ESSAYS ON THE DYNAMICS OF QUALITATIVE ASPECTS OF FIRMS' BEHAVIOR

by

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Abstract

This dissertation contains two independent but related papers which investigate theoretically and empirically qualitative aspects of firms' behavior in dynamic settings.

CHAPTER 1.

ENDOGENOUS ATTRITION OF FIRMS:

An Investigation with COMPUSTAT Data

Chapter One develops a dynamic programming model of firms' attrition and investigates econometric aspects of firms' exit decisions. Structural econometric analyses of exit decisions of firms involve rather naturally a number of qualitative dimensions. This chapter investigates the exit decision empirically by means of panel data from COMPUSTAT for U.S. manufacturing firms which are publicly traded. A number of different techniques are employed, which include Poisson models, structural form models and duration models.

Our findings show that observable characteristics of the individual firms are important in understanding the dynamics of firm's attrition. Cyclical effects and macroeconomic

variables have also a strong impact on bankruptcies, liquidations and reorganizations. Unobserved firm heterogeneity, modeled by means of random effects, is not significant in explaining exit decisions by firms. Firms' attrition is more likely to result from random events at the time of exit.

CHAPTER 2

AN EMPIRICAL INVESTIGATION ON THE DYNAMICS OF QUALITATIVE DECISIONS OF FIRMS

Chapter Two focuses on qualitative aspects of financing, investment and output decisions of firms. Such dimensions can be modeled econometrically by means of dynamic limited dependent variables models. We develop a partial equilibrium dynamic stochastic programming problem of investment, dividend and financing decisions for a typical firm and we use it to examine firms' behavior under exogenous borrowing constraints.

We use panel data from COMPUSTAT for publicly traded U.S. manufacturing firms. We apply limited dependent variable models' techniques to study the discrete decisions of whether or not firms pay dividends, or whether they use borrowing or equity issue financing for investment. We study the pattern of transitions over time across various regimes that represent alternative modes of finance while controlling for individual heterogeneity with a general stochastic structure for unobservables. Structural form models show considerable success in explaining the dynamics of such decisions, with individual characteristics of the firms which include firm fundamentals, and lagged values of the decisions, showing a strong explanatory impact. The dynamics of the estimated models reveal high persistence in manufacturing firms to repeat their last period's decision. Firm heterogeneity modeled by means of random effects, explains also a significant part of firms' qualitative decisions.

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Finally, I wish to dedicate my dissertation to my parents Nikiphoros and Harikleia, my brother George and my uncle Theodore. Without their love and moral support I would have never completed this endeavor.

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Chapter 1

ENDOGENOUS ATTRITION OF FIRMS: An Investigation with COMPUSTAT Data[1]

[1]This chapter is coauthored with Yannis M. Ioannides. This research has been supported by grants SES9000-200 and SES9211-231 from the National Science Foundation. We are grateful for this assistance. We are also grateful to Bronwyn Hall for giving us access to the Manufacturing Sector Master File and to her COMPUSTAT Merger List without which this work would have been impossible. Plutarchos Sakellaris made several very helpful suggestions. All data used for the estimations in this paper have been archived at the Survey Research Center, University of Michigan.

1 Introduction

Structural econometric analyses of exit decisions of firms involve rather naturally a number of qualitative dimensions. A full understanding of such dimensions requires modeling by means of dynamic limited dependent variable models. Research to date has obtained only a limited, at best, understanding of these dimensions. This may primarily due to unavailability of econometric techniques of sufficient flexibility and generality. This is no longer the case. The present paper explores endogenous attrition of firms by utilizing COMPUSTAT data. Attrition is an important aspect of firms' behavior for which limited dependent variable models are indispensable modeling devices, and which may not have an exact analog to individuals' behavior. That is, firms may disappear as economic units because of a deliberate decision to exit (e.g., bankruptcy or other possibilities) or to merge with or to be acquired by other firms. [2]

Studies of endogenous attrition include the contributions by Meghir (1988), who uses reduced-form models, and by Olley and Pakes (1991) and Pakes and Ericson (1990), who conduct structural form estimations. The endogeneity of the exit decision has received comparatively little attention, with the work by Pakes and Ericson (1990) and Olley and Pakes (1991) being extraordinary exceptions. Recent work by Hopenhayn (1992) provides comparative statics for average q values in a dynamic model which allows for endogenous entry and exit. Hopenhayn observes that the distribution of average q values is affected

[2] To be sure, the formation and dissolution of households provide, in some sense, analogs to the pattern of modal changes in the identities of firms and may well have a serious economic motivation, as the literature on the economics of the household has shown. Nonetheless, such changes may not be considered truly economic transactions in the same way that changes in the ownership of firms are. Personal bankruptcy, on the other hand, bears some similarities to corporate bankruptcy in that individuals may seek the protection of the courts from creditors.

by self-selection as result of changes in technology parameters and uncertainty. Jovanovic (1982) develops a model of incomplete information and observes the evolution of firms in an industry where the efficient firms survive while the inefficient ones decline and fail. His findings associate firms' entries and exits with size, rates of return and concentration on the industry.

Empirical studies on firm attrition have been very limited; they have typically been concerned with specific or local industries or have used plant data. A recent empirical study of exit of firms [Schary(1991)] uses data from the textile cotton industry for the period 1924-1940 and shows that profitability is not important in explaining the form of exit (that is, whether through merger, voluntary liquidation or bankruptcy) and that random factors are quite important in determining exits. Dunne *et al.* (1988) provide exhaustive analysis of stylized facts for exits (and entries), for the U.S. manufacturing industries. They use a general framework which allows for industry switching as an exit and entry phenomenon and they find persistent patterns for exits and entries which are correlated with industry characteristics and performance of the firms. Deily (1991) uses an ordered probit model for estimation of exit strategies for U.S steel firms and finds that individual plant characteristics including size, revenues and costs explain a part of plant-closing behavior.

We develop in this paper a partial equilibrium model of the firm and use it to examine the dynamics of the exit decision. We investigate attrition in different ways by exploiting the information in the COMPUSTAT data, including aggregated data using Poisson models, structural, and reduced form models. Section 2 of this paper develops a standard partial equilibrium, dynamic stochastic programming problem of the firm and introduces the event of exit as a random event. We explore comparative dynamic properties of the exit decision. A description of the COMPUSTAT data and the exit information is given on Section 3. Section 4 provides a number of alternative econometric specifications for the empirical analysis of attrition and discusses and compares the results across each specification. Main conclusions can be found on Section 5. The Appendix provides information on data construction.

