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Evidence across Sectors and over Time

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Evidence across Sectors and over Time[!]

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Abstract:

In addition to the usual variables representing firm- and industry-specific features that impact the firm's survival, this paper uses three R&D related variables to reflect two Schumpeterian technological regimes: creative destruction (the entrepreneurial regime) and creative accumulation (the routinized regime). After controlling for age, size, entry barriers, capital intensity, the profit margin, the concentration ratio, the profit-cost ratio and entry rates, the empirical results confirm the theoretical relationship between technological regimes and the survival rate of new firms: new firms are more likely to survive under the entrepreneurial regime. Moreover, this effect is larger within the younger cohorts of firms than within the older ones.

Keywords：Firm Survival, Technological Regimes, Taiwanese Manufacturing.

JEL Classification: L1, L2

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I. Introduction

The survival rate of firms did not receive much attention in the literature until the 1980s. Being stimulated by Gibrat's Law (1931), which states that a firm's performance is irrelevant to its size or scale, most of the empirical studies in the 1950s and 1960s focused on the relationship between the growth rate and firm size by making use of firm-level data. However, Mansfield (1962) also considered small-sized firms in his sample and found a negative relationship between growth and initial size, which was clear evidence against Gibrat's Law. To explain his striking result, Mansfield (1962) raised the problem of sample selection bias, i.e. it may be harder for small firms to survive and thus firms that we observe in our sample are those that are more efficient[1].

To explain the empirical evidence against Gibrat's Law and the differences in survival chances, economists have relied on models that emphasize firm heterogeneity and market selection. For example, Jovanovic (1982) has provided a passive learning model where firms learn about their efficiency as they operate in the industry. Alternatively, Ericson and Pakes (1995 and 1998) have provided an active learning model, emphasizing the role of a firm's active research and exploration while perceiving a profit opportunity in a certain industry. Accordingly, age and size should be positively linked to the survival rate of firms. Following these random selection theories, some empirical studies investigating the link between size/age and survival have been put forward. For example, Evans (1987a, 1987b), Hall (1987), Dunne, *et al.* (1989), Dunne and Hughes (1994), and Lotti, *et al.* (2003) have found empirical support for the positive relationships between a firm's size and its survival and between a firm's age and its survival.

Other studies have focused on industry-specific factors. For example, Agarwal and Audretsch (1999, 2001) have investigated the impact of the life cycle and the technology intensity of industry on the relationship between firm size and its survival. Their empirical results suggest that in the mature stage of an industry smaller firms are not necessarily confronted with a lower likelihood of survival.

In more general terms, the survival rates of new firms vary systematically across industries, as observed by Dunne, *et al.* (1989). To explain this observation, industry-specific factors such as the intensity of innovation, the concentration ratio, the minimum efficient scale (for this point in the Finnish economy see also Nurmi, 2006), the profit rate and industry growth are considered in the empirical studies performed by Audretsch (1991 and 1995). His empirical tests are based on the hypothesis well-posited by Geroski (1995, p.21), that ‘the growth and survival prospects of new firms will depend on their ability to learn about their environment, and to link changes in their choices of strategy to the changing configuration of that environment … (t)he more turbulent the market environment, the more likely it is that firms will fail to cope. If the process of entry continually throws up new aspirants for market places, then slow learning coupled with a turbulent environment means that high entry rates will be observed jointly with high failure rates.’ The empirical evidence confirms the conclusion also put forward by Geroski (1995, p.23) that ‘entry appears to be relatively easy, but survival is not’.

Thus - on the basis of the previous literature - factors affecting the survival rate of a newborn firm can be classified into two categories: firm- and industry-specific. As far as firm-specific factors are concerned, the most important are age and size,[2] while the most important industry-specific factors are more related to market structure and to the extent of entry barriers.

However, an interesting aspect, which is seldom considered in the empirical studies on survival, is the type of “*technological regime*”. According to Neo-Schumpeterian economists such as Nelson and Winter (1982), Winter (1984), Dosi (1988), Malerba and Orsenigo (1993, 1995, 1996) and Breschi, *et al.* (2000), there are two types of technological regimes: creative destruction and creative accumulation.

