

Survival of Newly Founded Businesses: The Post-Entry Performance

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I. INTRODUCTION AND BACKGROUND

A number of studies have been undertaken on industry dynamics or about the process by which new firms either survive and grow, or else exit from the industry. A new literature has emerged in the last few years, which focuses on the question, what happens to new firms subsequent to their entry?, both in terms of their likelihood of survival and their growth patterns. Most of the studies use a theory of organisational ecology by Hannan and Freeman (1989), which emphasises organisational characteristics and environmental conditions; particularly the number of employees and invested capital. In addition, the theory offers a comprehensive set of factors that influence the hazard rate of newly founded business organisations. In particular, this theory deals with the evolutionary process within or between populations of organisations observed over long periods of time [see also Singh and Lumsden (1990)]. Originally, Stinchcombe (1965) directed the attention of organisational theorists, based on a hypothesis of a "*liability of newness*", to the age-dependent decline in organisational death rates. A number of studies [Freeman, Carroll, and Hannan (1983)] found that the organisational death risk declines monotonically with age. Later, Brüderl and Schüssler (1990) also empirically tested the Stinchcombe's "*liability of newness*" hypothesis and showed that it is not a good representation of the mortality (hazard) of business organisations. Organisational ecologists often discuss the "*liability of smallness*" in connection with the liability of newness [Aldrich and Auster (1986); Brüderl and Schüssler (1990); Audretsch and Mahmood (1994)]. The assumption is that large new businesses have better survival prospects than small new businesses. Initial size may be measured in terms of either the amount of financial capital or the number employed at the time of founding. A large pool of financial resources improves the chances of a new firm to weather the critical start-up period and to cope with random shocks from the environment. Furthermore, large

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organisations may have advantages in raising more capital (legal form), may face better tax conditions, and may be in a better position to recruit qualified labour. However, smaller firms have the advantage of low overhead costs, and they require minimal resources for sustenance. A successful business may begin on a relatively small scale and build up step-by-step in an exploratory fashion.

Similar arguments that characteristics specific to the firm influence their new-firm survival have also been tested by Audretsch (1995) using the industrial organisation theory. For example, a greater start-up size of the firm increases the likelihood of survival, since the cost advantage confronting a firm operating at a sub-optimal scale level of output will be reduced. At the same time, the greater the size, the less it will need to grow in order to exhaust potential scale economies and ultimately survive. That is, if the start-up size of the firm is large enough relative to the MES of the industry, the firm need not grow at all and will still be viable in the long run. Both a positive relationship between firm size and post-entry growth rates have been found in the United States Hall (1987); Dunne, Roberts and Samuelson (1988) and (1989); Audretsch (1991); and Audretsch and Mahmood (1995), the United Kingdom Dunne and Hughes (1994), Germany [Wagner (1994); Mahmood (1996)], and Canada [Baldwin (1995)]. In addition other studies [Doms, Dunne and Roberts (1995)] show that firm-specific factors such as capital intensity and the use of specific advanced manufacturing technologies influence new-firm survival. Taken together, the wave of recent empirical studies therefore provides systematic evidence that new-firm survival is in most cases specific to factors particular to the firm and industry. In addition, the innovative environment of the industry has also been hypothesised to influence the new-firm survival of the firms. Empirical evidence for the United States [Audretsch (1991, 1995)] suggests that the likelihood of survival tends to decrease as the degree of innovative activity in an industry increases. However, the growth rates of those firms that do survive tend to be positively related to the degree of innovative activity in the industry. Other theories also suggest that new-firm survival will be influenced by the degree of scale economies in an industry [Audretsch (1995)].

A set of recent theories—belonging in a broad sense to the “Empiricist” traditions—suggests that new-firm survival is not random across firms, but rather shaped by characteristics specific to the firm. Dixit (1989) and Hoppenhayan (1992) both argue that new-firm survival will be influenced by the amount of sunk costs in the industry. A greater degree of sunk cost, should reduce the likelihood of exit and lead to lower observed growth rates for surviving firms. Audretsch (1991, 1995) provides the empirical evidence linking the extent of sunk costs to a lower likelihood of exit and lower observed growth rates of surviving firms. All of these empirical studies actually do not test the theoretical arguments from organisational ecology.

