Gibrat's like pattern of growth over time (due to market selection particularly adverse against smaller firms)?

The empirical findings support the following string of answers: NO/YES/YES.

Our interpretation is that previous results rejecting Gibrat's Law have been partially determined by incomplete consideration of the entry and selection processes. More specifically, Gibrat's Law fails to hold because a given population of firms is characterized by the presence of both newborn firms and "fragile" firms (which will subsequently fail). Smaller firms are over-represented in both categories, but it is precisely the presence of smaller fast-growing firms that leads to the rejection of Gibrat's Law. As a result of market selection, surviving larger firms tend to behave in accordance with Gibrat's Law and this holds for both incumbents and newborn firms. Hence, if these results are correct, and if they are confirmed by other studies, Gibrat's Law and industrial dynamics are interrelated and it is incorrect either to assume or to deny Gibrat's Law *a priori*. Although the Law is not confirmed in general, it may be an accurate representation of the pattern of growth assumed

[3] In fact, the leading Italian firms in the industry proved unable to cope with this technological revolution, with a consequent contraction of the entire industry in the following years. In this connection, the Italian Radio, TV &

by a mature population of well-established firms, that is, a population already selected by market forces.

The paper is organized as follows. Section 2 presents the dataset and deals with some methodological issues related to the estimation of Gibrat's Law; Section 3 discusses the econometric results and Section 4 summarizes the main findings of the study.

2. Data and methodology

In this paper we use a unique data set from the Italian National Institute for Social Security (INPS). This data set identifies all incumbents and newborn firms with at least one paid employee in the Radio, TV & Telecommunication equipment industry in Italy, and tracks their employment performance at yearly intervals from January 1987 to January 1994.[4] The original INPS file was checked in order to identify entry and failure times correctly and to detect inconsistencies in individual tracks due to administrative factors, and cancellations due to firm transfers, mergers and take-overs. This cleaning procedure reduced the total number of firms in the database to 3,285, of which 122 were new entries in January 1987.

The central relationship tested in this study is the original logarithmic specification of the Law:

$$\log S_{i,t} = \beta_0 + \beta_1 \log S_{i,t-1} + \varepsilon_{i,t} \qquad (1)$$

where $S_{i,t}$ is the size of firm *i* at time t, $S_{i,t-1}$ is the size of the same firm in the previous period and $\varepsilon_{i,t}$ is a random variable distributed independently of $S_{i,t-1}$. Following Chesher (1979, p.404), if both sides of equation (1) are exponentiated, it becomes clear that if β_1 is equal to unity, then growth rate and initial size are independently distributed[5] and Gibrat's Law is in operation. By contrast, if $\beta_1 < 1$ smaller firms grow at a systematically higher rate than do their larger counterparts, while the opposite is the case if $\beta_1 > 1$. If - as in the majority of previous studies - growth and exit are not treated as homogeneous phenomena (that is, on the disputable hypothesis

Telecommunication industry can be regarded, in the period under examination, as an aging one.

[4] All private Italian firms are obliged to pay national security contributions for their employees to INPS. Consequently, the registration of a new firm as "active" signals an entry into the market, while the cancellation of a firm denotes an exit from it (this happens when a firm finally stops paying national security contributions). For administrative reasons - delays in payment, for instance, or uncertainty about the actual status of the firm - cancellation may sometimes be preceded by a period during which the firm is "suspended". The present paper considers these suspended firms as exiting from the market at the moment of their transition from the status of "active" to that of "suspended", while firms which have halted operations only temporarily during the follow-up period, and which were "active" in January 1994, have been treated as survivors.

[5] Following a random walk (with drift) stochastic process.

that exit is equal to a minus one rate of growth), empirical estimates need only deal with surviving firms, obtaining results conditional on survival.