To the best of our knowledge this is the first time that attrition has been examined using COMPUSTAT data. Results with Poisson models and aggregated data on exits confirm a significant role for macroeconomic variables, especially interest rates. Results with a number of different parametric duration models also give good results for cyclical variables. Estimation results with dynamic probit models confirm that unobserved individual effects are not important explaining attrition whereas cyclical effects and macroeconomic variables have a strong impact on attrition.

2 A Prototype Model of a Firm Facing an Exit Decision

The analytical core of the modern literature on investment behavior may be traced back to models of firms' behavior, introduced by Abel (1979; 1980) and Hayashi (1982), Those models assume to maximize the expected value to its shareholders, that is the present value of dividend payments after tax, subject to a cash flow constraint and to stock accumulation constraints. We introduce below a model that is rooted in that tradition but, in addition, accounts for the exit decision [Olley and Pakes (1991) and Pakes and Ericson (1990)].

2.1 The Standard Model

We follow a standard formulation of a firm's decision problem, such as Abel and Blanchard (1986), and adapt it to the case of uncertainty. First, we introduce notation to describe the model of firms' behavior. Let V_t be a firm's value, as of the beginning of time period t, defined in the standard fashion as the expected value of a firm's stream of net cash flows.

Let K_t be its stock of the single capital good with which it produces in period t; I_t, its corresponding period t investment which is assumed to augment capital in the following period. Let, in addition, a_t, be the firm's age; $\mathbf{w}_t$, a vector of parameters some of which may be deterministic or stochastic, whose evolution over time is determined exogenously, for simplicity, by a family of distribution functions $P_{\mathbf{W}} = \{P(\cdot \mid \mathbf{w}), \mathbf{w} \in \mathbf{W}\}$; ω_t, the vector of prices, with the price of the investment good being the numeraire; $\pi_t(K_t, a_t; \omega_t; \mathbf{w}_t)$, the restricted profit function, which gives current period profits as a function of the vector of state variables and satisfies the usual properties [McFadden (1978)]; $c_t(I_t, K_t; \mathbf{w}_t)$, the adjustment cost of undertaking new investment, a convex increasing function of I_t, and K_t; β, the firm's discount factor, $0 \leq \beta < 1$; D_t be the period t net dividend payment to the firm's shareholders; X_t, net borrowing by the firm during t; B_t, the principal of its outstanding stock of debt; $(1 + r_{t-1})B_t$, the principal plus interest due in the beginning of period t and $\bar{B}_t$, the maximum stock of debt the firm may hold as of the end of period t.[3] E_t is the expectation operator at time t and $\mathcal{N}_t$ the information state as of time t.

This problem may be treated analytically by means of the theory of dynamic programming. The Bellman equation for an incumbent firm can be written in terms of the firm's value function, $V_t \equiv V_t(K_t, B_t, a_t; \omega_t; \mathbf{w}_t, r_t \mid \mathcal{N}_t)$, which is defined as the expected present value, as of the beginning of time period t, of the stream of dividend payments to the firm's owners as follows:

$$V_t(K_t, B_t, a_t; \omega_t; \mathbf{w}_t, r_t \mid \cdot) =$$

[3]There exist several alternative specifications of a firm's borrowing constraints. It would be interesting to consider the case where the firm may borrow unlimited amounts at a borrowing rate that increases with the stock of debt outstanding.

$$\sup_{\{I_t, X_t\}} : D_t + \beta E_t \left\{ V_{t+1}(K_{t+1}, B_{t+1}, a_{t+1}; \omega_{t+1}; \mathbf{w}_{t+1}, r_{t+1} \mid \cdot) \right\}, \tag{1}$$

subject to the equations of motion for aging

$$a_{t+1} = a_t + 1, \tag{2}$$

and for capital accumulation

$$K_{t+1} = (1 - \delta) K_t + I_t. \tag{3}$$

Dividends, investment and borrowing in each period are related through the cash flow constraint:

$$D_t = \pi_t(K_t, a_t; \omega_t; \mathbf{w}_t) - c_t(I_t, K_t; \mathbf{w}_t) - I_t + X_t. \tag{4}$$

We do not allow for firms to issue new shares and thus constrain dividends [4] to be non-negative:

$$D_t \geq 0. \tag{5}$$

Borrowing in period t is constrained by:

$$X_t \leq \bar{B}_t - (1 + r_{t-1}) B_t. \tag{6}$$

[4]Tax considerations are in practice extremely important and should be reflected in the definition of the dividend payments and of the various entries in the cash flow constraint. Standard formulations by several authors including Fazzari *et al.*(1988), Himmelberg(1990), Whited(1988) and others provide a correction for β, and the amount of dividends the firm pays to its shareholders, by incorporating the tax rate on dividends and capital gains, the latter being always smaller at least for the U.S. tax system.

Finally, the accumulation equation for debt[5] is:

$$B_{t+1} = (1 + r_{t-1})B_t + X_t. \tag{7}$$

Some remarks are in order. First, the sup operator inside the large brackets in the RHS of (1) defines the investment and borrowing decisions. Also, the following transversality condition ensures that the problem is well defined:

$$Prob\left\{\lim_{t\to\infty} \beta^t B_t \leq 0\right\} = 1$$

This condition ensures that the debt of the firm should not increase "too fast" as time goes on; i.e. the firm should pay all its debts as time goes to infinity.[6]

2.2 Attrition

We now come to consider the exit decision and through that the consequences of endogenous attrition. Authors writing in this area are not unaware of the consequences of endogenous attrition. This is evidenced by the care such researchers have taken in splitting the sample to potentially constrained and unconstrained firms, or by taking extreme precautions, such as Hayashi and Inoue (1991), to avoid using data that are subject to endogenous attrition.

We also note the care with which endogenous exit has been modeled by Pakes and

[5] Note that in effect the debt accumulation equation may also stand for accumulation of liquid assets which may earn the same rate of return as that paid on debt.

[6] For a detailed description of transversality conditions in a more general setup see R.R. Wright (1987). Kamien and Schwartz (1981) discuss the transversality condition for several cases in a continuous time setup while Ekeland and Scheinkman (1986) have a very detailed treatment of the dynamic problem transversality condition in discrete time.