Other recent empirical studies of Fichman and Levinthal (1991) and Brüderl (1992) use the arguments of organisation ecology, in which they modify the liability of newness argument. This suggests that organisational hazard actually follows an inverted U-shaped pattern, rather than continuously declining with increasing age. This argument is associated with the "*liability of adolescence*", which states that organisational mortality rates follow an inverted U-shaped pattern: During the first short period the hazard (mortality) rate is low and the end of adolescence is marked by a mortality maximum, from which rate finally decline monotonically. They argue that newly founded organisations often have stock of initial resources. This stock helps them to survive for some time during which they can establish their new structures. This early stage of an organisational life-cycle is named "*adolescence*". During adolescence mortality rates should be low, whereas at the end of this phase, when initial resources are eventually used up and the final evaluation has to be made, mortality should increase dramatically. Afterwards, the usual arguments for a declining rate apply. Overall this "*liability of adolescence*" results in inverted U-shaped mortality rates.

A wave of empirical literature has now emerged which provides empirical evidence in favour of liability of adolescence. Several studies found non-monotonic mortality rates for a wide variety of organisational populations¹ [Singh, House, and Tucker (1986); Aldrich, Staber, Zimmer and Beggs (1990)]. Our study will try to provide further evidence on the liability of adolescence hypothesis by using a longitudinal data set for the U.S. from the theory² of organisational ecology, explained above, we will derive some testable hypotheses and test them applying the log-logistic rate model using our samples.

The purpose of this paper is to use the log-logistic model and test the hypothesis drawn from the organisational ecology and examine how resources and market environment conditions influence hazard rates. Further, it will be shown how hazard rates vary between low-, moderate- and high-tech industries within two-digit and across two-digit industries.

The following section describes the longitudinal data base. The third section presents the estimation method to be implemented. The fourth section describes the variables. Empirical results are then presented in section five and finally, the last section provides the conclusions.

II. THE LONGITUDINAL DATA BASE

A longitudinal data set is used based on the actual start-up and closure dates of newly established plants. This data set provides bi-annual observations on all the

¹ For the arguments, as to why some studies found monotonically declining rates, whereas others found inverted U-shaped rates. see Brüderl (1992).

² For a description and application of other theories relevant to start-up research, such as human capital, social network and transaction cost theories, see Granovetter (1983), and Aldrich and Wiedenmayer (1990).

firms and plants in the U.S. Small Business Administration's (SBA) Small Business Data Base (SBDB). The data base is derived from the Dunn and Bradstreet (DUNS) market identifier file (DMI), which provides a virtual census on about 4.5 million U.S. business establishments for every year between 1976–1986 [Acs and Audretsch (1990), Chapter Two].

The data base links the ownership of each establishment to its parent firm, thereby enabling the performance of the establishments which are independent firms to be distinguished from those which are branches and subsidiaries of parent firms. Thus, the data base makes it possible to identify each record or establishment as:

- a single-establishment firm, in which case the establishment is an independent legal entity;
- a branch or subsidiary belonging to a multi-establishment firm; or
- the headquarters of a multi-establishment firm.

Besides a detailed identification of the ownership structure of each establishment, the USELM file of SBDB links the performance of each establishment at two-year intervals beginning in 1976 and ending 1986, thereby tracking each establishment over what constitutes a ten-year longitudinal data base.