Let $\chi_{i,t}$ be an indicator function which takes value 1 if firm *i* is still alive at time *t* and 0 otherwise. Accordingly, observed data on firm size can give only the conditional expectation of $S_{i,t}$ given $S_{i,t-1}$ and $\chi_{i,t}=1$, i.e. according to our specification,

$$E\left(S_{i,t} \mid S_{i,t-1}, \chi_{i,t} = 1\right) = \beta_0 + \beta_1 \log S_{i,t-1} + E\left(\varepsilon_{i,t} \mid S_{i,t-1}, \chi_{i,t} = 1\right) \tag{2}$$

If the conditional expectation of ε_t is zero, the regression function for the selected sub-sample is the same as the population regression function, the only drawback being a loss of efficiency due to the smaller number of observations available. But if this is not true, the last term of equation (2) need to be included in the regression function. It is for this reason that a rule for χ_t is required, and the most natural way to deal with this kind of selection is to use a survival equation (i.e. a probit model), given that we can exactly identify when a firm exits the market. In a more general formulation, this is the same as saying that:

$$\begin{cases} Prob(\chi_i=1) = \Phi(\alpha' z_i) & \text{Probit } \textit{Selection Equation} \quad (3a) \\ y_i = \beta' x_i + \varepsilon_i & \text{observed only if } \chi_i=1 \quad (3b) \end{cases}$$

If we denote the residual of equation (3a) with $\mu_{i,t}$ and if we assume that the error terms are normal, respectively $\varepsilon_i \sim N(0, \sigma_\varepsilon)$ and $\mu_i \sim N(0, \sigma_\mu)$ with $corr(\varepsilon_i, \mu_i) = \rho$, we can reformulate equation (2) as:

$$E\left(S_{i,t} \mid S_{i,t-1}, \chi_{i,t} = 1\right) = \beta_0 + \beta_1 \log S_{i,t-1} + \rho \sigma_\varepsilon \lambda_i \tag{4}$$

where $\lambda_i = \dfrac{\phi(\alpha' z_i)}{\Phi(\alpha' z_i)}$ is the inverse of the Mills' ratio.[6] The two-step estimation procedure requires one to estimate the probit selection model first. Once λ_i has been obtained for each observation, the growth equation (4) is estimated, augmenting the observations with the Mills' ratio

[6] We use Φ to denote the cumulative density function of the Normal distribution and φ to denote its density function.

inverse, to obtain an additional parameter estimate $\beta_M = \hat{\rho}\hat{\sigma}_\varepsilon$ from which we can simply recover the two-step estimate of $\hat{\rho} = \frac{\beta_M}{\hat{\sigma}_\varepsilon}$. We used Maximum Likelihood estimation[7] with heteroskedasticity robust standard errors.

Table 1 – Number of Active Firms, Average Size and its Standard Deviation.

Year	Number of Active Firms	Average Size of Surviving Firms	Standard Deviation
		ALL FIRMS	
1987	3285	35.99	285.14
1988	3216	37.07	277.46
1989	2893	44.34	343.17
1990	2743	44.89	337.04
1991	2564	46.10	336.10
1992	2347	45.11	368.56
1993	2149	46.31	346.37
1994	1933	45.83	378.60
		INCUMBENTS	
Year	**Number of Active Firms**	**Average Size of Surviving Firms**	**Standard Deviation**
1987	3163	36.94	290.43
1988	3095	37.97	282.61
1989	2786	45.36	349.46
1990	2646	45.81	342.89
1991	2476	47.00	341.73
1992	2265	46.00	374.84
1993	2078	47.18	352.00
1994	1871	46.76	384.66
		NEWBORN FIRMS	
Year	**Number of Active Firms**	**Average Size of Surviving Firms**	**Standard Deviation**
1987	122	11.38	41.61
1988	121	14.10	52.70
1989	107	17.55	61.11
1990	97	19.82	67.45
1991	88	20.74	70.39
1992	81	20.12	67.90
1993	71	20.83	65.76
1994	62	17.76	54.91

Consistently with most previous studies, both the main and the selection equations were augmented with the age variable (which is obviously only relevant to incumbent firms).

[7] Since Heckman's (1979) estimator may be inefficient and biased for small samples.

Regressions were run separately for all firms, all firms with a dummy for newborn ones, only incumbent firms and only newborn firms. The same specifications were tested over the entire period (1987-1994) and year by year (7 separate estimates for each group of firms). The descriptive statistics in table 1 confirm the importance of market selection: only 59% of incumbents and 51% of newborn firms survive until the end of the 7 years period. This selection, as it is evident from the average sizes of surviving firms, is dramatically biased towards smaller firms (especially in the first years).