Ericson (1990) and Olley and Pakes (1991). Both of these studies employ powerful non-parametric techniques. These techniques may be useful with even more ambitious models involving, e.g., attrition due to bankruptcy which may be caused by a multitude of factors, which reflect the combined impact of idiosyncratic, industry-specific and cycle-specific factors. An important issue here that requires utilization of data on market valuations of firms is whether the model may be used to detect the extent to which bankruptcies are "anticipated" by the market. In fact our model is aimed at elucidating this possibility.

There may be many reasons for firms to exit. In the COMPUSTAT Merger List, prepared by Bronwyn Hall, several categories of exits are distinguished. We discussed them in detail in Section 3 below. The importance of attrition follows by recognizing that all those discrete events examined earlier are defined conditionally upon a firm's being in existence.[7]

We may introduce exit by modifying the problem introduced in (4) above, as follows. A firm exits and never reappears again when Φ, the value to the firm from exiting, exceeds the firm's value.[8] We do not, for the time being, distinguish the reason for exit but note that this basic model may be extended to account a rich set of possibilities. We discuss such extensions later in this paper.

We consider the firm's optimization problem in its simplest form, that is in the absence of any constraints. The firm's objective function is the expected present value of cash flows, conditional on the firm's existence:

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[7] See Pakes (1991) for an extensive discussion of the measurability conditions this imposes.

[8] Olley and Pakes (1991) and Pakes and Ericson (1990)] are two of the few works in the literature that discuss exit. The value associated with exit may, in general, be a function of other variables, such as capital stock and the information available as of that time.

$$\max\left\{\Phi,\ \sup_{\{I_t,X_t\}}\ : E_t\left[\sum_{t=0}^{\infty}\beta^t\pi_t(K_t,a_t;\omega_t;\mathbf{w}_t)-c_t(I_t,K_t;\mathbf{w}_t)-I_t\right]\right\}. \tag{8}$$

The max operator in the RHS of (8) defines exit behavior. We proceed to formulate this problem as an optimal stopping problem.

We simplify matters by assuming that the random variables that enter into the restricted profit function $\pi_t(K_t, a_t; \omega_t; \mathbf{w}_t)$ are independently and identically distributed over time. This is, of course, a very strong assumption. Let us suppose further that the only remaining uncertainty is with respect to the price of output and all other elements of $\mathbf{w}_t$ are deterministic. The uncertain price of output will, for simplicity, be referred to as ω_t; it becomes known in the beginning of period t, before that period's investment and other decisions are made.[9] For technical reasons we assume that the support of ω_t is a countable set.

We assume that $\pi_t(\cdot)$ is monotonically increasing and convex in ω_t, and is weakly concave and increasing in K_t. Since the adjustment costs for investment are convex and increasing, we can easily justify a technical requirement that cash flows in every period are bounded upwards and downwards by scalars. We show, by using results in Bertsekas (1987), Sections 5 and 6, that a unique solution to Problem (8), subject to constraints (2) – (7), exists. This is accomplished by expanding the state and decision spaces in order to include a termination state. That is, consider a state variable Y_t, $Y_t \in \mathbf{R} \cup \{\varsigma\}$, where ς denotes the termination state. We define, respectively, the decision d_t as, either the amount of investment $d_t = I_t$, $I_t \in \mathbf{R}$, or the discrete decision associated with the termination state: $d_t =$ exit. Once the system has entered the termination state, it remains there. The

[9]The probability distribution function of ω_t may depend on K_t and I_t but not on its own prior values $\omega_{t-1}, \ldots, \omega_0$. We do not pursue this here.

evolution of the state over time is described as follows:

$$Y_{t+1} = \begin{cases} \varsigma, & \text{if } d_t\text{=exit, or } Y_t = \varsigma; \\ (1-\delta)K_t + I_t, & \text{otherwise.} \end{cases} \tag{9}$$

We use $Y_{t+1} = F_t^s(Y_t)$ to refer to the evolution of the state (9) concisely. The period t reward function for the firm's optimization problem is defined as:

$$g_t(Y_t, d_t, \omega_t) = \begin{cases} \pi_t(K_t, a_t; \omega_t) - c_t(I_t, K_t) - I_t, & \text{if } Y_t \neq \varsigma, \text{ and } d_t \neq \text{exit}; \\ \Phi, & \text{if } d_t = \text{exit and } Y_t \neq \varsigma; \\ 0, & \text{if } Y_t = \varsigma. \end{cases} \tag{10}$$

The firm's optimization problem now becomes: Find a policy $\{d_0, d_1, \ldots\}$, where the decision at the beginning of period t is function of the state and of the realization of ω_t, $d_t(Y_t, \omega_t)$, so as to maximize the sequence of problems

$$g_t[Y_t, d_t(Y_t, \omega_t), \omega_t] + \lim_{N\to\infty} : E_{\omega_k, k=t+1,\ldots} \left\{ \sum_{k=t+1}^{N} \beta^{k-t} g_k[Y_k, d_k(Y_k, \omega_k), \omega_k] \right\},$$

subject to the state evolution constraints (9). This statement of the problem allows us to apply the powerful theory of dynamic programming. In particular, under our assumptions, the key results in Section 5.1, Bertsekas (1987), apply and so do their extensions in Section 6.3, *ibid.* We appeal to *Proposition 2*, *ibid.*, p.184, and write the Bellman equation for the value function and the associated optimal policy:

$$V_t^e(Y_t, \omega_t) = \max_{d_t} : g_t(Y_t, d_t, \omega_t) + \beta E_{\omega_{t+1}} \left\{ V_{t+1}^e(F_t^s(Y_t), \omega_{t+1}) \right\}. \tag{11}$$

This statement of the problem implies a form for the exit rule. In view of (10) and (11), the exit rule is defined in terms of a function $\Xi_t(K_t, a_t)$, which defines a threshold value for the price of output, such that

$$d_t = \begin{cases} \text{exit}; & \text{if } \omega_t \leq \Xi_t(K_t, a_t); \\ I_t(K_t, \omega_t, a_t), & \text{otherwise.} \end{cases} \tag{12}$$

It is convenient to define the exit rule in terms of an indicator function $\mathbf{1}(.)$, where $\mathbf{1}(C) = 1$ if condition C is true, and $\mathbf{1}(C) = 0$, otherwise. That is:

$$\Upsilon(t) \equiv \mathbf{1}(\Phi - \sup_{\{I_t\}} : \pi_t(K_t, a_t, \omega_t; \mathbf{w}_t) - c_t(I_t, K_t) - I_t + \beta E_{\omega_{t+1}} \left\{V^e_{t+1}\right\} > 0) \tag{13}$$

The firm exits if the sell-off value exceeds the value from staying in business.