III. METHOD OF ESTIMATION

The techniques of survival analysis or event-history [see Blossfeld *et al.* (1989); Blossfeld and Rohwer (1995)] are used to test our theoretical arguments derived from the organisational ecology literature. The variable of interest in the analysis of duration is the *length of time* that elapses from the beginning of some event (birth of a firm) either until its end (exit of a firm) or until the measurement is taken (censoring), which may precede termination. The process being observed may have begun at different points in time. Censoring is a pervasive and usually unavoidable problem in the analysis of duration data. The central concept of this method is the hazard rate, which gives (approximately) for every age the probability that a firm will die in the next, short interval, conditional on still being alive. For multivariate analysis, however, parametric rate models can be used which specify the rate as a function of age³. This section describes the standard log-logistic model. In the single transition (episode) case the log-logistic model is based on the assumption that the duration variable follows a log-logistic distribution. This model has the advantage that it is able to capture both inverted U-shaped and monotonically declining rates.

The standard log-logistic model has two parameters α and β see Equation (1), so there are two possibilities to include variables. This model uses exponential link functions, so one gets the following model formulation for the transition rate from the origin state j to the destination state k . Variables that are supposed to influence the

³ For other parametric distributions, such as the Weibull, Log-Normal and Sichel, [see Blossfeld and Rohwer (1995)]. For a three parametric generalisation of the Log-Logistic Model, [see Brüderl (1991)].

shape of the rate should be attached to the β -vector, whereas α -effects correspond as shift-factors for the maximum rate. This model allows for a monotonically falling (β less than or equal 1) as well as for an inverted U-shaped hazard rate ($\beta > 1$). With this model we will test the "liability of adolescence" hypothesis.

$$r_{jk}(t) = \frac{b_{jk} a_{jk}^{b_{jk}} t^{b_{jk}-1}}{1 + (a_{jk} t)^{b_{jk}}} \dots \dots \dots \dots \dots \dots \dots \quad (1)$$

$$a_{jk} = \exp \{ A^{(jk)} \alpha^{(jk)} \}$$

$$b_{jk} = \exp \{ B^{(jk)} \beta^{(jk)} \}$$

The time t_{max} when the rate reaches its maximum, r_{max} , is given by

$$t_{max} = \frac{1}{a} (b - 1)^{\frac{1}{b}} \dots \dots \dots \dots \dots \quad (2)$$

$$r_{max} = a(b - 1)^{1 - \frac{1}{b}} \dots \dots \dots \dots \dots \quad (3)$$

It can be seen from Equation (3), that a negative effect of a variable in the α -vector lowers the maximum rate and, from Equation (2), that the maximum shifts to the right. It follows that variables which shift the peak, i.e., influence the length of adolescence, should be introduced into the α -vector. If few variables are introduced into both vectors, the β -effect still determines the shape of the rate, but α - and β -effects together determine the maximum.

IV. EXPLANATORY VARIABLES

Minimum Efficient Scale (MES)

The Comanor-Wilson (1967) proxy is used for measuring MES and is defined as the mean size of the largest plants in each industry, accounting for one-half of the industry value of shipments, 1977. This measure has proven in numerous studies at least to reflect the extent to which scale economies play an important role in an industry [Scherer and Ross (1990)]. This variable should exert a positive influence on the hazard rate because new firms typically operate at a scale of output that is less than the MES level [Audretsch (1991)]. Consequently, a shorter adolescence is expected indicating a higher risk for new establishments.

Start-up Size

The size of the establishment when it was founded is measured by the number of employees. A negative influence on the hazard rate is expected, i.e., larger start-ups should face a reduced risk, because as the start-up size increases it approaches the MES level of output. A longer adolescence and a right shift has to be expected.

Market Growth

This is measured as the percentage change in the total sales of the four-digit standard industrial classification (SIC) industry within which the establishment operated between 1976–1986. This measure is derived from the Annual Survey of Manufacturers of the U.S. Bureau of the Census. Market growth is expected to increase the growth potential of new establishments, and therefore should decrease the degree of risk confronting them. This indicates a lower risk and a shift to the right.

Research and Development/Sales

The 1977 Federal Trade Commission's line of business company R&D/Sales ratios are used. The sign of the coefficient is expected to be negative, since new establishments generally do not have access to a large R&D laboratory. A lower risk and a shift to the right is expected.⁴

V. EMPIRICAL RESULTS

A log-logistic distribution was identified on the basis of visual inspection of the transformed survivor functions plots. Among other models, the log-logistic model yielded the best fit among other distributions, such as Weibull, log-normal and exponential distributions.