The creative destruction, also referred to as the *Entrepreneurial Regime*, refers to technological innovations that tend to replace the old technology, or more specifically, to shorten the life cycle of the technology being adopted by the established incumbent firms. In other words, this regime is characterized by technologies with high opportunities, low appropriability and low cumulativeness, as discussed in Malerba and Orsenigo (1993) and denoted as *Schumpeter Mark I* in Breschi, *et al.* (2000).[3] Thus innovation is naturally brought about by new firms, while the established older firms have less of an incentive to evolve. Consequently, an industry subjected to the technology regime of creative destruction tends to have lower entry barriers, and new firms are likely to dominate the innovation activities of the industry. Accordingly, new firms in this type of industry are more likely to survive, as stated by Van Dijk (2000) and Audretsch (2001).

The other type of technology regime, referred to as the *Routinized Regime*, is instead characterized by creative accumulation technology, that is, innovation makes the prevailing technology deeper and more efficient to serve the current market or improve production processes, and usually requires more experience in the related industry or market. More specifically, this regime is characterized by technologies with lower opportunity, higher appropriability and higher cumulativeness as discussed in Malerba and Orsenigo (1993) and denoted as *Schumpeter Mark II* in Breschi, *et al*. (2000). Thus the experienced incumbent firms have innovative comparative advantages in such kinds of industries. As a result, the entry barriers will be higher and the survival rate for the new firms will be lower (see Van Dijk, 2000 and Audretsch, 2001).

The remainder of this paper is organized as follows: Section II describes the data and the related econometric specification, Section III reports the empirical results and Section IV concludes.

II. Methodology

Data and Specification

The firm-level data are drawn from the census surveys conducted by the Directorate General of Budget, Accounting and Statistics (DGBAS), Executive Yuan, Taiwan in 1981, 1986, 1991, and 1996. This is an official survey containing information on many firm-level characteristics such as employment, R&D expenditures, sales, capital, profit and output, etc. Moreover, it also contains a firm’s ID that is constant over the four different periods of the survey, and the 4-digit industry classification of each firm’s product. The availability of the firm’s ID allows us to trace the status of each individual firm across different census years, and to build a longitudinal dataset. Thus, we can observe whether a firm listed in a given census year, say, 1991, can survive for another five years or not. In addition, the industry classification allows us to compute some industry specific variables, such us R&D intensity, and entry ratios, etc. to suit our goal of testing the hypothesis concerning technological regimes.

Being conducted at five-year intervals, the drawback of the dataset is that it omits the exit and entry of firms between the census years. In addition, there is no information regarding the date when the firm was in fact established, or about the personal characteristics of the establishers. Consequently, as noted earlier, the personal characteristics cannot be included in our study, although they may also affect the hazard rate of firms as addressed in the literature.

To suit our objective, we select all the firms in the 1991 census, or a total of 132,449 firms. Our empirical strategy is to conduct a survival test over the period 1991-1996. Then, via the firm's ID number, we will trace each of the selected firms in the census data for 1981, 1986, 1991 and 1996 to establish a longitudinal dataset. A surviving firm is defined as a firm in the census data for 1991 that not only appears again in the 1996 census data but also remains in the same 4-digit industry. In other words, a firm that has switched to another industry during the period from 1991 to 1996 is regarded as not surviving. Accordingly, we construct a SURV dummy variable that takes on a value of one for a surviving firm and zero for one that does not survive.

In addition, firms can be categorized into three cohorts based on their age as follows:

(1) The cohort for 1981 includes firms that already exist in the 1981 census data, and comprises 28,295 firms. Obviously they are firms in existence for more than 10 years, $10 \leq AGE$, and constitute the oldest group of firms in our sample. The corresponding dummy variable is denoted as COH81, which takes on a value of one for observations in this group, and a value of zero otherwise.

(2) The cohort for 1986 is composed of firms that newly appear in the 1986 census data, i.e., firms at least 5 years of age but less than 10 years of age, $5 \leq AGE < 10$. There are 33,473 firms in the group. The dummy COH86 takes on a value of one if the observation belongs to this cohort, and zero otherwise.

(3) The cohort for 1991 denotes firms that newly appear in the 1991 census data, i.e., firms less than 5 years of age, $AGE < 5$. This group contains 70,682 firms. The dummy variable, COH91, equals one if the observation belongs to this cohort, and zero otherwise.

