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MODELING THE TIMING OF BUSINESS FIRM EXITS

Peter Garrod and Walter Miklius

The available theoretical analyses of the timing of business failures have followed two different approaches: (1) developed models based on the sequential decision-making approach to entrepreneurial action; or (2) developed models based on gambler's ruin. Sequential decision making models assume that at any given moment the decision to continue or quit is based on the sum of past experiences and currently perceived alternatives. Gambler's ruin models assume that a firm (i.e., the gambler) starts off with a specified wealth position and then each period either wins (gains wealth) or losses (diminishes his wealth) through some process involving random events. The ruin of the gambler occurs when his wealth position is reduced to zero. Gambler's ruin models are based on initial work by Feller (1968).

The two types of models have been put to distinct uses: explanation and prediction. In the explanatory analyses, the underlying theory is used descriptively to model the process underlying the exit decision. Descriptive models are concerned with, and tested by, more than just prediction alone. Evidence concerning the validity of the underlying axioms is relevant as well as consistency of the implications with observed behavior. In the case of predictive models, however, the realism of its axioms are not important and the model is tested by its predictive accuracy. Criticisms of the existing analyses, however, have tended to confuse the two uses of the models.

Sequential decision making models have been used as explanatory models (Jovanovic (1982) and Frank (1988)). In Jovanovic's "selection by learning" model, firms are uncertain about their own efficiency and can resolve this uncertainty only by entering and producing. Random variation is introduced by including a serially uncorrelated shock in the cost function. Jovanovic did not use his model for prediction but for description. He performed no predictive tests nor did he test the reasonableness of his assumptions.

In a recent paper, Frank (1988) presents a descriptive intertemporal model of industrial exit that is closely related to the model of Jovanovic. In this model, returns are a function of luck, effort and talent. Initially, the level of talent is unknown and can only be discovered through experience. The rate of entrepreneurial learning is assumed to be positively related to the scale of operation and the scale of initial operation (entry size) is assumed to offer evidence on the beliefs held by the entrepreneur (the larger the entry size, the more optimistic the entrepreneur). As sunk costs in Frank's model provide a measure of the entrants' optimism, there is a positive relationship between the magnitude of sunk costs and the life of the firm. Another assumption, resulting from the specified interaction between scale and entrepreneurial learning, is that new entrepreneurs will tend to work harder, while near retirement entrepreneurs will tend to work less. Frank's model predicts that failure rates initially are low, then increase to a peak, and then decline with the age of the firm. Frank also did not explicitly test the reasonableness of his assumptions. Frank did test the implications of his model using business failure data provided by Altman (1983). Altman's data, however, pertain to bankruptcies rather than exits in general. As shown in Table 1., exits via bankruptcies account for a relatively small percentage of all exits.[3] Bankruptcy is likely to be a relatively more important way of exit for large corporations than for small business firms. Small firms are more likely to simply discontinue operations, discharge employees, sell off assets, and close down. Furthermore, the predicted time pattern of bankruptcies is different from that of exits. Also, Londregan [1988] in his study of plant closures in the petroleum refining industry found distinctly different exit patterns for small and large plants, the probability of failure for small operations decreased with age while that of large plants increased with age. Thus, as yet there is no evidence that models based on gambler's ruin should be rejected, particularly for industries containing large numbers of small firms, and when exits are not measured by bankruptcies.

Gambler's ruin models, on the other hand, have generally been used to predict bankruptcies of individual firms, i.e., as predictive models. Wilcox (1976), in analyzing the financial strength of a set of large firms, used a gambler's ruin model to predict which firms were likely to fail. Santomero and Vinso (1977) and Vinso (1979) applied gambler's ruin models to the prediction of bankruptcy.

The use of gambler's ruin models to predict bankruptcy have been criticized by Scott (1981) for their simplistic assumptions about management behavior and lack of empirical success. Frank (1988) rejects theoretical analyses based on gambler's ruin because the model is inconsistent with access to capital markets, and because the predicted pattern of exits is not consistent with observed patterns. While the assumption of no access to capital markets is clearly unrealistic for large firms (particularly corporations), for industries dominated by small firms it may be more realistic than an assumption of unlimited access to such markets.