The exit rule $\Xi_t(\cdot)$, the value function $V^e_t(\cdot)$, and the associated optimal policy are, in general, very difficult to obtain in closed form. Comparative statics–type results are often easier to obtain from the stationary version of the Bellman equation, and it is to such a special case that we now turn.

2.3 The Stationary Case

The stationary version of the Bellman equation is:

$$V^e(Y, \omega) = \max_{\{d\}} : g(Y, d, \omega) + \beta E_{\omega'} \left\{V^e(F^s(Y), \omega')\right\}.$$

In order to better understand the properties of the solution to this equation, we may use the properties of the payoff function per period to rewrite the value function in the stationary case.

For the threshold function $\Xi(K)$ we have:

$$V^e(K, \Xi(K)) = \Phi; \quad \forall K. \tag{14}$$

The existence and uniqueness of the value function $V^e(.)$ is a direct implication of Theorem 9.12 in Stokey, Lucas and Prescott (1989). The Bellman equation may be written as:

$$V^e(K,\omega) = \begin{cases} \Phi, & \text{if } \omega \leq \Xi(K); \\ \max_{I(K)} : \pi(K,\omega) - c(I,K) - I & \\ \qquad +\beta E_{\omega'} \left\{ V^e((1-\delta)K + I, \omega') \right\}, & \text{otherwise.} \end{cases} \tag{15}$$

The functions $V^e(K,\omega)$ and $\Xi(K)$ are obtained by solving simultaneously the above equations (14) and (15). The optimal policy in this stationary setting implies that the probability ζ that a firm exits is a function of K only. It is obtained in terms of the probability distribution function for ω, $H(\cdot)$, and of the exit rule $\Xi(K)$ such that:

$$\zeta(K) = \text{Prob}\{\omega \leq \Xi(K)\} \equiv H(\Xi(K)).$$

The separability of the payoff function, with ω_t appearing only in π_t and I_t not appearing in π_t, along with the assumption that investment becomes productive after one period imply that optimal investment is a function of existing capital and not of the current realization of ω_t, $I_t = I(K_t)$.

We now consider the existence and uniqueness of $\omega = \Xi(K)$. Given that

$$F(I,K,\omega) = \pi(K,\omega) - c(I,K) - I$$

is a continuous convex and increasing function with respect to ω, since $\pi(K,\omega)$ is convex, increasing and continuous with respect to ω, so is the maximum value function $V^e(K,\omega)$. $V^e(K,\omega)$ is a one to one function with respect to ω for given K, which implies that for any Φ and for a given K there is a unique ω which is a function of K, $\omega = \Xi(K)$ such that:

$$\Phi = V^e\left(K, \Xi(K)\right).$$

Further insight into the properties of attrition may be obtained by using (15) to get an expression for $E_\omega\{V^e(K,\omega)\}$. That is:

$$E_\omega\{V^e(K,\omega)\} =$$

$$H[\Xi(K)]\Phi + \int_{\Xi(K)}^{\infty} [\pi(K,\omega) - c(I(K),K) - I(K) + \beta E_{\omega'}\left\{V^e((1-\delta)K + I(K),\omega')\right\}]\, h(\omega)d\omega, \tag{16}$$

where $h(.)$ and $H(.)$ denote the density and cumulative probability distribution functions of ω, respectively.

If the probability of exit were independent of the realization of ω and thus constant and equal to ζ,[10] then equation (16) above implies:

$$E_\omega\{V^e(K,\omega)\} =$$

$$\zeta\Phi + (1-\zeta)[\pi(K,\omega) - c(I(K),K) - I(K)] + \beta(1-\zeta)E_{\omega'}\left\{V^e((1-\delta)K + I(K),\omega')\right\}. \tag{17}$$

It is interesting to note that the probability of survival modifies the firm's effective discount rate. In fact this provides a good way to visualize the impact of the likelihood of exit is to think of it as reducing the effective discount factor. This intuition derives from the problem of the consumer[11] and continues to be useful in the case of equation (15) as well as in non-stationary versions of the model.

We conclude by saying the impact of the likelihood of exit may be seen as making the effective discount factor endogenous, e.g. a function of the capital stock K_t as well as of the realization of ω_t. Thus we should expect that the endogeneity of the firm's discount rate would be reflected in the firm's fundamentals.

[10] One way to justify such an assumption would be that with a constant probability a firm loses its ability to produce. Such an assumption has been made elsewhere in the literature. E.g., Pissarides (1985) assumes that jobs break up with a constant probability.

[11] It is essentially due to Cass and Yaari (1967), p. 262, and has been explored extensively by Blanchard (1985).

2.4 Dynamics with constant probability of exit

We now assume that the event that the firm may exit is independent from the firm characteristics and has constant probability, ζ. Under this assumption and by defining $V(K_t,.)$ to be the expected value of the firm conditional on the firm's survival at the current period, t, equation (17) can be written as:

$$V(K_t,\omega_t) =$$

$$\max_{\{I_t,K_{t+1}\}} \pi(K_t,\omega_t) - c(I_t(K_t),K_t) - I_t(K_t) + \beta E\{\zeta\Phi + (1-\zeta)V(K_{t+1}),\omega_{t+1})\}. \quad (18)$$

subject to the capital accumulation equation:

$$K_{t+1} = (1-\delta)K_t + I_t. \quad (19)$$

and to the initial condition that K_0 is given.

Let q_t be the Lagrange multiplier corresponding to (19). Maximization of the above expected value subject to the capital accumulation constraint gives a first order condition of the form:

$$q_{t-1} = \beta(1-\zeta)\left[\frac{\partial\pi(K_t,.)}{\partial K_t} - \frac{\partial c(I_t,K_t)}{\partial K_t} + (1-\delta)q_t\right]. \quad (20)$$

The Lagrange multiplier q_t that adjoins the capital accumulation constraint (19), may be interpreted as the marginal q [Hayashi (1982)]. It satisfies:

$$q_t = 1 + \frac{\partial c(I_t,K_t)}{\partial I_t}. \quad (21)$$

The first order conditions of the firm's problem have the standard interpretation. A firm should be indifferent between investing in last period $t-1$, or waiting to invest in the present period, given the probabilities for exit from the market. Note that the effective discount factor in the present case is equal to $\beta(1-\zeta)$ and thus is smaller because of the effect of the probability $(1-\zeta)$ that the firm will survive until period t.