Model and Variables

There are many factors determining the survival rate of a firm as discussed in the related literature. As noted earlier, these can be divided into two categories: firm-specific factors and industry-specific factors. To estimate the effects of these factors on the determination of the survival rate, we use the approach of the binary probit model, simply because of the limitations of the data structure. In other words, it is because there is no information regarding a firms' starting year, and due to the drawback of the 5-year interval that makes the exit and entry of firms between two census years unobservable, that the alternative approach of the hazard rate function adopted in some of the related literature is not feasible. More specifically, the discrete variable of SURV is considered as the dependent variable in a probit regression, and the explanatory variables to be included are measured as described below:

Firm-specific Factors

In regard to the firm-specific factors affecting the survival rate, the two most important are age and size. As discussed earlier, new and small size firms tend to have lower survival rates. From the age point of view, therefore, the oldest cohort in our sample, that is, the 1981 cohort, should have the highest survival rate, and the youngest group of firms, the 1991 cohort, should be expected to have the lowest survival rate. Hence, the estimated coefficient of the cohort dummy COH81 is expected to be bigger than that of COH86, which in turn is bigger than that of COH91.

A few simple statistics roughly confirm this viewpoint, as shown in Table I. On average, the survival rate for the whole sample is 55.21%. However, the survival rate for the oldest group, the 1981 cohort, is 60.94%, which is higher than the 57.84% for the 1986 cohort, which in turn is higher than the 51.67% for the youngest cohort, or the 1991 cohort.

Table I

Survival Rate and Age of Taiwanese Firms

Cohort	Total	1981	1986	1991
Number of Firms	132449	28295	33473	70682
Surviving Firms	73125	17243	19361	36521
Survival Rate	55.21%	60.94%	57.84%	51.67%

Firm size and the survival rate are positively correlated as commonly found in the literature. This is also supported by a first glimpse at our sample. Table II below computes the survival rate for each scale of firms. For the group of firms with the largest scale (Scale 5, in the last column of Table II), the survival rate is 70.12%, and the smaller the scale, the smaller is the survival rate. For the smallest scale firms (Scale 1 in Table II), the survival rate is the lowest at 52.42%.

Table II
Scale of Firm and Survival Rate

Firm Size	Scale 1	Scale 2	Scale 3	Scale 4	Scale 5
Number of Firms	86706	37702	4809	1899	1333
Surviving Firms	45454	22345	3146	1245	935
Survival Rate	52.42%	59.26%	65.41%	65.57%	70.12%

The scales are defined as follows: scale 1= employment<10, scale 2=10≤ employment<50, scale 3=50≤employment<100, scale 4= 100≤employment<200, and scale 5= 200≤employment.

Industry-specific Factors

There are also many industry-specific factors affecting the survival rates. Based on our review of the literature, the variables to be considered in our regression are as follows (see also Table III for the summary and related definitions):

Capital Intensity The average capital input per real output value for each 4-digit industry is computed and denoted as KQR. Intuitively, a higher capital intensity to some extent reflects less flexibility in terms of adjusting to market turbulence, and will thus have a negative effect on the survival rate. On the other hand, the KQR can be considered to be a proxy for sunk costs and barriers to entry as well as barriers to exit, thus increasing the likelihood of survival of the incumbent firms. See Cabral (1995, 1997) for a discussion. Consequently, the effect of KQR on the survival rate is ambiguous, and depends on which of the forces dominates.

Market Environment In addition, four other variables that are indicators of the market environment, or the degree of competitiveness, are designed for each of the 4-digit industries. They are HH (the Hirschman-Herfindahl concentration index), PCM (the profit margin), MES (the minimum efficient scale) [4] and ENTR (the entry rate of new firms). Theoretically, the first three measures (i.e., HH, PCM and MES) are negatively related to the degree of competitiveness of the market. That is, the higher the three indexes, the lower the degree of competitiveness and thus the greater is the likelihood of a firm surviving. However, the entry rate of new firms (ENTR) reflects the market turbulence of an industry. A higher ENTR signals a higher degree of market turbulence, thus corresponding to a lower survival rate. [5]

Technology Regime Three R&D related variables are designed for the regression to capture the relationship between technology regimes and the survival rate. They are RDI (R&D intensity, defined as the ratio of R&D expenditure to total employment for each 4-digit industry), RDN (the R&D share of new firms, defined as the ratio of R&D expenditure by new firms to the total R&D expenditure of the industry as a whole), and finally CORR (the rank correlation coefficient between the RDI and Employment).