3. Results

Tables 2 and following present the regressions results over the entire period examined (1987-1994) and year by year. The model specification is reported in the headline, while coefficients estimates are presented together with robust standard errors and level of statistical significance (*=90%; **=95%; ***=99%). Estimates of the Gibrat's coefficient β_1 are also coupled with a Wald test, whose null is β_1=1 (that is the Law is not rejected). After the coefficients estimates of the sample equation have been presented, some overall diagnostic tests are reported, among which the estimate of the correlation between the residuals of the two models (ρ) and the related significance level of the corresponding Likelihood Ratio test,[8] and a Wald test for the overall validity of the model. As can be seen from all tables, the need for the sample selection model has been confirmed, especially in the first years of the period examined. Finally, the reader can follow the market selection process by looking at the number of observations, the decrease of which marks the incidence of firms' failures.

Examination of table 2 (all 3,285 firms operating in January 1987) prompts a number of considerations:

1) consistently with previous studies (see Section 1), Gibrat's Law is rejected, with a β_1=0.847 significantly different from 1; smaller firms seem to grow faster than their larger counterparts. Moreover, an initial larger size improves the likelihood of survival, although in a non-linear fashion (this result is also consistent with previous empirical studies);

[8] The test statistic is LR = 2 (log L_U - log L_R), where log L_U and log L_R are the log-likelihoods for the unrestricted and restricted versions of the model, that is distributed as a χ^2 statistic with 1 degree of freedom under the null hypothesis that the restriction ρ = 0 is valid.

Table 2 – Estimates for all firms, basic model.

ALL FIRMS		Growth equation. $\ln S_{i,t}=\beta_0+\beta_1 \ln S_{i,t-1}+\varepsilon_{i,t}$			Selection equation	$\Pr(\delta_{i,t}=1)=F(\ln S_{i,t-1}, \ln S_{i,t-1}^2, \text{const})$			
		1987-94	**1987-88**	**1988-89**	**1989-90**	**1990-91**	**1991-92**	**1992-93**	**1993-94**
Growth Equation	β_1	0.847***	0.959***	0.968***	0.973***	0.988***	0.986***	0.986***	0.982***
		(0.023)	(0.005)	(0.005)	(0.007)	(0.007)	(0.008)	(0.008)	(0.011)
	β_0	0.360**	0.183***	0.155***	0.091***	0.020	-0.006	-0.019	0.028
		(0.168)	(0.011)	(0.013)	(0.017)	(0.018)	(0.021)	(0.020)	(0.030)
Wald Test β_1=1		44.50***	78.44***	42.27***	13.69***	3.15*	3.07*	2.79*	2.58
Selection Equation	α_1	0.227***	0.298***	0.411***	0.334***	0.319***	0.332***	0.374***	0.240***
		(0.040)	(0.081)	(0.050)	(0.066)	(0.062)	(0.060)	(0.064)	(0.063)
	α_2	-0.025***	-0.029**	-0.041***	-0.027***	-0.035***	-0.040***	-0.035***	-0.031***
		(0.008)	(0.014)	(0.008)	(0.009)	(0.010)	(0.009)	(0.011)	(0.010)
	α_0	-0.066	1.690***	0.758***	1.140***	1.072***	0.928***	0.826***	0.965***
		(0.047)	(0.088)	(0.060)	(0.085)	(0.084)	(0.082)	(0.084)	(0.087)
ρ		0.467	0.054***	0.109***	0.049**	0.073	0.045	0.077	-0.012
λ		0.344	0.018	0.036	0.015	0.023	0.014	0.024	-0.004
Wald χ^2		1360.97***	42470.04***	38275.57***	17548.49***	19762.35***	15749.22***	14505.59***	7358.87***
log L		-4372.26	-1343.91	-1897.21	-1180.25	-1340.00	-1346.80	-1233.71	-1251.28
Number of observations		3285	3285	3216	2893	2473	2564	2347	2149
	Censored	1352	69	323	150	179	217	198	216
	Uncensored	1933	3216	2893	2743	2564	2347	2149	1933

Table 3– Estimates for all firms, basic model augmented with age.