The above system of equations provides very simple and interesting dynamic characteristics. First, it is easy to show that the steady state value of marginal q is a function only of the depreciation rate, δ and of the parameters of the cost of capital adjustment function. This result comes from the assumption that the cost function for investment, $c(I_t, K_t)$, is linearly homogeneous in K_t and I_t, which implies that the partial derivative $\partial c(I_t, K_t)/\partial I_t$ is a function of the ratio I_t/K_t only. That ratio equals to δ in the steady state. It is clear, then, that the marginal q is independent of the probability of exit in the steady state.

We can also make simple inferences for the steady state value of capital using equation (21). Assuming smoothness conditions for the profit function, $\pi(K_t, .)$, capital in the steady state appears only in the partial derivative of $\pi(.)$ with respect to K_t, $\partial\pi(K_t, .)/\partial K_t$. Reasonable market conditions imply diminishing returns to capital for the profit function, which in turn imply that the steady state value of capital is a decreasing function of the constant probability of the firm's exit, ζ. This has a very straightforward explanation. Firms in high risk environments optimize by maintaining a smaller capital, so that they are more flexible in disposing or reselling it.

2.5 A Linear-Quadratic Example with Constant Probability of Exit

A quadratic profit function,

$$\pi(K_t, .) = \alpha_0 K_t - \frac{\alpha_1}{2} K_t^2, \qquad \alpha_0 > 0, \alpha_1 > 0,$$

and a quadratic adjustment cost of capital

$$c(I_t, K_t) = \frac{\gamma}{2}\frac{I_t^2}{K_t}, \qquad \gamma > 0,$$

after some manipulation yield a first order optimality condition of the following form:

$$q_{t-1} = \beta(1-\zeta)\left[\alpha_0 - \alpha_1 K_t - \frac{1}{2\gamma}(q_t - 1)^2 + (1-\delta)q_t\right]. \tag{22}$$

We examine the solution of the system of difference equations (21) and (22). Working with the steady state solution first, we see that the steady state value for q is given by:

$$q^* = 1 + \gamma\delta.$$

That is, q^* depends only on the following parameters of the model: the depreciation rate, δ and the parameter of the cost of capital adjustment function, γ. In particular, it is independent of the probability of exit. The steady state value for the capital stock is given by:

$$K^* = \frac{1}{\alpha_1}\left[(1+\gamma\delta)\left((1-\delta) - \frac{1}{\beta(1-\zeta)}\right) - \frac{1}{2}\gamma\delta^2 + \alpha_0\right].$$

We note that a higher probability of exit, ζ, implies a lower capital stock at the steady state. Equivalently stated, this result says that higher probability of exit results in a lower discount factor, $\beta(1-\zeta)$, the size of the capital stock in the steady state, will be lower. We may also obtain an expression for the value of the firm in the steady state:

$$V^*(K^*, .) = \frac{1}{1-\beta(1-\zeta)}\left\{\left[\frac{\alpha_0}{\alpha_1} + \frac{1}{2}K^* - \frac{\gamma\delta^2}{2} - \delta\right]K^* + \beta\zeta\Phi\right\}.$$

Its dependence on ζ is complicated. If Φ is sufficiently low, then a higher probability of exit results in a lower firm value in the steady state.

It is also interesting to consider the dynamics of the system of equations (19) and (22) near the steady state. We work in the standard fashion and linearize the system around the steady state. The system, then, becomes:

$$q_t - q^* = \frac{\frac{1}{\beta(1-\zeta} - \frac{\alpha_1}{\gamma}K^*}{(1-\delta) - \frac{1}{\gamma}(q^* - 1)}(q_{t-1} - q^*) - \frac{\alpha_1((1-\delta)(1+\gamma\delta) - \frac{1}{\gamma}}{1-2\delta}(K_{t-1} - K^*)$$

$$K_t - K^* = \frac{1}{\gamma}K^*(q_{t-1} - q^*) + (1-2\delta)(K_{t-1} - K^*)$$

It is convenient for the dynamics to write the system in matrix form:

$$\begin{pmatrix} q_t - q^* \\ \\ K_t - K^* \end{pmatrix} = \begin{pmatrix} \frac{\frac{1}{\beta(1-\zeta)} - \frac{\alpha_1}{\gamma}K^*}{1-2\delta} & \frac{\alpha_1\left((1-\delta)(1-\gamma\delta) - \frac{1}{\gamma}\right)}{1-2\delta} \\ \\ \frac{1}{\gamma}K^* & 1-2\delta \end{pmatrix} \begin{pmatrix} q_{t-1} - q^* \\ \\ K_{t-1} - K^* \end{pmatrix}.$$

The eigenvalues of the matrix

$$\begin{pmatrix} \frac{\frac{1}{\beta(1-\zeta)} - \frac{\alpha_1}{\gamma}K^*}{1-2\delta} & \frac{\alpha_1\left((1-\delta)(1-\gamma\delta) - \frac{1}{\gamma}\right)}{1-2\delta} \\ \\ \frac{1}{\gamma}K^* & 1-2\delta \end{pmatrix}$$

fully determine the dynamics of the system near the steady state. Depending on the magnitude of the parameters of the model the above system may either converge to the steady state, or diverge from it making the dynamics unstable. Further analysis of the eigenvalues shows that the signs and magnitudes may not determined without specifying values to the parameters. Extensive explorations with a variety of numerical values did not suggest any specific pattern.

3 Description of the COMPUSTAT Data

The data used in this work are based on the "Manufacturing Sector Master File: 1959–1987" created initially by Bronwyn H. Hall [Hall (1988)] under the auspices of a National Bureau of Economic Research project. The Manufactured Sector Master File consists of a non-balanced panel of 2726 publicly traded firms with 90 variables for several years in the period 1959–1987. There are 49,225 observations in all. The original data were extracted by Bronwyn Hall from the Annual COMPUSTAT Industrial and Over-the-Counter Files for 1978 through 1987. Data items come from a variety of sources such as income statements, balance sheets, flow of funds statements, etc. A detailed description of the construction of the data is presented by Bronwyn Hall [Hall (1990), pp. 26-30].