Theoretically, a higher R&D intensity (RDI) implies higher innovation opportunities for the industry, thus providing better conditions for the survival of the new firms. In other words, a higher RDI implies that the more likely that the industry is subjected to the so-called entrepreneur regime, the more likely that the survival rate for new firms will be higher. That is, for the 1991 cohort the estimated coefficient for RDI is expected to be greater than that for the 1986 cohort, which in turn is greater than that for the 1981 cohort. In the case of the pooled sample, we consider the RDI and the cross dummies of COH86RDI (defined as COH86 times RDI) and COH91RDI (defined as COH91 times RDI), and expect to find a positive coefficient for both COH91RDI and COH86RDI, and a larger coefficient for COH91RDI than for COH86RDI. On the other hand, the RDI may also reflect the sunk costs, which may tend to deter the likelihood that the incumbent firms will exit the market and also discourage the entry of new firms. Consequently, the effect of RDI on the survival rate becomes ambiguous.

A higher RDN indicates that the more that the innovation activities come from the new firms, the more likely it is that the technology regime will exhibit creative destruction, or be of the so-called entrepreneur regime.

Therefore, a higher RDN implies a better opportunity for entry through innovation, and a higher survival rate for new firms. Accordingly, we would expect that for an industry with a high RDN, the youngest cohort (1991) should have the highest survival rate, while the oldest cohort (1981) should have the lowest survival rate. To test this hypothesis, the cross dummies of COH86RDN (defined as COH86 times RDN) and COH91RDN (defined as COH91 times RDN) are considered in the regression involving the whole of the sample data. Furthermore, the estimated coefficient for COH91RDN is expected to be greater than that for COH86RDN.

The last technology regime-related variable is CORR, which is defined as the rank correlation coefficient between the RDI and employment for each 4-digit industry. The higher the CORR, the more R&D that will be conducted by the big firms, reflecting a likely environment that is beneficial for big firms to conduct innovation, that is, a routinized regime. In the extreme, a zero CORR indicates no relationship between firm size and R&D intensity, thus implying a better environment for new firms to survive, i.e. an entrepreneur regime. To sum up, theoretically speaking, the lower the CORR, the more likely the industry will be characterized by the entrepreneur technology regime, and thus the environment will be more beneficial for new firms seeking to survive. On the contrary, a higher CORR implies that it is more likely that the underlying industry will be characterized by a routinized regime, and will thus be less beneficial to the new firms. As a result, we would expect that the coefficient for COH91CORR will be less than the coefficient for COH86CORR, where COH91CORR is COH91 times CORR, and COH86CORR is COH86 times CORR. For convenience, the variables are listed in Table III. The descriptive statistics of the independent variables are reported in Table IV, and the matrix of correlation coefficients is reported in the Appendix as Table A1.

Table III

List of Variables Adopted

Variable (expected sign)	Description
SURV	Surviving Dummy, it takes a value of 1 for a surviving firm (defined as above), otherwise 0
LE91 (+)	Log (Employment of each Firm in 1991)
COH81 (base)	Cohort Dummy, it takes a value of 1 for firms newly appearing in 1981, otherwise 0. Note this cohort will be used as the base group, and thus will not be included in the regression. (Oldest cohort)
COH86 (-)	Cohort Dummy, it takes a value of 1 for firms newly appearing in 1986, otherwise 0. (Middle aged cohort)
COH91 (-)	Cohort Dummy, it takes a value of 1 for firms newly appearing in 1991, otherwise 0. (Youngest cohort)
KQR (-)	Capital/Real Output for each 4-digit industry
HH (+)	Hirschman-Herfindahl Index, defined as the sum of squares of each firm's output share for each 4-digit industry
PCM (+)	Profit/Output Ratio for each 4-digit industry
MES (+)	Minimum Efficient Scale Index for each 4-digit industry. Defined as the ratio of the median firm's scale to the mean scale for each 4-digit industry
ENTR (-)	Entry Rate (number of new firms/total number of firms) for each 4-digit industry
RDI (?)	R&D intensity, the ratio of R&D/Employment for each 4-digit industry
COH86RDI (+)	COH86 times RDI
COH91RDI (+)	COH91 times RDI
RDN	R&D share of new firms, the ratio of New Firms' R&D / R&D for all firms in the 4-digit industry.
COH86RDN (+)	COH86 times RDN
COH91RDN (+)	COH91 times RDN
CORR	Rank correlation coefficient between R&D/Employment and Employment
COH86CORR (-)	COH86 times CORR
COH91CORR (-)	COH91 times CORR