The purpose of this note, therefore, is to examine the relative usefulness of the two approaches to modeling business failure and, thus, to test their implications in a consistent manner. This is accomplished by investigating some simple models of the timing of business failure based on sequential decision making and gambler's ruin. The first step is to insure that the models are capable of reproducing the exit patterns actually observed in the real world. For this purpose, the available data on business firm exits is described in the following section. These data clearly establish that the mortality of business firms in industries dominated by small firms exhibit something analogous to "infant mortality" in biological populations, i.e., the conditional probability of a firm's failure decreases with its age. In sections 3 and 4, some simple "generic" models of the exit decision process are presented and it is shown that they are all capable of generating the observed shapes of the mortality functions. Section 5 reports on the consistency between the decision variables identified in these models and information obtained by a small survey of former Honolulu restaurant owners and examines the feasibility of empirically testing the different models. A brief summary of the conclusions is presented in the last section.

2. The Shape of Business Firm Mortality Functions.

The first available study of business mortality found in the literature is that of Hutchinson, Hutchinson, and Newcomer [1938]. This study covered the experience of all business enterprises, except financial concerns and public utilities, in the city of Poughkeepsie, New York, for a period of 94 years, 1844-1936 inclusive. Two definitions of mortality were used: (1) A change in ownership was assumed not to terminate the business as long as its identity could be traced; and (2) a change of ownership was assumed to terminate the business. The total number of observations were 11,222 and 10,033 respectively.

The second available study by Churchill [1955] provided estimates of business survival for the U. S. based on the experience of firms in the immediate post-WWII period (1947-54). Change of ownership was considered to be a termination of business. The estimates were based on 6.3 million business records available for the study.

More recently, Star and Massel [1981] estimated the survival rates for various types of 17,252 retail businesses started in Illinois in one single year, 1974. Transfer of ownership was defined as a "discontinuance" in this study. Their results suggest that in comparison to the Poughkeepsie, N.Y. and post-WWII data, there has been an improvement in retail firm survival rates.

The most recent data available are found in Aungtrakul's [1988] study of the survival of restaurants in Honolulu, Hawaii. In this study, transfer of ownership was not defined as a discontinuance unless the name of business was changed. The data, shown in Table 2 along with the data from the other cited studies, indicate that restaurant survival in Honolulu roughly parallels survival in the retail and service industries reported in the other studies.

Lomax [1954] used the data compiled by Hutchinson, et al., to experiment with various possible mathematical forms for business conditional mortality functions (CM(t)), where conditional mortality is defined as the probability that a firm fails in period t given that it has survived through period t-1, and concluded that the hyperbola

$$CM(t) = \beta/(\alpha+t) \qquad [1]$$

where t is the age of the firm, gives the best fit for the retail and service industries while the exponential function

$$CM(t) = \alpha e^{-\beta t} \qquad [2]$$

gives the better fit for firms in the manufacturing industries. The coefficients of correlation were 0.99, 0.98, and 0.96 for the retail, service, and manufacturing industries respectively. Both specifications conform to the desirable boundary conditions and monotonic behavior exhibited by the data. However, the hyperbola has the advantage that simple expressions can be obtained for the cumulative mortality (M) and survival functions (S), i.e.,

$$S(t) = 1 - M(t) = [\alpha/(\alpha+t)]^{\beta} \qquad [3]$$

Hyperbolas were fitted to all the available data sets and the estimated parameters are reported in Table 3 along with the estimated median life expectancy. The fits were quite good and all the estimated parameters were statistically significant at the 99 percent level with the exception of the Illinois data for which there are very few data points. The results show that while there are differences in the mortality of firms in different types of businesses and differences in the mortality of firms in the same type of business among available data sets, the form of the mortality function appears to fit the data in all sets and for every type of business. More important, they lead to the conclusion that the conditional probability of a firm's survival indeed increases with the firm's age. However, use of the hyperbola as a functional form to model mortality is restrictive, once specified, the

conditional mortality is necessarily non-monotonically decreasing and hypotheses about the form of the conditional mortality function cannot be tested.

In the economic duration literature, a class of functions derived from probability models known as hazard functions are utilized to model phenomena involving time spans (Kiefer, 1988). In the context of the lifespan of a firm, a hazard function is simply a conditional mortality function. The use of two simple hazard functions, one based on the Weibull distribution and the second on the log-logistic distribution, allow for simple tests of constant conditional mortality (independent of time) and of monotonic conditional mortality to be carried out. The conditional mortality (or hazard) function corresponding to the Weibull distribution is:

$$CM(t) = \alpha\beta t^{(\beta-1)} \qquad [4]$$

which is linear in logs. A simple test of a hypothesis of constant mortality is a test of $\beta=1$. Acceptance of this hypothesis implies that $CM(t)=\alpha$ which is the conditional mortality or hazard function derived from the exponential distribution.