As described in Section III the log-logistic model contains two parameters, so there are two possibilities to include variables, in α and β -vectors, i.e., variables included in the α -vector tend to shift the maximum to the right or left depending on the sign, and variables included in the β -vector influence the shape of the rate (see Equation 1, Section III). First, we used a log-logistic model without variables in both α and β -vectors and found that the estimated parameters of both models turn out to be statistically significant and their values in magnitude are greater than one. This implies that the rate first rises monotonically up to a maximum and then declines monotonically, indicating an inverted U-shaped hazard rate in our data.

We now compare each model of the low-, moderate-, and high-tech industries without variables in the α -vector by using the likelihood ratio test with the model, including the variables in the α -vector. The likelihood ratio statistics show, with four degrees of freedom at a significance level of 0.05, that the null hypothesis should be accepted. That is, the additional variables in the α -vector do significantly improve the model fit.

⁴ This measure should show the importance of technology in the industry. Acs and Audretsch (1990) studied innovative activity of what Winter (1984) termed the technological regime. Industries where small firms have the innovative advantage tend to correspond to the "entrepreneurial regime", while the industries where large firms have innovative advantage correspond more closely to the "routinised regime". Under the entrepreneurial regime, or where innovative activity tends to emanate more from the small firms than from large enterprises, the hazard rate is expected to have a positive sign in contrast to the routinised regime, where large firms tend to have the innovative advantage.

Table 1 reports the empirical findings. We investigate now the impact of determinants in terms of scale and shift-effects on the hazard rate for each of the nine low-tech industries. We first test whether the shift and/or scale effects are influenced in such models where scale economies (MES) play an important role across all nine industries. We observe a positive coefficient for almost eight industries, but in most of the industries no significant relationship is supposed to exist. Only in the food industry is the coefficient negative but insignificant, i.e., the influence of shift-effect towards the right is observed only in this industry. The lumber and printing industries depict high t -ratios indicating a stronger shift-effect to the left. So, it seems that in most of the industries scale economies tends not to play an important role in shifting the maximum. On the other hand, it shows a shorter adolescence than expected and a higher risk.

Now we look at the start-up size variable and its impact on the hazard rate. Of the nine low-tech industries the relationship is found to be negative indicating a lower maximum which is shifted toward the right. The estimated coefficient is found to be significantly (judged by the t -value) different from zero for four industries (food, apparel, furniture and leather), and for all other five industries the coefficient remains insignificant. This implies that adolescence seems to be longer for establishments in the four significant industries, further suggesting that with increasing size, the maximum can be shifted to the right. As expected, we can conclude by stating that start-up size strongly lowers the death risk for newly founded firms.

Growth shows a positive significant effect only in the lumber industry. The risk exposure confronting establishments in this industry is substantially raised. From the remaining eight industries, the sign of the coefficient is found to be negative for food, textiles, printing and leather indicating a shift towards the right. On the other hand, a positive coefficient is found for apparel, furniture, paper and metals indicating an earlier maximum. This result does not support the hypothesis that the risk tends to be lower for establishments founded in high-growth industries and greater for those in industries with low or even negative growth, except in the lumber industry.

Industry R&D intensity tends to be higher in the lumber and printing industries as can be seen in the statistically significant coefficient. This further suggests that R&D intensity has a strong positive shift-effect to the left. In contrast, risk tends to be reduced in the apparel industry indicating a lower maximum which is shifted to the right. For the remaining food, textiles, leather and metals industries the coefficients are statistically insignificant and their signs vary indicating a shift in both directions.