The COMPUSTAT panel data set contains data from all firms traded on the New York and American Stock Exchanges and a number of firms traded in over-the-counter markets. Minimum requirement for inclusion of a firm in the current panel is the existence of data for at least three consecutive years between 1976 and 1985.

The Manufacturing Sector Master File is supplemented by a list of all firms which exited from the above panel between 1976 and 1987. Those data were obtained from the Directory of Obsolete Securities and from the Capital Changes Reporter, and contains information on acquisitions, bankruptcies, reorganizations, liquidations and mergers.

General patterns of firm entry and exit in U.S. manufacturing industries have been examined extensively by means of a variety of data sets. [12] Our data on attrition in the Manufacturing Master File [Hall (1990)] come from Bronwyn Hall. The COMPUSTAT Merger File [Hall (1989)] contains the results of Bronwyn Hall's investigations into the whereabouts of every firm which disappeared from the Compustat Annual Industrial and OTC Files between 1976 and 1987. The file at our disposal has been corrected and updated from the August 1988 edition and exits that occurred in 1986 and 1987 have been added.

3.1 Attrition

In addition to information essential for the identification of each firm, such as its CUSIP, the following information is available that pertains to attrition. First, the year in which the actual acquisition, bankruptcy, liquidation, or name change took place. This is not necessarily the year in which the firm exited from the file; often it is later. There will be exits up until 1989, since data may disappear much earlier from COMPUSTAT (and Hall's sample consists of all firms for which we do not have data in 1987 and possibly earlier years). Second, a code telling why the firm exited from the file.

The different categories of exits are listed below and distinguished by the character code used in the data. The number of exits for each category as a percentage of total exits are given in parentheses. M: the firm was acquired by another publicly traded firm (48.26%); P: the firm went private (or was purchased by a privately held firm) (22.3%); PL: the firm went private in a leveraged buyout (6.0%); F: the firm was acquired by a foreign entity (9.17%); B: the firm went bankrupt. There is no real distinction between Chapter 7 and Chapter 11 in Hall's data (3.46%); L: the firm was liquidated (3.38%); R: the firm

[12] Most noteworthy are a series of studies by Dunne and Roberts. See Dunne *et al.* (1988) for an excellent summary.

underwent reorganization and may have later reappeared (1.35%). Some bankruptcies are included here. NC: the firm changed its name. The new name and identification code are shown as of the acquiring firm (0.29%). NO: After much investigation, no reason for exit was found and the firm is still in existence (2.99%). D: the firm is still in existence and still (at least to a certain extent) publicly traded, but it has been delisted from an exchange and COMPUSTAT no longer carries its data (2.8%).

Further descriptive statistics for key variables are provided in Table 2. For the percentage of exits for all firms see the fourth column of Table 6. Also, additional aspects of the data are described in the sections below.

4 Empirical Aspects of Attrition

The exit model of section 2.2 in combination with the basic model of Section 2.1 provide a conceptual basis for examining exits of firms. Those models lend themselves readily to estimation by means of dynamic discrete choice models.

We start with a structural model that follows closely the derivation in Section 2 above. The discrete event $\mathcal{Y}_t$ of a firm's exit, as a terminal state, is modeled as the outcome of a comparison between the value from exiting, Φ_t, and the value from staying on past period t, V_t^e, defined according to (11) above as:

$$\mathcal{Y}_t \equiv \begin{cases} 1, & \text{if } \Phi_t - V_t^e, \\ 0, & \text{otherwise.} \end{cases} \tag{23}$$

We do not, for the time being, qualify the exact nature of a firm's exit. Below we generalize this model to account for two different types of exits.

As Section 2 indicates the value function is, in general, a function of observable state variables, market characteristics and prices and a set of possibly unobservable characteristics of a particular firm. Let Y_{i0t} denote a vector of characteristics and market variables for firm i, β_0 a vector of unknown parameters to be estimated, and ϵ_{0t} an unobservable stochastic component of the firm's value. We assume that the value of firm i, should it decide to continue operation at time t, can be written as follows:

$$V(Y_{i0t}, \beta_0) + \epsilon_{i0t}, \tag{24}$$

Similarly the value to a firm i, should it decide to exit, is assumed to be written as:

$$\Phi(Y_{i1t}, \beta_1) + \epsilon_{i1t}, \tag{25}$$

where Y_{i1t} is a vector of characteristics and market values, β_1 is a vector of unknown parameters and ϵ_{i1t}, an unobservable stochastic component of the value to a firm by exiting. The definition of the exit variable according to (23) implies that the probability that the firm exits at time t is:

$$Prob\{\mathcal{Y}_t = 1\} = Prob\left\{\Phi(Y_{i1t}, \beta_1) - V(Y_{i0t}, \beta_0) > \epsilon_{i0t} - \epsilon_{i1t}\right\}. \tag{26}$$

The model defined by (23), (24) and (25) may be estimated with panel data on firms' characteristics and exits as a dynamic limited dependent variable model once the distribution functions for $\{\epsilon_{i0t}, \epsilon_{i1t}\}_{t=1}^{T}$ has been specified. E.g., if $\{\epsilon_{i0t}, \epsilon_{i1t}\}_{t=1}^{T}$ are assumed to obey a bivariate normal distribution then (23) may be estimated as a dynamic probit model.

Two important aspects of the problem complicate the estimation. First, the fact that once a firm exits, no more data are available for it, dictates that the estimation model must be able to handle an unbalanced panel. Second, the desire to account for individual heterogeneity imposes serious estimation problems which may be overcome either by seriously restricting the stochastic structure assumed for $\{\epsilon_{i0t}, \epsilon_{i1t}\}_{t=1}^{T}$, or using one of the recently developed quadrature algorithms[13] or simulation methods.[14]

We model individual heterogeneity, by assuming that the stochastic term in (25) and (24), ϵ_{ijt}, consists of a random time-invariant individual effect for each firm i, η_{ij}, and an unobserved component for firm i at time t, ν_{ijt}, which is assumed to be uncorrelated with η_{ij}:

$$\epsilon_{ijt} = \eta_{ij} + \nu_{ijt}, \quad j = 0, 1; \;\; i = 1, ..., I. \tag{27}$$

The random effect η_{ij} is assumed to be normally distributed across the I firms in the panel with 0 mean and variance σ_{η}^2. The error ν_{ijt} is also assumed to be normally distributed with mean 0 and variance σ_{ν}^2.