The conditional mortality function corresponding to the log-logistic probability model is [4]

$$CM(t) = \alpha\beta t^{(\beta-1)}/(1+\alpha t^\beta) \qquad [5]$$

When $\beta>1$, conditional mortality first increases with t and then decreases. When $0<\beta\leq1$, conditional mortality decreases with age. A test of the monotonicity of conditional mortality is then equivalent to testing whether $\beta>1$. After fitting [4], the hypothesis of constant conditional mortality was rejected (at the 99 percent significance level) for every data set. The results of fitting log-logistic functions to the available mortality data are given in Table 4. The estimated parameters for four of the data sets indicated the possible presence of a non-monotonic conditional mortality. However, in each of these cases, the peak conditional mortality would have occurred at less than one year of age, and conditional mortality was monotonically decreasing afterwards. As this peak occurred in range for which there were no data and β was only significantly larger than 1 in two cases (manufacturing in New York and retailing in Illinois), the data can be said to support a hypothesis of monotonically decreasing conditional mortality, especially after the first year. Thus, based on the available evidence, the use of hyperbolas in firm mortality models is not an incorrect specification.

3. Exit Models Based on Gambler's Ruin

We assume the following basic scenarios. As in the case of an infant, a new firm may be born with birth defects. These "birth defects" pertain to errors made by the entrepreneur. For example, he/she may have overestimated the demand for the firm's product or underestimated production costs, i.e., had he/she made the correct estimates, the firm would not have entered the industry. However, once the firm had entered it would take time to discover the errors. The signals on whether errors were made are provided by the firm's realized revenues and costs. However, there is a lot of noise in this information due, in part, to the stochastic fluctuations in demand. Given this basic scenario the main task is to determine the timing of exit which, in turn, requires specification of the "decision rule," i.e., the definition of the event(s) that will cause the firm to leave the industry. One such rule is provided by economic theory which states that a firm will exit the industry if it cannot cover its variable costs. This rule, however, has to be modified to account for variations among periods, i.e., the firm may more than cover its variable costs during one period but not in the next one. Thus the modified exit decision rule is specified as follows: the firm will exit the industry in the first post entry period when its cumulative cash outflow exceeds its cumulative cash inflow. Therefore, the exit rule supplied by economic theory leads one to models based on gambler's ruin. The question remains whether models based on gambler's ruin are capable of generating the shapes of empirical mortality functions.

To simplify the discussion initially let's assume that the entering firm has no cash reserves and no fixed assets or that the assets it owns have no salvage value. Let x_i represent sale revenues in period i and assume that the relationship between operating costs, which are defined to be equal to cash outlays, and revenues are given by $c_0 + cx_i$. The constant term (c_0) represents the fixed cash outlay per period and c the marginal cost per dollar sale (which must be less than 1 for the firm to be profitable). Given these definitions, the firm will survive the first period if $x_1 \geq c_0/(1-c)$ or $x_1 \geq \Theta$ where Θ is the amount of revenues required to achieve a breakeven cash flow. Therefore the probability that the firm will fail in the first period is simply the probability that revenues (x) are less than Θ or

$$P[x_1 < \Theta].$$

Similarly, the probability that the firm fails during the second period would be

$$P[x_1+x_2 < 2\Theta \mid x_1 > \Theta]$$

That is, for the firm to fail in the second period, the firm has to have survived the first period, and the sum of

revenues in excess of Θ in the first period plus the revenues in the second period have to be less than Θ.[5]

In general, the probability of a firm failing in period n would be

$$P[X_n < n\Theta \mid X_{n-1} > (n-1)\Theta] \quad \text{where}$$

$$X_k = \sum_{i=1}^{k} x_i$$

or the firm has to have survived period n-1 and the revenues in period n combined with the excess of revenues over the breakeven levels from the n-1 previous periods has to be less than $n\Theta$. Clearly, the probability of failing in the first period is the highest, and the probability of failing in a given period decreases as n increases, i.e., the conditional probability of surviving given the firm has survived the previous period increases as n increases. This simple model is similar, but less complex, than most gambler's ruin models appearing in the literature and is quite similar to Tinsley's (1970) multiperiod model.

The actual shape of the mortality functions will depend on the distribution of revenues (x) and the break-even value (Θ). Examples of cumulative and conditional mortality functions assuming that revenues (x) are distributed according to the exponential distribution are illustrated in Figure 1. Given this distribution, the shape of curves depends on the ratio of the breakeven level (Θ) to expected revenues (μ) or on $r = \Theta/\mu$. The smaller r -- the smaller the breakeven level of revenues relative to the average level of revenues -- the greater the likelihood of the firm's survival. Thus, anything that would increase the breakeven level, such as increased debt service, would shift the mortality function upward and decrease the probability of the firm's surviving.