Table IV
Descriptive Statistics of Industry-Specific Variables

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
LE91	129	162.749	1299	20995	3.1111	14743
ENTR	129	0.68517	0.16278	88.3863	0	1
RDN	129	0.13069	0.25143	16.8593	0	1
RDI	129	9.31667	15.03448	1202	0	72.5873
CORR	129	0.20578	0.14618	26.5454	-0.4083	0.737
PCM	129	0.18214	0.07507	23.4964	0.0932	0.7047
KQR	129	0.8187	0.44355	105.6119	0.1298	3.6637
HH	129	0.09672	0.18565	12.4773	0.0008	1
MES	129	0.38402	0.17137	49.5381	0.0106	1

Note: N= No. of Observations (a total of 129 sectors under the 4-digit industry classification in the census).

III. Empirical Results

The regression results from the binary probit model for the whole sample are reported in Table V.[6] Three models, denoted as Models A, B and C, are considered in the report. Model A contains independent variable LE91 (firm size), the cohort dummies (age) of COH86 and COH91 (i.e., the base cohort is that for 1981 denoted by COH81), and three regime-related variables, namely, RDI, RDN and CORR, as shown in the second column of Table V. In addition, Models B and C contain more industry-specific variables, such as KQR (the Capital/Output Ratio), HH (the Herfindhal Index of Concentration), PCM (the Profit Margin), MES (the Minimum Efficient Scale) and ENTR (the Entry Rate). Note that the HH and PCM variables are considered alternatively in Models B and C, due to its significant correlation as shown in Table A1 in the

Appendix.

In another experiment, we try the model where we drop RDI and its related variables COH86RDI and COH91RDI, and find no significant change in the estimated coefficient. Hence, the results are not reported here but are available upon request.

Using the pooled sample allows us to test the difference in terms of the estimated coefficient between different cohorts. For this purpose, cohort dummies are included in the explanatory variables, including COH86 and COH91. Note that we pick the oldest cohort (age greater than 10 years) as the base group so that the dummy for COH81 is excluded from the regression. To test the relationship between the technological regimes and the survival rate of new firms, the cross dummies of R&D-related measures and different cohorts are considered, such as COH86RDI, COH91RDI; COH86RDN, COH91RDN; and COH86CORR, COH91CORR. The results are as follows:

Size, Age and Survival

The relationship between firm size and the survival rate is represented by the coefficient of LE91 (the log of employment in 1991). The estimated coefficients are significantly positive for each of the Models A, B and C. This result indicates the positive relationship between firm size and the survival rate, which is consistent with the stylized fact commonly observed in the literature.

The firm’s age is positively linked to the survival rate, according to the self-selection theory of Jovanovic (1982). Therefore, we would expect the survival rate for the 1981 cohort to be greater than that for the 1986 cohort, which in turn will be greater than that for the 1991 cohort. Our empirical results confirm this relationship, as shown in Table V. In addition to those variables considered in the single cohort sample (not reported), we include two cohort dummies COH86 and COH91, to test whether the survival rates are different across cohorts. Using the 1981 cohort as the benchmark, if age is positively related to survival, then we would expect not only a negative coefficient for COH86 and COH91, but also a smaller coefficient for COH91. In fact, this is supported by the empirical results of all three models in Table V, where the estimated coefficients for COH86 and COH91 are –0.0042, and –0.0641, respectively, for Model A, –0.0102 and –0.0793 for Model B, and -0.0105 and -0.0794 for Model C, although the coefficients for COH86 are not significant in all three models. In other words, the empirical evidence confirms that younger firms have a lower survival rate**.**

Entry Barriers and Survival

Many industry-specific factors are considered in the regressions of Model B and Model C. As noted earlier, for every 4-digit industry, KQR, HH, PCM, MES, ENTR, RDI, RDN, and CORR are measured. These variables can be divided into two categories: one relating to the identification of the technological regime (RDI, RDN and CORR), and the other relating to commonly adopted industry-level variables (KQR, HH, PCM, MES and ENTR).

For the group of non-technology related variables, namely, KQR, HH, PCM, MES, and ENTR, the empirical results can be summarized as follows:

KQR (Capital/Real Output): The estimated coefficients for KQR are significantly negative for both Models B (-.0472, significant at the 5% level) and C (-0.0356, also significant at the 5% level). This result may reflect the fact that high capital dependence reduces the operational flexibility in responding to market fluctuations and thus makes a firm more likely to fail. As discussed earlier, the variable KQR, as a proxy for sunk cost, which will decrease the incentive of the incumbent firm to exit (i.e., make it more likely to stay in business and be observed as surviving), will be positively related to survival. That is, if the sunk-cost effect is big enough to dominate the result, we would expect the estimated coefficient for KQR to be positive. However, it seems that our empirical results do not support this sunk-cost effect as being big enough.