4.1 Estimation of Exits by Means of a Dynamic Probit Model

Under the above assumptions for the stochastic structure and the additional assumptions that $V_t^e(Y_{i0t}, \beta_0)$ and $\Phi_t(Y_{i1t}, \beta_1)$ may be written as linear functions of the parameter vectors,

$$V_t^e(Y_{i0t}, \beta_0) = Y_{i0t}\beta_0,$$

and

$$\Phi_t(Y_{i1t}, \beta_1) = Y_{i1t}\beta_1,$$

[13] See Butler and Moffitt (1982)

[14] See Hajivassiliou and McFadden (1992) and Börsch-Supan *et al.* (1992).

the model (23), (24) and (25) may be estimated as a dynamic probit model with random effects. Since only the difference $V_t^e(Y_{i0t}, \beta_0) - \Phi_t(Y_{i1t}, \beta_1)$ may be identified, we do not separate the vectors Y_{i0t} and Y_{i1t} of the RHS and include in a single vector, Y_{it}, characteristics of the firm and its environment, such as individual, industry, and macroeconomic (or cyclical) variables. Cyclical variables include the rate of interest (measured by the Treasury Bill rate), GNP growth rate, prices etc.

We follow the standard finance literature and use in addition a number of firm variables and ratios widely used in corporate finance. Descriptive statistics of firms include the following variables from the COMPUSTAT data: Investment, operating income, net and gross cash flow, sales, dividends, dividends and common stock repurchases and total debt. All these variables have been normalized after being divided by the net capital stock. Other variables include Tobin's q[15] and a number of ratios used in standard corporate finance theory[16] to which we now turn.

We consider a number of fairly commonly used measures of profitability, liquidity and leverage. Profitability is measured by the ratio of cash flow to sales, which measures the operating efficiency and the rate of internal cash generation. We also consider the ratio of cash flow to total tangible assets, which accounts for the ability of the firm to generate cash flows from resources, and the ratio of operating income to total tangible assets. A liquidity ratio used is defined as cash flow over total liabilities; it measures the firm's ability to meet total liabilities out of its cash generation. Finally, ratios intended to measure leverage include the total debt to total tangible assets, The first one measures the degree to which the firm's assets are financed by debt. The second, retained earnings to

[15] For a detailed description of the construction of Tobin's q, see Appendix A

[16] See Brealey and Myers (1991)

total tangible assets, is intended to reflect the extend to which existing assets have been financed by reinvested profits, it measures long term profitability,

Variable definitions are given in Table 1. Descriptive statistics of all variables and ratios are given on Table 2.

We highlight our results by considering first the case of no individual effects, that is: $\eta_{ij} = 0$, $\forall i$, and $\forall j$. Under the assumption that ν_{ijt} are uncorrelated across i and t, exits may be modeled rather naturally by means of a geometric distribution. That is, the probability that a firm i exits in year t is given by

$$\prod_{\tau=1}^{\tau=t-1} [1 - \mathcal{Y}_{i\tau}]\mathcal{Y}_{it}, \tag{28}$$

where the exit probability, $\mathcal{Y}_t$, is defined in terms of a probit model:

$$Prob\{\mathcal{Y}_t = 1\} = N(Y_i t\beta_j \geq \nu_{it}^*), \tag{29}$$

and ν_{it}^* denotes a standard normal variate. The results of such an estimation are reported on the first column of Tables 4a and 4b.

For the same model defined by (28) - (29) we now account for unobservable individual effects by means of a random effects specification as described by equation (27). The second column of the Tables 4a and 4b report the estimations of the model with individual effects.

We consider two different samples in order to exploit different characteristics of the data. Firms in the sample appear for the first time between 1959 and 1972, that is either their shares were traded publicly before 1959, or they went public sometime between 1959 and 1972. All firms of the sample either exited sometime between 1977 and 1987 or they continue to operate after 1987. We deleted all firms which exited before 1977 because we do not have any information on the reasons they exited. In other words, the sample is censored between 1959 and 1987 (some firms existed before 1959 and some after 1987) and there is a selection which excludes firms which exited before 1977. Attrition in our data naturally leads to a non-balanced panel. For the estimation, we use the Butler and Moffitt quadrature algorithm for the univariate probit model as adapted by Hajivassiliou to allow it to handle unbalanced panel data.[17]

The first subsample we consider contains only the firms which exited for reasons of bankruptcy, liquidation or reorganization[18] and never reappeared in the sample. Characteristics of this sample concerns only firms which exit at some point within the period of observation. There are 2,079 observations on this sample. Descriptive statistics for this subsample are given in Table 2. The probit estimation results on Table 4a provide a number of interesting insights. A comparison of the results without random effects in column I, with the results with random effects, in column II, suggests that the improvement in the likelihood function, measured by the likelihood ratio test, and the size of random effects variance ($\log(\sigma_\eta)$) which is very small, rejects the random effects model. In other words, firm heterogeneity is not important in explaining a firm's propensity to exit, for the subsample of firms which exited. This finding implies that it is a random event at the time of exit, beyond what is measured by means of firm observable characteristics at the respective period that causes a firm to exit.

Several of the explanatory variables give significant coefficients in the above model. Low investment relative to capital (I2K) is associated with higher likelihood that a firm exits. The intuition is rather simple: Firms with technologies that cannot be improved may be lead to bankruptcy or to liquidation. The direction of causality, however, may

[17]Butler and Moffitt(1982) describe a Gaussian quadrature procedure and provide a quick and efficient approximation to the estimation of a univariate probit panel data model. In this paper we used 5 evaluation points for the estimated normal integral.

[18]A discussion of the legal aspects of these events are given on Appendix B.

not be inferred. That is, it could be the case that firms exit because they do not invest perhaps because of financial constraints in obtaining funds. Higher values of the gross rate of return to capital (GRATE) (which is a characteristic of firms with small size) imply a higher likelihood of exit. The negative sign of the debt to capital (DEBT2K) ratio, though not very significant, suggests that exits are more likely to occur when firms find it harder to borrow more, possibly due to binding borrowing constraints. Higher likelihood of exit is also associated with low retained earnings to tangible assets ratio (RE2TANG), which may be interpreted as a measure of long term profitability of the firm. In other words, firms which are not expected to be profitable in the long run are more likely to exit.