ALL FIRMS		Growth equation. $\ln S_{i,t}=\beta_0+\beta_1 \ln S_{i,t-1}+\beta_2 Age_{i,t}+\varepsilon_{i,t}$ Selection equation $Pr(\delta_{i,t}=1)=F(\ln S_{i,t-1}, \ln S_{i,t-1}^2, Age_{i,t}, Age_{i,t}^2, const)$							
		1987-94	**1987-88**	**1988-89**	**1989-90**	**1990-91**	**1991-92**	**1992-93**	**1993-94**
Growth Equation	β_1	0.893***	0.974***	0.978***	0.980***	0.990***	0.988***	0.988***	0.982***
		(0.019)	(0.005)	(0.005)	(0.007)	(0.007)	(0.008)	(0.008)	(0.011)
	β_2	-0.026***	-0.009***	-0.007***	-0.005***	-0.002	-0.001	-0.001	0.000
		(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
	β_0	0.467***	0.219***	0.187***	0.123***	0.033	0.002	-0.008	0.033
		(0.116)	(0.012)	(0.014)	(0.019)	(0.024)	(0.025)	(0.028)	(0.039)
Wald Test $\beta_1=1$		31.64***	29.60***	18.04***	7.99***	2.17	2.57	2.56	2.61
Selection Equation	α_1	0.200***	0.274***	0.404***	0.337***	0.318***	0.326***	0.376***	0.236***
		(0.042)	(0.079)	(0.050)	(0.066)	(0.063)	(0.060)	(0.064)	(0.063)
	α_2	-0.022***	-0.027*	-0.041***	-0.028***	-0.037***	-0.038***	-0.035***	-0.031***
		(0.008)	(0.014)	(0.008)	(0.010)	(0.010)	(0.010)	(0.011)	(0.010)
	α_3	0.037***	0.032	0.021	-0.006	0.038	0.038	-0.010	0.026
		(0.013)	(0.027)	(0.018)	(0.027)	(0.026)	(0.026)	(0.030)	(0.030)
	α_4	-0.001**	-0.001	-0.001	0.000	-0.001	-0.001	0.000	-0.001
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	α_0	-0.174***	1.605***	0.671***	1.149***	0.842***	0.727***	0.890***	0.774***
		(0.058)	(0.117)	(0.087)	(0.144)	(0.146)	(0.167)	(0.209)	(0.223)
ρ		0.450**	0.071***	0.124***	0.054**	0.092	0.055	0.081	-0.015
λ		0.326	0.023	0.041	0.016	0.029	0.017	0.026	-0.005
Wald χ^2		2203.05***	42929.42***	38234.76***	19860.07	22145.77***	16578.43***	17287.31	8007.68
log L		-4331.79	-1309.29	-1879.30	-1167.77	-1336.34	-1345.34	-1223.25	-1250.80
Number of observations		3285	3285	3216	2893	2473	2564	2347	2149
	Censored	1352	69	323	150	179	217	198	216
	Uncensored	1933	3216	2893	2743	2564	2347	2149	1933

Table 4 – Estimates for newborn firms, basic model.