HH (Concentration Index of Output Share): The estimated coefficients are positive, as shown in Model B. That is, the higher the concentration of the output share in a given industry, the more likely it is that a firm will survive. This reflects the fact that, the lower the degree of competitiveness, the more likely it is that a firm will survive.

PCM (Profit/Output Ratio): The estimated coefficients are positive and significant as shown in Model C, in which the PCM is adopted to replace the variable for HH in Model B. Like HH, this index also reflects the degree of competitiveness for the underlying industry, as indicated by the high correlation coefficient of 0.6301 between the two variables (see Table A1 in the Appendix). That is, a higher profit margin, as represented by a higher PCM, implies lower competitiveness in the market, and corresponds to a higher survival rate for firms.

MES (Minimum Efficient Scale): The estimated coefficients are also significantly positive for all the regressions; that is, 0.9715 in Model B and 0.8894 in Model C. A higher MES reflects a lower degree of competitiveness, and hence makes firms within the industry survive more easily.

ENTR (the Entry Rate) measures the ratio of the number of new firms (appearing in the 1991 census data but not in the previous survey) to the total number of firms for each 4-digit industry. A higher ENTR indicates higher market turbulence or fiercer competitiveness, as noted in the literature. Hence, we would expect a negative relationship between the ENTR and the survival rate. This hypothesis is empirically supported by our empirical results, as shown in Table V, in which the estimated coefficients for ENTR in Models B and C are -0.5121 and -0.5475, respectively.

To sum up, our empirical results show that among those industry-specific variables, both KOR (the capital/output ratio, denoting the degree of sunk cost and/or the flexibility of adjustment to market variation) and ENTR (the new firms' entry ratio, reflecting the degree of competitiveness in an industry) are negatively related to the survival rate of new firms. On the contrary, the other three variables for HH (the concentration index), PCM (the level of the profit margin) and MES (the minimum efficient scale), all reflecting the level of the entry barriers, are positively related to the survival rate of new firms. All of these results consistently provide empirical support for the theoretical relationship where the lower the degree of competitiveness, the more likely it is that a firm will survive.

Technological Regimes and Survival

The three variables RDI, RDN and CORR are designed to capture the relationship between technological regimes and the survival rate.

RDI (R&D intensity, measured by the ratio of R&D/Employment**)**: As noted earlier, a higher RDI implies that the industry is characterized by the entrepreneur regime of technology, and hence will provide better opportunities for new firms to enter and survive. Thus, it is expected that, the higher the RDI, the higher will be the survival rate for the youngest cohort (that is, 1991) as compared with that for the 1986 cohort, which in turn will have a higher survival rate than the 1981 cohort. The empirical results in Table V weakly confirm this hypothesis, as shown by comparing the coefficient of the cross dummies of COH91RDI and COH86RDI. All three Models A, B and C exhibit a larger coefficient for COH91RDI than for COH86RDI, although only one of the coefficients (COH91RDI in Model A) is significant.

RDN (R&D share of new firms): Like RDI, a higher RDN implies better innovation opportunities for new firms, thus helping new firms to overcome the disadvantages of scale and other market barriers, and hence indicating the features of the entrepreneur regime for the underlying industry. Thus, we would expect RDN to have a 'higher' positive effect on the survival rate for newer firms. This is indeed supported by the empirical results. As shown in Table V, all three models exhibit significantly positive coefficients for COH86RDN and COH91RDN. In addition, the younger cohort's cross-dummy with RDN has a larger coefficient than that of the older cohort. For example, in Model B we have 0.3601 (COH91RDN), which is greater than 0.2953 (COH86RDN), which in turn is greater than -0.3052 (RDN). A similar pattern can be found in Model C. The economic meaning of this result deserves a more explicit interpretation. The negative coefficient for RDN indicates that, if the oldest cohort (that is COHORT 1981) is operating in the industry where the new firms' R&D is more active, it is more likely to fail. On the other hand, a positive and larger coefficient for COH86RDN and an even larger one for COH91RDN than that of RDN, indicates that the younger the cohort, the more likely it is that the firms will survive in an industry where the new firm's R&D is more active.