Applications of gambler's ruin models typically assume that the firm starts with an initial cash or capital position. A similar set of mortality functions is generated if the assumption that an entering firm has no cash reserve is relaxed. Suppose that a firm has initial cash reserves of F. The firm will fail in period n if

$$X_n < n\Theta - F/(1-c)$$

The corresponding conditional probability statement is

$$P[X_n < n\Theta - F/(1-c) \mid X_{n-1} > (n-1)\Theta - F/(1-c)]$$

This probability statement generates a set of curves with the same shapes as those in Figure 1, but in this case the probability of survival (for the exponential case) increases by a factor of $e^{F/[\mu(1-c)]}$ if $F/(1-c) < n\Theta$ and equals 1 otherwise.

So far we have assumed that the firm starts at full speed, i.e., the distribution of revenues is the same in the first and subsequent periods. A more realistic assumption would be that a firm starting business would have expectations that revenues would start at some level and then increase to a higher level as the firm becomes established. That is, the firm will expect to have low or negative cash flow initially and that the cash flow will increase over time, eventually leveling off at a (hopefully) positive level. In this scenario, to be viable, the firm will must have cash reserves to cover the initial cash outflow.

For example, suppose expected revenues in period i are given by $(1-\alpha^i)\tau$, $0 < \alpha < 1$. That is, τ is the maximum expected level of revenues for the mature firm and revenues of the young firm approaches this level from below. Actual revenues in any given period (x_i) will be stochastically distributed around $(1-\alpha^i)\tau$. In this specification, the smaller α, the faster revenues approach τ. In this scenario, assuming the same simple cost function as above, i.e., Cost $= c_0 + cx$, the conditional probability of failing is

$$P[X_n < (nc_0 - F)/(1-c) \mid X_{n-1} > ((n-1)c_0 - F)/(1-c)]$$

Thus the faster the growth in revenues (the smaller α), the larger the cash reserves (F), and the larger τ, the less likely the firm is to fail. The mortality function will be flat and equal to zero for the first $n^* = F/c_0$ periods and start to increase thereafter.

All of the above models could be implemented using the hazard functions and are capable of generating the shapes of observed mortality functions. That is, models based on gambler's ruin cannot be rejected on empirical grounds.

IV. Sequential Decision Making Exit Models

Suppose a firm starts with some revenue and cost expectations, and as the firm matures, management becomes aware (learns), that the actual performance is less than the expected performance. If actual performance continues to fall below expectations, the firm may decide to cease operations. That is, the firm has a prior estimate of the distribution of revenues and uses observed revenues to revise its estimates, and goes out of business when it posterior estimate falls below a certain level.

For most realistic distributions the derivation of a revised probability density function becomes very complex.

One exception, however, is the normal distribution. If the firm had prior expectations of average revenues μ_o with expected variance σ^2/n_o, and after n periods observes total revenues of X_n, then according to Bayes theorem, the posterior distribution will be normal with mean equal to $(\mu_o n_o + X_n)/(n_o + n)$ and variance $\sigma^2/(n_o + n)$. If the firm has a decision rule such that it will cease operations when expected revenues fall below ß, the probability that a firm will cease in period n is

$$P[X_n < \phi(n) \mid X_{n-1} > \phi(n-1)] \text{ where } \phi(n) = n_o(\beta-\mu)+n\beta.$$

This conditional probability of ceasing business is of the same general form as the conditional probability statements used to generate Figure 1 and generates curves of the same general shape. The larger ß, the smaller the prior estimate of the mean (μ_o), and the smaller the true mean of the population (μ), the more likely the firm is to receive a signal indicating that it should cease operations.

Thus if the firm underestimates revenues, it is more likely to receive a negative signal. This has the expected impact of decreasing the probability of survival in any period. The mortality curves still have the same shape as in Figure 1, but they will be higher and flatter (smaller slope).

When the firm has no strong prior beliefs regarding the expected distribution of revenues and costs, the decision to continue or not to continue operations can be modeled as a test of composite hypotheses. That is, the firm will continue in business if some measure of performance is greater than a critical value (ϕ) and will cease if the measure is below ϕ. Suppose ϕ is defined as $\beta+\delta$ and the measure of performance is total revenues to date (X_n). The magnitude and sign of δ will depend on the firm's risk preference. The probability of the firm receiving or observing a signal that would cause it to cease operations in period n is then

$$P[X_n < n\phi \mid X_{n-1} > (n-1)\phi]$$

This probability statement also generates curves of the same general shape as those illustrated in Figure 1. The larger ϕ, the smaller μ, and the larger σ, the greater the probability of receiving a signal to quit in period n. Also, the smaller n, i.e., the younger the firm, the greater the likelihood of receiving a negative signal.