NEWBORN FIRMS		Growth equation. $\ln S_{i,t}=\beta_0+\beta_1 \ln S_{i,t-1}+\varepsilon_{i,t}$			Selection equation	$Pr(\delta_{i,t}=1)=F(\ln S_{i,t-1}, \ln S_{i,t-1}^2, const)$			
		1987-94	**1987-88**	**1988-89**	**1989-90**	**1990-91**	**1991-92**	**1992-93**	**1993-94**
Growth Equation	β_1	0.725***	0.929***	0.922***	0.951***	1.009***	0.979***	0.994***	0.982***
		(0.125)	(0.023)	(0.031)	(0.022)	(0.025)	(0.029)	(0.021)	(0.042)
	β_0	0.405	0.367***	0.263***	0.185***	0.038	0.027	-0.006	0.033
		(0.470)	(0.053)	(0.079)	(0.056)	(0.055)	(0.085)	(0.063)	(0.106)
Wald Test β_1=1		4.79**	9.85***	6.12**	4.92**	0.13	0.54	0.08	0.19
Selection Equation	α_1	0.228	7.249***	0.673**	0.670**	0.476*	0.317	0.512**	0.775**
		(0.248)	(0.674)	(0.312)	(0.341)	(0.287)	(0.351)	(0.226)	(0.357)
	α_2	-0.071	-1.092***	-0.077	-0.104**	-0.082*	-0.073	-0.081**	-0.142**
		(0.052)	(0.102)	(0.063)	(0.053)	(0.044)	(0.052)	(0.035)	(0.063)
	α_0	-0.034	2.010***	0.631**	0.714**	0.848**	1.203**	0.567**	0.482
		(0.198)	(0.417)	(0.249)	(0.335)	(0.381)	(0.487)	(0.274)	(0.404)
ρ		0.860*	0.001	0.246**	0.225	-0.585	0.145*	-0.928***	0.327
λ		0.994	0.001	0.109	0.067	-0.178	0.059	-0.281	0.111
Wald χ^2		33.40***	1667.57***	863.29***	1817.77***	1597.20	1175.47***	2287.17***	535.31***
log L		-160.39	-60.02	-105.56	-51.80	-44.92	-65.26	-31.94	-44.34
Number of observations		122	122	121	107	97	88	81	71
	Censored	60	1	14	10	9	7	10	9
	Uncensored	62	121	107	97	88	81	71	62

Table 5 – Estimates for incumbent firms, basic model.

INCUMBENT FIRMS		Growth equation. $\ln S_{i,t}=\beta_0+\beta_1 \ln S_{i,t-1}+\varepsilon_{i,t}$				Selection equation	$Pr(\delta_{i,t}=1)=F(\ln S_{i,t-1}, \ln S_{i,t-1}^2, const)$		
		1987-94	**1987-88**	**1988-89**	**1989-90**	**1990-91**	**1991-92**	**1992-93**	**1993-94**
Growth Equation	β_1	0.854***	0.962***	0.970***	0.974***	0.987***	0.987***	0.985***	0.982***
		(0.023)	(0.005)	(0.005)	(0.008)	(0.007)	(0.008)	(0.008)	(0.012)
	β_0	0.371**	0.171***	0.149***	0.086***	0.020	-0.008	-0.015	0.026
		(0.160)	(0.012)	(0.013)	(0.017)	(0.019)	(0.021)	(0.020)	(0.032)
Wald Test $\beta_1=1$		41.83***	64.20***	36.44***	11.88***	3.24*	2.77*	3.21*	2.38
Selection Equation	α_1	0.224***	0.307***	0.403***	0.315***	0.316***	0.338***	0.361***	0.222***
		(0.042)	(0.082)	(0.051)	(0.068)	(0.064)	(0.061)	(0.066)	(0.065)
	α_2	-0.023***	-0.030**	-0.040***	-0.023**	-0.034***	-0.040***	-0.033***	-0.028***
		(0.008)	(0.014)	(0.008)	(0.010)	(0.010)	(0.010)	(0.011)	(0.010)
	α_0	-0.063	1.664***	0.764***	1.170***	1.081***	0.913***	0.850***	0.987***
		(0.049)	(0.090)	0.764	(0.088)	(0.087)	(0.083)	(0.086)	(0.090)
ρ		0.390	0.050***	0.100***	0.047**	0.080	0.044	0.080	-0.018
λ		0.285	0.017	0.033	0.014	0.025	0.014	0.025	-0.006
Wald χ^2		1420.84***	41558.40***	38032.74***	16802.53***	18833.90***	15019.50***	13898.11***	6977.67***
log L		-4195.29	-1265.31	-1773.78	-1124.22	-1292.87	-1273.91	-1185.92	-1204.72
Number of observations		3163	3163	3095	2786	2646	2476	2265	2078
	Censored	1292	68	309	140	170	211	188	207
	Uncensored	1871	3095	2786	2646	2476	2265	2078	1871

Table 6 – Estimates for incumbent firms, basic model augmented with age.