CORR (Rank Correlation Coefficient between RDI and Employment): As discussed earlier, a higher CORR implies that the underling industry is more likely to be subjected to the routinized regime of technology, which works against the newer firm. Thus, we would expect a negative relationship between the CORR and the survival rate for the younger cohort than for the older cohort. Table V confirms this hypothesis, as shown by comparing the estimated coefficients of the two cross dummies of COH91CORR and COH86CORR, (–1.1997 and –0.682, respectively, for Model A, –1.0408 and –0.5928, respectively, for Model B, and -0.9975 and -0.5602, respectively, for Model C).

To sum up, our empirical results show that in an industry with higher R&D intensity (RDI), higher innovation opportunities (R&D shares for new firms, RDN) and lower accumulation (CORR- correlation between the RDI and employment), new firms are more likely to survive. On the contrary, in an industry with lower RDI and RDN and a higher CORR, new firms are less likely to survive. In other words, our empirical findings support the theoretical relationship between the technological regimes and firm survival, as addressed by the Neo-Schumpeterian economists. That is, new firms are more likely to survive in an industry characterized by an entrepreneur regime, but are less likely to survive under a routinized regime. In addition, the finding emerges from the data that this divide between the two technological regimes is more important for younger cohorts than for the older ones.

Table V

Probit Regression of Survival for Taiwanese Firms

Dependent Variable: SURV

	Model A	Model B	Model C
Intercept	0.0923 (0.0176)**	-0.1557 (0.0485)**	-0.2592 (0.0489) **
LE91	0.1000 (0.0031)**	0.1056 (0.0032)**	0.1046 (0.0032) **
COH86	-0.0042 (0.0238)	-0.0026 (0.0241)	-0.0105 (0.0241)
COH91	-0.0641(0.0205)**	-0.0691 (0.0207)**	-0.0794 (0.0207) **
KQR		-0.0472 (0.0162)**	-0.0356 (0.0182) **
HH		0.3308 (0.0794)**	
PCM			1.7127 (0.1627) **
MES		0.9715 (0.0574)**	0.8894 (0.0526) **
ENTR		-0.5121 (0.0356)**	-0.5475 (0.0354) **
RDI	0.0010 (0.0009)	0.0021 (0.0009)**	0.0016 (0.0009)
COH86RDI	0.0012 (0.0012)	0.0005 (0.0012)	0.0006 (0.0012)
COH91RDI	0.0022 (0.0010)**	0.0012 (0.0010)	0.0012 (0.0010)
RDN	-0.0415 (0.0304)	-0.3052 (0.0319)**	-0.2919 (0.0320) **
COH86RDN	0.1970 (0.0456)**	0.2953 (0.0458)**	0.2955 (0.0458) **
COH91RDN	0.1816 (0.0399)**	0.3601 (0.0405)**	0.3593 (0.0405) **
CORR	-0.0978 (0.1106)	0.8307 (0.1235)**	0.5870 (0.1240) **
COH86CORR	-0.6821 (0.1577)**	-0.5928 (0.1596)**	-0.5602 (0.1597) **
COH91CORR	-1.1997 (0.1360)**	-1.0408 (0.1376)**	-0.9975 (0.1378) **
Log-likelihood	-90025.33	-89624.85	-89577.87
Number of obs	132449	132449	132449

Notes: Numbers in parentheses are standard errors. Superscripts '*' and '**' denote significance levels of 10% and 5%, respectively.

IV. Concluding Remarks

Using the census data for Taiwanese manufacturing in 1981, 1986, 1991 and 1996, we first construct a longitudinal data set for all the firms that appeared in the 1991 census. Firm level and industry-specific variables are constructed, including age, size, and others to basically measure the degree of entry barriers for each 4-digit industry. More importantly, we construct R&D-related indexes, to reflect the technological regimes that have been referred to by Neo-Schumpeterian economists, including those of creative destruction (the entrepreneur regime) and creative accumulation (the routinized regime)

By means of a Probit model, this paper aims to test the relationship between the two technological regimes and the firms' survival rate as addressed by the Schumpeterian school. That is, for the industry featured by the entrepreneur regime, new firms can find more room to enter and survive. On the contrary, for the industry characterized by innovations involving creative accumulation or the so-called routinized regime, new firms face higher entry barriers and thus should have a lower survival rate.