Another factor that may affect the mortality function are the costs of exiting from the industry. Suppose the assets of the firm have a positive salvage value (SV). At a given point a time, the firm faces the choice of staying in business for one more period, in which case the net benefits to the firm would be

$$CP + E[\pi] + \delta SV$$

where $E[\pi]$ is the expected present value of profits from continued operations, CP is the firm's current net cash position and δ is the appropriate discount factor ($0 < \delta < 1$), or to sell the firm now and receive net benefits of

$$CP + SV.$$

The decision on whether to continue business or sell out then depends on the ratio $E[\pi]/(1-\delta)SV$. The firm will be better off continuing whenever expected profits from continued operations exceed the loss in current wealth incurred by postponing the receipt of the salvage value by one period. Thus firms that have no salvage value (i.e., those firms whose start-up, establishment, and capital costs are truly sunk costs) will be less likely to go out of business than firms with assets with salvage value.

Thus, exit models based on sequential decision makings are also capable of generating the observed shapes of mortality functions.

V. Pilot Survey - Restaurant Mortality

Since both types of models are capable of generating the observed patterns of firm mortality it is not possible to differentiate between them on the basis of this criteria. Our purpose in this paper, however, was to test their implications. Definitive tests of the models axioms would require a longitudinal study, i.e., it would be necessary to select a sample of firms and follow them from the initial planning stage prior to entry to their exit from the industry. Such testing, however, is beyond the scope of this study. Partial indicators, however, on the likely performance of the two models may be obtained from a cross-sectional survey of firms that have failed. For example, if the survey found that firms typically failed because they ran out of cash, this would be consistent with the gambler's ruin models. Similarly, it may be possible to determine the exit decision rules employed by entrepreneurs from survey responses.

We these possibilities in mind we conducted a pilot survey of the restaurant industry in Honolulu of fourteen owners/managers of restaurants that failed. The restaurant industry was selected because of its historically high entry and exit rates. The sample was not a random one since it was rather difficult to locate former restaurant owners/managers. Rather than drawing from a sampling frame, we relied on leads from those being interviewed to locate others. The interviews were unstructured (i.e., no survey instrument was used)

although the attention of respondents was directed toward factors identified in the preceding section both by asking questions of what happened in the case of a particular restaurant with which the respondent was involved and by use of hypothetical examples.

The fourteen interviewees can be readily separated into two groups: (1) Seven owners/managers of restaurants that are no longer in business; and (2) Seven current owners/managers of restaurants who in the past had started another restaurant which subsequently failed.[6] The first group's responses clearly indicates the importance of cash flow problems in the exit decisions. That is, in 6 of the 7 cases the restaurant closed when the owners ran out of money to pay bills.In the seventh case, there were additional complications but the restaurant finally closed because the owners ran out of cash. The percent of the restaurants that failed because of cash flow problems in sample probably under-represents that actual proportion, as multi-unit restaurants were over-represented. Their owners have an operating restaurant and therefore easier to locate. Although there is no basis for adjusting for this bias it is safe to conclude that the majority of failed restaurants exited because of running out of cash.

That a restaurant fails because of a cash shortage is not surprising. All the respondents emphasized that the restaurant business necessitates a long-run commitment. None of them expected to earn a profit on their investment for the first 3-to-5 years. The primary concern during these years is survival and the main measure of performance is cash flow. If the restaurant survives longer than this period it is expected to start to show a profit, particularly, after the initial loans are paid off.[7] Furthermore, because of the risk involved, financial institutions, as a rule, do not lend to restaurants without an established track record unless the owner pledges his own personal assets as collateral. Thus, the firm's access to capital markets is rather limited.

The respondents attributed their "running out of cash" to "undercapitalization," which is consistent with the importance of the cash reserve position discussed above.[8] All respondents agreed that insufficient funding is the main cause of restaurant failure. Sufficient cash reserves to cover six to twelve months of operating expenses was suggested as a rule of thumb for the required cash reserve for starting a new restaurant.