INCUMBENT FIRMS Growth equation. $\ln S_{i,t}=\beta_0+\beta_1 \ln S_{i,t-1}+\beta_2 Age_{i,t}+\varepsilon_{i,t}$ Selection equation $Pr(\delta_{i,t}=1)=F(\ln S_{i,t-1}, \ln S_{i,t-1}^2, Age_{i,t}+Age_{i,t}^2, const)$

		1987-94	**1987-88**	**1988-89**	**1989-90**	**1990-91**	**1991-92**	**1992-93**	**1993-94**
Growth Equation	β_1	0.897***	0.976***	0.980***	0.981***	0.989***	0.988***	0.987***	0.982***
		(0.019)	(0.005)	(0.005)	(0.007)	(0.007)	(0.008)	(0.008)	(0.011)
	β_2	-0.024***	-0.009***	-0.007***	-0.005***	-0.002	-0.001	-0.001	0.000
		(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
	β_0	0.469***	0.206***	0.183***	0.119***	0.032	0.000	-0.001	0.030
		(0.113)	(0.013)	(0.014)	(0.020)	(0.025)	(0.026)	(0.029)	(0.041)
Wald Test β_1=1		28.67***	24.34***	14.13***	6.95***	2.38	2.37	2.84*	2.45
Selection Equation	α_1	0.201***	0.273***	0.395***	0.321***	0.315***	0.331***	0.364***	0.219***
		(0.042)	(0.080)	(0.051)	(0.068)	(0.064)	(0.061)	(0.066)	(0.065)
	α_2	-0.022***	-0.027**	-0.040***	-0.025**	-0.036***	-0.038***	-0.033***	-0.028***
		(0.008)	(0.014)	(0.008)	(0.010)	(0.010)	(0.010)	(0.011)	(0.011)
	α_3	0.035***	0.050*	0.029	-0.022	0.037	0.045	-0.021	0.025
		(0.014)	(0.028)	(0.020)	(0.029)	(0.027)	(0.028)	(0.032)	(0.031)
	α_4	-0.001*	-0.002	-0.001	0.001	-0.001	-0.002*	0.001	-0.001
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	α_0	-0.174***	1.521***	0.642***	1.252***	0.849***	0.666***	0.992	0.805***
		(0.064)	(0.126)	(0.095)	(0.159)	(0.157)	(0.180)	(0.227)	(0.240)
ρ		0.392**	0.070***	0.123***	0.049**	0.097	0.055	0.085*	-0.024
λ		0.282	0.023	-1.130	0.015	0.031	0.017	0.027	-0.008
Wald χ^2		2167.32***	41738.56***	37736.36***	18992.16***	21237.49***	15739.73**	16520.88***	7499.94***
log L		-4160.56	-1235.60	-1755.35	-1113.08	-1289.84	-1272.29	-1185.11	-1204.40
Number of observations		3163	3163	3095	2786	2646	2476	2265	2078
	Censored	1292	68	309	140	170	211	188	207
	Uncensored	1871	3095	2786	2646	2476	2265	2078	1871

2) β_1 is not only closer to 1 in the yearly estimates (this being simply a consequence of the expected close similarity in size in two adjacent years), but this coefficient is increasing over time and not statistically different from 1 in the last periods. Overall, convergence to Gibrat-like behavior emerges. While these results remain virtually unchanged when a dummy for newborn firms is included,[9] some further considerations arise when one looks at table 3, which takes the age variable fully into account.

3) Consistently with previous studies, the inverse relationship between age and growth and the positive link between age and survival are both confirmed over the entire period. Yet age seems to lose its role in the second sub-period (1990-1994).

4) As in the previous estimates, Gibrat's Law is rejected in general, but some convergence towards the validity of the Law occurs over time. In this table the Wald test does not reject the hypothesis of $\beta_1=1$ from 1990-91: not surprisingly, the departure from Gibrat's Law is confined to the first three years, when the population of firms is still strongly characterized by the presence of small transient firms and when the sample selection is particularly significant (the null $\rho = 0$ is rejected).[10]

Before our sample is split into incumbent and newborn firms, a preliminary conclusion can be drawn. Gibrat's Law does not hold for the entire population of 3,285 firms and over the entire period, because smaller and younger firms exhibit a higher propensity to grow. Nevertheless, allowing for market selection through failures, the core of survivors display Gibrat-like behavior; that is, *within the sub-population of larger and more efficient firms*, Gibrat's Law seems to hold and relative size and age loose their roles. In other words, it is plausible to conclude that the 1,933 surviving firms exhibit (and will probably exhibit in the subsequent periods for which data are not available) growth patterns consistent with the Law of Proportionate Effect. This result is even more marked if attention is turned to newborn firms, where market selection through early failure is even more dramatic.