Table 2 presents the empirical results of all six moderate-tech industries: chemicals, rubber, stone, clay and glass, metals (except machinery), transportation, and misc. manufacturing. As mentioned above, a negative effect in the α -vector shifts

Table 1
 Regression Results for Two-digit, Low-tech Industries^a

Independent Variables	Food	Textiles	Apparel	Lumber	Furniture	Paper	Printing	Leather	Metals
α : Constant	-1.474 (-11.58)	-1.589 (-7.54)	-1.114 (-11.35)	-2.480 (-11.80)	-1.486 (-18.84)	-1.702 (-5.39)	-2.265 (-30.81)	-0.648 (-0.74)	-2.046 (-7.91)
Minimum Efficient Scale	-0.009 (-0.46)	0.054 (1.36)	0.002 (0.17)	0.881 (3.67)	0.058 (0.64)	0.154 (1.72)	0.028 (4.91)	0.106 (0.53)	0.015 (1.42)
Start-up Size	-0.003 (-2.41)	-0.001 (-0.63)	-0.008 (-4.83)	-0.002 (-0.93)	-0.004 (-2.33)	-0.001 (-0.17)	-0.001 (-0.59)	-0.008 (-2.02)	-0.003 (-1.58)
Growth	-1.369 (-0.49)	-1.648 (-0.67)	0.138 (0.11)	4.023 (2.21)	0.065 (0.03)	0.360 (0.15)	-0.705 (-0.70)	-4.583 (-1.17)	5.545 (1.18)
R&D/Sales	-0.117 (-0.53)	0.063 (0.04)	-0.804 (-2.77)	1.523 (2.63)	-	-0.591 (-1.333)	0.787 (3.29)	-4.213 (-0.93)	0.0961 (0.21)
β : Constant	0.309 (7.51)	0.361 (7.01)	0.371 (12.03)	0.335 (9.95)	0.345 (8.69)	0.095 (1.08)	0.267 (10.45)	0.415 (4.98)	0.213 (3.01)
Log of Likelihood	-1218.4	-742.8	-2038.3	-1860.6	-1258.4	-300.6	-3729.1	-280.2	-400.7
No. of Observations	560	341	947	850	580	156	1902	129	203

^a *t*-values in parentheses.

Table 2
Regression Results for Two-digit, Moderate-tech Industries^a

Independent Variables	Metals					Misc. Manufacturing Industries
	Chemicals	Rubber	Stone, Clay, Glass (Except Machinery)	Transportation	Misc. Industries	
α : Constant	-1.822 (-8.71)	-2.321 (-0.81)	-1.872 (-19.76)	-1.809 (-25.48)	-1.365 (-8.22)	-1.339 (-10.03)
Minimum Efficient Scale	-0.024 (-1.27)	0.008 (0.03)	-0.030 (-1.02)	0.058 (3.32)	-0.003 (-1.09)	0.063 (1.87)
Start-up Size	-0.001 (-1.09)	-0.001 (-1.05)	-0.003 (-1.27)	-0.002 (-1.14)	-0.005 (-2.11)	-0.004 (-1.86)
Growth	1.582 (0.91)	-3.576 (-0.13)	2.581 (1.13)	0.380 (0.35)	0.261 (0.70)	-0.657 (-0.38)
R&D/Sales	0.099 (1.29)	0.452 (0.15)	0.227 (3.21)	-0.110 (-1.95)	-0.003 (-0.03)	-0.068 (-0.71)
			β -Vector			
β : Constant	0.244 (4.69)	0.238 (4.96)	0.347 (7.59)	0.238 (7.40)	0.398 (9.17)	0.411 (12.82)
Log of Likelihood	-790.6	-991.6	-1039.5	-2218.6	-1016.5	-1843.4
No. of Observations	375	476	614	1068	461	826

^a T-values in parentheses.

the maximum to the right and lowers it. A moderate negative effect is found for the scale economies in the chemicals, stone, clay and glass and transportation industries. This suggests a stronger effect of scale economies on shifting the maximum to the right as compared to the low-tech industries. The result for these industries is not consistent with our MES-hypothesis. On the other hand, a positive significant coefficient is found for the metals industry, indicating a shift to the left. This suggests that the establishments operating in this industry are confronted by a shorter adolescence. A positive effect is also observed in the rubber industry but much stronger in the misc. manufacturing industry.