After controlling for other commonly adopted variables, including age, size, the entry barrier index of capital intensity, the profit margin, the concentration ratio, the profit-cost ratio and entry rates, our empirical results confirm the theoretical relationship between the technological regimes and survival rate of new firms, that is, new firms are more likely to survive under the entrepreneur regime, but are less likely to do so under the routinized regime.

Our empirical results also support the commonly found relationships in the related literature, including: (1) age and size are positively related to the survival rate, (2) the entry rate and capital intensity are negatively linked to the survival rate, and (3) the profit margin, concentration of real output, and minimum efficient scale are positively related to the survival rate.

Taken together, our paper can be regarded as a complement to the existing literature by providing empirical evidence to explain why the relationship between the new firm's survival varies from industry to industry. In this line of the literature, the degree of innovative activity is found to play an important role in affecting the new entrant's viability. Our empirical evidence suggests that the innovative activity can affect the survival rate of new firms in either direction depending on the type of technological regime in the underlying industry. Finally, this effect is larger within the younger cohorts of firms than within the older ones.

Based on these results, some policy implications can be drawn. Policies to promote entry can be effective or ineffective, depending on the type of subsidies, and the characteristics of the regime of the industry. A lump-sum subsidy or a financial loan to a new firm can promote entry for both types of industries. However, a relatively larger subsidy may be required for an industry with a routinized regime than for one with an entrepreneur regime, simply because of the higher levels of entry barrier under the former regime. Should a government choose R&D subsidies in attempting to promote entry, this may not prove effective if the underlying industry is characterized as a routinized regime. On the contrary, for an industry characterized as an entrepreneur regime, a R&D subsidy can efficiently increase the likelihood that a new firm will get a foothold in the market.

Notes

1. Empirical evidence against Gibrat's Law can also be found in Audretsch, *et al.* (1999) by using Italian data. For a thorough survey of "Gibrat's legacy" and related empirical studies see also Sutton (1997), Caves (1998), Lotti, *et al.* (2003) and Calvo (2006).

2. It should be noted that the personal characteristics of founders and entrepreneurs, which are not available in our dataset used in this study, may also be important in affecting the hazard rate as documented in the literature of Bates (1990), Reid (1991), Storey (1994), Arrighetti and Vivarelli (1999), Vivarelli (2004) and Masuda (2006). By the same token, other models describe entrepreneurship as a self-employment choice where current wages and expected profits from the new firm are compared (see Vivarelli, 1991 and Foti and Vivarelli, 1994), once risk aversion is taken into account (see Norton and Moore, 2006 and Cressy, 2006). For a recent discussion and comparison of the various theories of entrepreneurship, see Endres and Woods (2006).

3. See Dosi (1981) and Winter (1984) for earlier studies on technology regimes, showing how different opportunity and appropriability conditions and relevant knowledge bases may lead to different patterns of industrial evolution.

4. The minimum efficient scale is defined as the ratio of the median to the mean of employment distribution for each 4-digit industry. This is the same definition as that adopted by Baldwin and Scott (1987).

5. This is a hypothesis posited by Geroski (1995, p.21). A similar test is conducted in Audretsch (1995).

6. In addition to the whole sample regression, we have also applied the probit model to investigate the survival equation for each cohort for 1986, 1991 and 1996. Since one of the major concerns in this study is to see whether the effect of R&D-related factors (technological regimes) on survival differs for different cohorts, we suppress the reporting of results from the sample involving a single cohort. However, the estimated results are available upon request from the authors. In general, the sign of the estimated coefficients are the same as those estimated from the pooled sample, aside from some minor differences.

Appendix: Correlation Coefficients among the Independent Variables

Table A1
Correlation Coefficients (N=129)

	ENTR	RDN	RDI	CORR	PCM	KQR	HH	MES
ENTR	1							
RDN	-0.00393	1						
RDI	-0.03195	-0.01074	1					
CORR	-0.0383	0.06797	0.47175**	1				
PCM	-0.16751**	-0.08181	0.23571**	-0.11074	1			
KQR	-0.38245**	0.04593	-0.17847**	-0.22175**	0.0445	1		
HH	-0.09514**	-0.10963	0.22718**	0.00458	0.63014**	-0.11507	1	
MES	-0.0242	0.07333	-0.3696**	-0.52201**	0.10693	0.21563**	-0.03498	1

Note: The superscripts '*' and '**' denote significance levels of 10% and 5%, respectively.

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