Table 4 prompts the following comments:

5) As in the previous tables, Gibrat's Law is rejected over the entire period. Here the departure from the Law is larger than in the previous cases, with a lower $\beta_1=0.725$. Yet, β_1 is increasing over time and becomes not significantly different from 1 from the fourth period on.

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[9] The coefficient of this dummy variable is significantly different from zero, thereby pointing up differences in growth patterns between newborn and incumbent firms. The results are not given here, but are available on request.

[10] In this case, too, the inclusion of a dummy for newborn firms does not change the results.

6) Unlike in the previous tables, initial size seems to play a minor role in determining the likelihood of survival (probably due to the fact that almost all the new entries enter the market at a sub-optimal scale).

Hence, *even within the particular population of newborn firms*, smaller firms grow faster in the years immediately after entry, but then the reshaped population of surviving firms tends to behave in a Gibrat-like way. In other words, a post-entry size adjustment occurs immediately after entry when the very sub-optimal firms try to converge to the average entry size; this process ends within the first 3 years after entry.

Turning to incumbent firms alone, not surprisingly we find further confirmation for the previous results (see table 5 and table 6 with the additional age variable).

7) *Within incumbent firms,* Gibrat's Law is again rejected in general, but it is confirmed once market selection has reshaped the original population in favor of the larger and more efficient firms.

8) Unlike in the case of newborn firms, initial size and age continue to be good predictors of incumbents' likelihood of survival.

4. Conclusions

The main finding of this study on the Italian Radio, TV & Telecommunications equipment industry is that the rejection of Gibrat's Law, common to most previous empirical research and also found here, may be due to market dynamics and selection, that is, to the entry process and the failure of transient smaller firms. Indeed, whilst we find that Gibrat's Law must be rejected over a seven-year period in which both incumbent and newborn firms are considered, for both the sub-populations convergence towards a Gibrat-like behavior over time can be detected. In other words, the reshaped and smaller population of surviving firms resulting from market selection exhibits*, within itself*, patterns of growth consistent with Gibrat's Law.

Referring to the list of questions proposed in Section 2, we can conclude that Gibrat's Law is rejected in general terms (question *a*), but this rejection is due to the presence of a "fringe" of smaller and younger firms which are gradually selected out by market mechanisms. In other words, over time, some sort of shakeout (see Klepper and Miller, 1995) occurs and the remaining "core" of surviving firms tends to behave according to the Law of Proportionate Effect (question *c*[11]).

This process is even more marked among new entries (question b), since the fringe of sub-optimal scale firms is relatively larger. This is why the overall seven-year β_1 is lower than for

[11] This evidence is consistent with theoretical models of entry and market selection with learning (see Jovanovic, 1982; Pakes and Ericson, 1998; Cabral, 1997).

incumbent firms. Nevertheless, among newborn firms as well, there is evident convergence towards Gibrat's Law (question c).

In sum, the passage of time enables the market "to clean" a given population of firms[12] and the surviving industrial core (mature, larger, well-established and most efficient firms) does not seem to depart from a Gibrat-like pattern of growth. This result reconciles the recent literature with the very early studies on Gibrat's Law (see Hart and Prais, 1956; Simon and Bonini, 1958; Hymer and Pashigian, 1962) which tended to confirm the Law on the basis of samples comprising very large, old and well-established firms.

If these results are confirmed by future research, Gibrat's Law should no longer be considered a representation of overall industrial dynamics, but rather as a way to describe the growth behavior of mature, large and well-established manufacturing firms.

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[12] This process of gradual shakeout may be strengthened by economic recession, as was the case in Italian manufacturing during the early 1990s.

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