The start-up size exerts a negative relationship, but in most of the industries the coefficient is found to be insignificant. Surprisingly, this result differs from the low-tech industries. Only in the transportation industry is the coefficient significant indicating a shift to the right. This suggests that the risk is reduced for establishments which increase their start-up size. A moderate negative effect is observed for establishments in the misc. manufacturing industries, suggesting a shift to the right. These results support strongly the resources argument associated with the adolescence hypothesis.

None of the coefficients for industry growth measure is found to be statistically different from zero, although the sign varies across the six industries. Except for rubber and misc. manufacturing industries, the positive sign for the other four industries indicates a moderate scale effect and suggests that the maximum lies earlier. For the remaining two industries the maximum is found to be later. This shows that the risk exposure tends to be higher in chemicals, stone, clay and glass, metals and transportation, whereas it is lower in rubber and misc. manufacturing industries. For most of the industries, market growth does not increase the growth potential of new-establishments.

The industry R&D/Sales ratio exerts a positive but insignificant sign in the chemical and rubber industries, whereas in the stone, clay and glass industry the coefficient tends to be statistically significant. This suggests that the scale effect tends to be moderate for the chemicals and rubber industries but much stronger for the stone, clay and glass industry indicating an earlier maximum. In contrast, a negative significant coefficient is found for the metals industry indicating a stronger scale effect and a shift of the maximum to the right. For the remaining two industries the sign is negative but insignificant suggesting a later maximum. We do not observe a relationship supporting the argument that new establishments should face a lower risk.

Table 3 shows the results for the machinery, electrical equipment and instrument high-tech industries. The extent to which the existence of scale economies tends to raise the risk exposure in these three high-tech industries seems to be lower than that of the low- and moderate-tech industries. Of the three industries all the

Table 3

Regression Results for Two-digit, High-tech Industries^a

Independent Variables	Machinery (Except Electrical)	Electrical Equipment	Instruments
α : Constant	-2.154 (-31.67)	-1.665 (-16.72)	-1.564 (-4.65)
Minimum Efficient Scale	0.009 (1.72)	0.008 (1.61)	0.001 (0.05)
Start-up Size	-0.003 (-2.80)	0.001 (0.36)	-0.009 (-2.07)
Growth	1.243 (1.06)	-2.343 (-1.73)	1.805 (0.63)
R&D/Sales	0.071 (2.14)	-0.009 (-0.25)	-0.059 (-0.67)
β-Vector			
β : Constant	0.239 (8.84)	0.342 (9.27)	0.261 (4.51)
Log of Likelihood	-3335.7	-1542.8	-689.2
No. of Observations	1648	713	336

^a *T*-values in parentheses.

coefficients are found to be positive but insignificant. This suggests that the scale effect is moderate and the maximum lies earlier, further supporting the MES hypothesis.

Of the three high-tech industries the coefficient of the start-up size tends to be negative and significant. This suggests that start-up size shifts the maximum to the right and lowers the risk for newly founded firms. Adolescence tends to be longer for the new establishments operating in these two industries. On the other hand, newly founded businesses in the electrical equipment industry face a higher risk and the maximum is earlier than in the other two high-tech industries. This can be seen from a positive coefficient of the start-up size variable.

Surprisingly, this does not support the resources arguments for new establishments operating in this industry. The sign of the industry growth variable varies across these three industries. In the electrical equipment industry the risk tends to be lower and the maximum lies later, as it can be seen from the negative coefficient. The positive insignificant coefficient of the other two industries exerts a positive scale effect indicating an earlier maximum. The R&D/Sales ratio effect is also found to be different across these three industries. The significant scale and shift effect is observed for new establishments in the machinery industry indicating a higher risk exposure and an earlier maximum. In the remaining two industries the new establishment faces a moderately lower risk because of the negative coefficient. The maximum tends to lie on the right indicating a longer adolescence.