It appears, therefore, that for a majority of the restaurants the economic environment in which they operate resembles the gambler's ruin models rather closely. In contrast, none of the restaurants with which the second group was involved failed because of a cash shortage. At the time these restaurant went out of business, their owners had at least one other successful restaurant in business and apparently could have continued. It was not possible from the interviews to derive a simple exit rule. Expectations, however, definitely played a role. The gross revenues of a new restaurant are expected to continue to increase due to the development of repeat patronage and a new restaurant is expected to start generating a positive cash flow by the end of the first year. However, none of the restaurants where a shortage of cash was not the immediate cause of business failure ceased operation during the first months when gross revenue failed to increase or when cash flow failed to become positive after being in business for a year. Instead, the owners tried to remedy the perceived problems by changes in the menu, changing prices, increased advertising, etc. Thus, the timing of exit depends on the persistence in trying and the time required to observe the effects of these changes. In some cases, it took up to three years before the restaurant was finally closed.

Further complications are introduced by owners attempts to sell the restaurant and the belief, shared by some of the respondents, that it is easier to sell an ongoing restaurant than it is to sell an out-of-business establishment. Such a belief encourages a restaurant owner to keep operating in the hope of finding a buyer and/or securing a better price.[9]

The exit decision is even further complicated by legal implications of the restaurant leases. Typical restaurant leases specify a minimum rent or a percentage of gross sales, whichever is higher, and generally run for 15 to 20 years. The lease obligates the restaurant owner to make these payments for the duration of the lease. If the restaurant fails, the owner has several options. One is simply "to walk away from the business." In this case the lessor takes over and sells the restaurant's equipment. A second option is for the restaurant owner to declare bankruptcy. In this situation, the lessor becomes one of the creditors and gets compensated, if at all, from the proceeds of sales of the restaurant's assets. To protect themselves against these actions, the lessor may ask the potential restaurant owner to guarantee lease payments with his personal assets.

The third option is to sell the restaurant and seek the lessor's permission to assign the lease to the new owner. Alternatively, the new owner may merely sublease the restaurant space and the original owner may still be liable for payment of the lease rent in case of default by the new owner.

Even if the owner of a failed restaurant continues to pay the minimum rent, the lessor may declare the lease to be in default since most standard leases require the restaurant to be open for business for a specified

minimum time period. In practice, many of the issues pertaining to leases of discontinued restaurants are settled in negotiations between lessees and lessors. Nevertheless, the available opportunities to get out of leases at a minimal cost undoubtedly affects the timing of exit. For example, appearance of a potential purchaser may induce the owner to decide to leave the industry immediately if the future profitability of the restaurant is questionable. However, he would have continued operating in the absence of the appearance of a potential buyer.

The main fixed asset of restaurants is equipment. It accounts from over three-fourths to practically 100 percent of all fixed assets. Although there is an active second-hand market in restaurant equipment the liquidation value of these assets is relatively low. For example, the respondents estimated that one-year old restaurant equipment upon liquidation would return only 10 to 20 percent of its original value. The salvage value of assets, therefore, does not appear to be an important variable in exit decisions in the restaurant industry. The long-term restaurant lease is another asset, although in the case of failure, it becomes a liability. The effect of the lease on the decision process would be indirect, i.e., the more desirable the location of the restaurant the easier it may be to locate a potential tenant to take over the lease.

In short, it seems that in the case of restaurants where the cause of exit was not a cash shortage, the exit decision process is quite complex. While in these cases the sequential decision-making model appears to be the most capable of providing a description of the process, the model would have to be quite a bit more complicated than those discussed above.

VI. Conclusion.

The previous theoretical studies of the timing of business failures followed two approaches, i.e., either developed models based on sequential decision making, or developed models based on gambler's ruin. The purpose of this study was to investigate the implications of the two approaches.

The first criteria used to evaluated the different models was their relative ability to reproduce observed patterns of mortality. On the basis of the results of previous studies we concluded that these patterns exhibit a conditional mortality function that declines with the age of the firm. We find, however, that exit models based on either of the two approaches are able to generate the empirical mortality functions. Therefore, this criteria cannot be used to differentiate between the two models.

One of the potential uses of the models is prediction, however the testing of the predictive power of the two types of mortality models would require a longitudinal survey spanning the lifetime of firms in the sample, a task beyond the scope of this study. Instead, we conducted a cross-sectional survey of owners or managers of failed restaurants in Honolulu, Hawaii. Although the survey was small (n = 14), it supplies some clues on the potential usefulness of the two approaches. Overall, the survey results support the usefulness of models based on gambler's ruin. The majority of the failed restaurants appear to have failed because they ran out of cash and the access of owners to capital markets is very limited because usual financial institutions do not lend to firms without an established track record. Indeed it appears that the environment in which they operated resembles the gambler's ruin scenario rather closely.