VI. CONCLUSIONS

Based on a visual inspection of transformed survivor plots we found that the log-logistic model among other models fit the data significantly. Using the longitudinal data base of newly founded businesses, we found that the hazard rate follows an inverted U-shaped pattern. The estimated log-logistic rate showed consistency with the theoretical assumptions of the liability of adolescence argument. Rates reached a maximum for all low-, moderate-, and high-tech industries. As the adolescence ends, afterwards, they showed a monotonic decline. We found a difference in the length of adolescence across two-digit. Brüderl (1991) found that adolescence lasts not much longer than one year. In order to test the resources arguments of liability of adolescence we estimated the influence of market structure variables, i.e., scale economies, initial start-up size, industry growth and technology, on the new plant hazard rate. Further, we examined whether the influence of these variables differ within the low-, moderate- and high-tech industries as well as across two-digit industries. The finding of this paper suggests that the risk exposure remains elevated within two-digit industries in the presence of scale economies.

The influence of the start-up size tends to be similar between all two-digit low-, moderate- and high-tech industries indicating a strong support of the hypothesis. This suggests that better resource endowments should protect new firms from failure, so that the hazard rate should be lower for new firms with more resources. The influence of market growth on the hazard rate is found to be not much different between the two-digit low-, moderate-, and high-tech industries. Finally, the effect of the R&D/Sales ratio on the hazard rate confronting new establishments is found to be alternating within the two-digit low-, moderate- and high-tech industries. In this paper we did not separate branches and subsidiaries opened by existing firms from independent firms, but the effect of the ownership structure in determining the risk confronting any given plant plays an important role.

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Comments

This paper by Talat Mahmood competently tests the “liability of adolescence” hypothesis based on a longitudinal data set for the U.S. obtained from U.S. Small Business Administration’s Small Business Data Base. A primary hypothesis of this paper is that new firm hazard (mortality) rates follow an inverted U-shaped pattern, which implies that the hazard rate is low in the initial short period and the end of this period is marked by mortality maximum, from where the mortality rate declines monotonically. His results obtained from fitting a log-logistic model on longitudinal data provide support to the hypothesis that the hazard rate follows an inverted U-shaped pattern. He shows that a number of factors influence the hazard rates of firms and a desegregation of industries does matter. Hence he finds considerable differences within and across two-digit low- and high-tech industries.

The relationship between firm age and firm growth over the life cycle of the firm has been examined by a number of other studies which merit attention. Indeed, there is evidence to show that the average growth of firms decreases with firm age [Evans (1987); Dunne, Roberts, and Samuelson (1989)]. In this regard, Jovanovic’s (1982) model has the most interesting implications. Jovanovic (1982) developed a dynamic learning model for evolution of firms where firm efficiency depends on the unobserved ability of the entrepreneur. Firms tend to learn about their true efficiencies with experience. In a perfectly competitive environment, firms try to maximise profits on the basis of imperfect information. In this setting firms founded by high ability entrepreneurs survive and thrive, while those founded by low ability entrepreneurs fail. There are several testable predictions in Jovanovic’s model. One implication is that, holding firm size constant, firm age and firm closure are negatively related. In other words, the probability of firm failure decreases as the firm gets older. Thus, start-up firms are more likely to fail than older firms.¹ This is a note of caution for policy-makers attempting to spur growth of small firms. According to this model, many of the small firms may be inefficient and not contribute to long term development.

The relationship between firm size and firm growth is epitomised in the so-called Gibrat’s law. This law states that firm growth and firm size is independent of its current size and past growth [Hart and Prais (1956)]. In a given time period, the probability of a large firm doubling in size is as great as it is for a small firm, subject to random variations [Mansfield (1962)]. Lucas (1978) explains why firm growth

¹A basic assumption in this version of Jovanovic’s model is that output and managerial inefficiencies have a decreasing and convex relationship. This assumption is plausible both from the point of view of theory and empirical evidence [Evans (1987) and McPherson (1995)].

would be independent of size. Although some modifications to Gibrat's law have been suggested, in the narrower sense the hypothesis of independence of firm size and firm growth remains intact [Nelson and Winter (1978) and Jovanovic (1982)]. The studies by Hard and Prais (1956) and Lucas (1978), based on data of the largest firms in the U.S. and the U.K., claimed that approximate independence of firm size and firm growth exists implying that Gibrat's law holds. Nevertheless, several empirical studies dispute even the narrower version of Gibrat's law. For instance, studies based on data of smaller firms found an inverse relation between firm size and firm growth [Scherer (1980)]. More recent evidence from samples of small firms, both from developed and less developed countries, convincingly shows that firm growth decreases with firm size [Evans (1987) and McPherson (1995)]. Even some recent studies based on large firm data also note that Gibrat's law fails for several size categories [Kumar (1985) and Hall (1987)].

Even though there is conflicting evidence in the literature on the size-growth relationship of firms, it is fair to remark that Gibrat's law holds only for large firms. On the contrary, empirical evidence strongly suggests that a negative size-growth relationship holds for small firms. Hence, it indicates that conventional theory of firm growth and firm survival has limitations of its own and thus cannot be applied in the analysis of small firm dynamics.

The concept of flexible specialisation, pioneered by Piore and Sabel (1984), provides new motivation for production and employment at a smaller scale. According to this new and growing literature, Fordism as a form of production organisation has shown a relative decline in advanced industrialised countries (especially in Europe) while production based on interfirm cooperation has expanded [Rasmussen, Schmitz, and van Dijk (1992)]. A leading symptom of this change is said to be the changing "size structure of production and employment" in these countries [Sengenberger (1988)]. The most important feature of flexible specialisation is its interfirm networking between the firms. One of the advantages of this interfirm cooperation (or cooperation of independent firms) is that the participating firms can take advantage of the benefits of integration without actually integrating.

More recently, the concept of interfirm cooperation has been developed into small firm industrial districts (defined simply as a concentration of firms within the same manufacturing sector and operating in a limited area such as in Italy, southern Germany, Denmark, Spain and Japan) where flexible specialisation is the most important characteristic [Storper (1989); Pyke, Becattini and Sengenberger (1990) and Pyke and Sengenberger (1992)]. It is suggested that size does not determine the growth potential of firms, but how they cooperate with other firms in the industry and in which political and economic environment they operate. The success of these industrial districts is associated with their economic and social organisation based on small firms and the balance between competition and cooperation. These small firms

in a particular industrial district have strong networks among themselves in which specialisation and subcontracting allow them to have division of labour, which in turn induces efficiency and economies. The success of a firm in an industrial district depends on the success of the whole network of firms in that district of which it is a part.

It is well known that interfirm cooperation is also an important feature of Japanese industrial organisation. Unlike the history of vertical, horizontal, and conglomerate mergers in Western firms [Scherer (1980)], Japanese firms traditionally rely on subcontracting of parts and intermediate goods, which forms a layer of suppliers [You (1995)]. The success of this production organisation owes a great deal to the trust (vested in Japanese culture), which is the cornerstone of sustained cooperation and development. In sum, the industrial districts in Europe and subcontracting cooperation in Japan indicate that flexible specialisation and interfirm cooperation of small firms may be substitute for mergers and increases in firm size, especially in developing countries.

It would be interesting if Talat Mahmood explains in his paper more explicitly how his methodology hinges on these earlier developments, especially on the literature on industrial districts. Can his model be replicated to analyse survival of firms in developing countries? In this regard, in my opinion the paper could be made more useful by providing some analogies/generalisations for newly founded business in developing countries.

Finally, coming to the empirical results, Talat Mahmood has assumed a distribution for his dependent variable. There is no denying the fact that choosing an inappropriate distribution can lead to biased estimates. There is a growing literature based on Bayesian econometrics, especially the Bayesian stochastic frontier literature, which offers numerous interesting possibilities with regard to distributional assumptions. Finally, the paper could be made much more interesting.

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