One-half of the restaurants in the sample, however, did not exit because of a cash shortage. For these restaurants the sequential decision-making models appear to be more appropriate. The survey results, however, suggest that the exit model has to much more complex than the models developed in section 4. Furthermore, the information requirements for testing a sequential decision-making model are quite onerous. The information requirements for models based on gambler's ruin include the initial cash reserves of the entering firm, the distribution of revenues and the cost function. With this information, one should be able to predict the timing of exit. For models based on sequential decision-making we would need the same information plus data on the various expectations of entrepreneurs not only prior to entry but during the lifetime of the firm in order to develop an operational exit decision rule. This type of information is notoriously difficult to obtain since it is not revealed in any of the firms transactions.

In summary, we conclude that gambler's ruin provides a potentially more productive approach to modeling the exit process, at least for firms in industries dominated by small firms. These would industries in the retail sector, the services sector, and a number of product lines in manufacturing.

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Table 1.   Number of Discontinued and Bankrupt Business per 10,000 Operating Concerns by Industry, 1951--1955 Average.

Industry	Number of Discontinued Businesses	Number of Business Bankruptcies	Ratio of Bankruptcies to Total Discontinuances
Manufacturing:			
Food and Kindred Products	450	57	.13
Textile Mill Products	910	76	.08
Apparel	1,080	116	.11
Leather and Leather Goods	780	146	.19
Lumber and Timber Products	1,820	17	.01
Furniture and Fixtures	660	164	.26
Paper and Allied Products	350	51	.15
Printing and Publishing	330	21	.06
Chemicals and Allied Products	590	56	.09
Stone, Clay, and Glass Products	640	38	.06
Metals, Primary and Fabricated	500	63	.13
Machinery, Except Electrical	690	57	.08
Electrical Machinery	630	114	.18
Transport Equipment	550	85	.15
Retail:			
Groceries	560	19	.03
Motor Vehicles	1,080	26	.02
Automotive Parts and Accessories	600	17	.03
Shoes	540	47	.09
Lumber and Building Products	550	44	.08
Appliances, Radios, and Televisions	830	89	.11
Home Furnishings	700	74	.11
Eating and Drinking Places	950	24	.03
Drugs	270	24	.09

Source: Miklius, Casavant and Huang [1976]

Table 2. Cumulative Mortality Rates

Age	Poughkeepsie, N.Y.[a]						U.S. 1947[b]			Illinois[c]	Hawaii[d]
	Manufact.		Retail		Services		Man.	Ret.	Serv.		
	(1)[e]	(2)[f]	(1)[e]	(2)[f]	(1)[e]	(2)[f]					
(years)				(percent)							
0.5							18	26	23		
1.0	23.1	24.0	29.6	32.5	32.7	32.9				18.6	28.3
1.5							40	51	47		
2.0	34.6	37.1	43.8	45.8	45.7	47.2				39.5	43.0
2.5							54	64	60		
3.0	46.9	49.8	53.2	55.0	55.1	56.8				51.3	53.0
3.5							62	71	67		
4.0	54.7	57.8	59.4	61.6	61.8	63.7				59.3	58.2
4.5							67	75	72		
5.0	60.2	63.2	64.3	66.2	66.9	66.0				64.9	63.6
5.5							71	78	75		
6.0	65.5	67.7	68.4	70.4	70.8	73.0				66.8	66.6
6.5							74	80	77		
7.0	67.8	70.4	71.5	73.5	74.3	76.3				NA	69.3
7.5							76	81	78		
8.0	70.2	73.3	74.1	76.3	76.9	79.3				NA	71.4
8.5							77	82	79		
9.0	72.6	76.0	76.2	78.6	79.2	81.5				NA	73.8
9.5							78	83	80		
10.0	74.6	78.7	78.2	80.8	81.2	83.4				NA	76.1
10.5							80	84	81		

NA = Not Available

[a]Source: Hutchinson, Hutchinson and Newcomer [1938].

[b]Source: Churchill [1955].

[c]Source: Star and Massel [1981].

[d]Source: Aungtrakul [1988].

[e]Not counting change in proprietorship as a new business.

[f]Counting change in proprietorship as a new business.

Table 3.   Estimated Mortality Function Parameters Using Hyperbolas, by Type of Business.

Item	Estimated Parameters[a]		Stnd. Error	Log(Like-ihood) Function	Median Life Expectancy (years)
	α	β			
Poughkeepsie, 1844-1936[b]					
Manufacturing	3.81 (9.88)	1.08 (14.82)	.00880	36.45	3.43
Retail Trade	2.01 (21.77)	0.84 (36.73)	.00437	44.15	2.58
Services	2.03 (10.76)	0.91 (18.33)	.00949	35.63	2.32
Poughkeepsie, 1844-1936[c]					
Manufacturing	4.20 (13.20)	1.26 (19.12)	.00685	39.21	3.08
Retail Trade	1.91 (11.28)	0.87 (19.59)	.00891	36.32	2.33
Services	2.32 (7.35)	1.03 (11.91)	.01346	31.78	2.23
U.S. 1947-1954					
Manufacturing	1.73 (12.25)	0.85 (21.56)	.08275	38.97	2.18
Retail Trade	0.98 (1.53)	0.78 (22.22)	.09437	37.67	1.40
Services	1.05 (10.13)	0.73 (19.37)	.01196	36.08	1.66
Illinois: Businesses Started in 1974					
Retail Trade	6.97 (2.53)	1.91 (3.14)	.02128	17.23	2.76
Honolulu, Hawaii 1971 - 1985					
Restaurants	1.68 (14.1)	0.76 (6.49)	.01017	40.88	2.51

[a] Asymptotic t-ratios in parentheses.
[b] Not counting change in proprietorship as a new business.
[c] Counting change in proprietorship as a new business.

Table 4. Estimated Mortality Function Parameters Based on the Log-Logistic Probability Model.

Item	Estimated Parameters[a] α	β	R^2	Age at Max CM (years)	Asym. t-Stat Ho: $\beta > 1$
Poughkeepsie, 1844-1936[b]					
Manufacturing	0.228	1.018 (47.64)	0.996	0.060	0.830
Retail Trade	0.411	0.931 (126.61)	1.000	0	
Services	0.468	0.937 (39.81)	0.995	0	
Poughkeepsie, 1844-1936[c]					
Manufacturing	0.303	1.071 (50.11)	0.998	0.217	3.305
Retail Trade	0.450	0.940 (49.19)	0.997	0	
Services	0.448	1.014 (28.00)	0.990	0.030	0.375
U.S. 1947-1954					
Manufacturing	0.459	0.951 (40.72)	0.995	0	
Retail Trade	0.727	0.886 (29.57)	0.990	0	
Services	0.619	0.874 (26.36)	0.987	0	
Illinois - Businesses Started in 1974					
Retail Trade	0.253	1.230 (17.34)	0.987	0.741	3.244
Honolulu, Hawaii 1971 - 1985					
Restaurants	0.406	0.889 (75.79)	0.999	0	

[a] t-ratios in parentheses.

[b] Not counting change in proprietorship as a new business.

[c] Counting change in proprietorship as a new business.

Footnotes

(1) We wish to thank Laurence H. Miller, Daniel B. Suits, and Gerald Russo for their helpful comments.

(2) Senior authorship is not assigned.

(3) Actually, filing for bankruptcy does not necessarily mean exit of the firm from the industry. There are two bankruptcy processes: liquidation and reorganization. Liquidation involves dismantling of the firm and the selling of its assets, while reorganization is a rehabilitation procedure which allows the firm to continue operating while making a financial settlement with its creditors. Most bankrupt firms attempt to reorganize first, and liquidate only when unsuccessful.

(4) It is generally simplest to estimate the survivor function, $S(t) = 1/(1 + \alpha t^{\beta})$, for the logistic distribution, as this function can be expressed as $1/S(t)-1 = \alpha t^{\beta}$, which is linear in logs.

(5) Here and in the rest of the paper it is assumed that there is a zero time preference for money. This is a simplifying abstraction from reality. A more realistic assumption would be to include a discount factor. However, this would unduly complicate the presentation without adding any clarity or modifying the conclusions.

(6) Of the first group of respondents, four have since opened another restaurant and three are now in other lines of business.

(7) These statements regarding the long-term nature of restaurant business are supported by other evidence. For example, typical restaurant leases are for 15 to 20 years as compared to a typical 5 year lease for retail stores.

(8) Some respondents referred to an unfavorable debt-to-equity ratio as "undercapitalization." The reduction in the probability of survival due to this factor, however, is indirect. That is, the size of the loan repayment obligation increases the amount of sales necessary to achieve a positive or breakeven cash flow.

(9) The opinion of other respondents, however, was that it is indeed easier to sell an ongoing restaurant that is doing well but that this is not true if one is trying to sell a failing restaurant.

Figure 1.   Conditional Mortality Curves

For Different Values of Θ