It is also noteworthy that variables of macroeconomic interest have strong impacts on bankruptcies and liquidations. For the sample of the firms which exited, the probability of exit is higher the higher the interest rate, measured by the Treasury Bill rate (TBILL). As debt to capital is held constant, we interpret this as a cost of borrowing effect. Surprisingly, higher GNP growth rates (DGNP) are associated with higher probabilities of exit.

The second sample we consider includes all 2,161 firms, totaling 43,409 observations. Many of the firms of this sample never exited, or they exited for reasons other than bankruptcy, liquidation or reorganization. The probit estimations results on Table 4b are very similar to the results of Table 4a of the subsample discussed above. Again, a comparison between column I, the homogeneous model, and column II, the random effects model, shows that there is no support for the random effects model. The improvement in the likelihood is not significant, according to the likelihood ratio test, while the variance of the random effects is negligible. The conclusion is similar to the previous model: The decision of a firm to exit depends on random factors, which can be modeled in terms of fundamentals of the firm and cyclical events only. Inclusion of an unobservable characteristic for each firm, in addition to observable factors, such as fundamentals and cyclical effects, is not significant in explaining exit.

The significant variables in this sample, are very similar to the ones in the bankruptcy sample: Again, higher investment is associated with low exit probability and so is higher amounts of net cash flows (NCF2K). The negative net cash flow coefficient, which was insignificant in the bankruptcy sample, has a very simple intuition: Firm with high cash flows find it easier to pay back their debt obligations, and so the probability of exit for reasons of bankruptcy, liquidation or reorganization is relatively low. Similar is the intuition for the negative sign of the profitability ratio, operating income to total tangible assets (OPY2K): Firms with higher profitability are less likely to disappear from the sample. The results also show that firms with higher debt to tangible assets ratio (B2TANG), which account for the degree of the firm's assets which finance the debt, are more likely to exit. As far as macroeconomic variables are concerned, we obtain that higher interest rates are associated with higher probability of exit.

We control for possible industry effects by means of industry dummies. We use 20 industry dummies to account for 20 manufacturing industries as classified by COMPUSTAT. For a complete description of these variables, see Section A.4 in the Appendix. The likelihood ratio test shows that inclusion of industry dummies improves the performance of the model. Apart from the obvious advantage of the improvement of the explanatory power of the model, the fact that the industry structure is significant in explaining firm attrition, suggests that a more careful examination of exit behavior in terms of industry characteristics of the panel could pay off significantly in terms of additional results.

The number of firms in COMPUSTAT that exit at some point during the sample is very small It is for this reason that estimation along the above lines has been rather cumbersome. It is for this reason that we now turn to a more detailed analysis of the reasons for exiting.

4.2 Repeated Cross Section Estimation of Exits by Means of a Multinomial Probit Model

We wish to use additional information provided in the data which includes details on exits from acquisitions by other firms on the sample or outside the sample (including privatization of acquisition by foreign entities). We consider therefor a more general model which allows us to study the determinants of exits when firms may avail themselves of three alternative courses of action. A firm may declare bankruptcy, or be liquidated, or be acquired (mergers included) by another firm, or continue operation.

As explained in the previous section, firms appear in the sample sometime between 1959 and 1972 and exit sometime between 1977 and 1987. Of course the sample is censored between the years 1959 and 1987, that is, some firms existed before 1959 and some after 1987. It is such endogenous attrition that causes the panel to become non-balanced.

No software is currently available for estimating limited dependent variable models with non-balanced panel data with random effects when the number of decisions are more that two. In this case the quadrature procedure used earlier becomes inapplicable. The best techniques which are available at present time use simulated methods and require a balanced panel.

While awaiting the development of appropriate software, we ignore the panel structure of the data and consider ten repeated cross–sections of firms for the years 1978 to 1987. We estimate ten different multinomial probits using simulation estimation methods as developed by Hajivassiliou and McFadden (1992) and Börsch-Supan et al. (1990).

The endogenous discrete event now becomes:

$$\mathcal{Y}_t \equiv \begin{cases} 1, & \text{if a firm is acquired by another firm;} \\ 2, & \text{if a firm goes bankrupt or is liquidated;} \\ 0, & \text{if a firm continues operation.} \end{cases} \tag{30}$$

The econometric modelling in this case is very similar to the one in the previous section. We associate a value level to each of the above decisions of the firm, V_1, V_2, and V_0, respectively, which take the form:

$$V_j = V(Y_{it}, \beta_j) + \epsilon_{j,t}, \qquad j = 0, 1, 2, \tag{31}$$

where Y_{it} is a vector of firm characteristics, β_j a vector of unknown parameters to be estimated, and $\epsilon_{j,t}$ is an unobservable random term, assumed to be distributed normally. For example, the probability that a firm chooses bankruptcy (or liquidation) is given by:

$$Prob\,\{\mathcal{Y}_t = 2\} =$$

$$Prob\,\{(V(Y_t, \beta_2) - V(Y_t, \beta_0) > \epsilon_{0,t} - \epsilon_{2,t}) \quad \cap \quad (V(Y_t, \beta_2) - V(Y_t, \beta_1) > \epsilon_{1,t} - \epsilon_{2,t})\}$$

Because of identification restrictions, affecting the probit model, we can only estimate the coefficients for two of the three alternatives. We choose in estimating the first two. The results are summarized on Tables 5a and 5b.

An interesting feature of the results is that they show consistent patterns for the period examined. Analytically, the investment to net capital stock ratio (I2K) shows a negative effect on the likelihood of both acquisitions and bankruptcies. This effect, even not significant for all years, implies that firms with higher investment-capital ratio are less likely to disappear from the market. Operating income to capital (OPY2K) also has a negative effect, with the effect being stronger in bankruptcies. This accords with intuition. The significant positive effect of the sales to capital ratio (SALES2K) is hard to explain:

Firms with high sales seem more likely to exit or to be acquired. Similar is the case for the dividends to capital ratio (DIV2K). It shows a positive pattern for the early years of estimations but it becomes negative for the latest years. The debt to capital ratio (DEBT2K) has a negative effect on the likelihood of bankruptcy and a positive one for acquisitions, implying that firms with high debt are less likely to go bankrupt or liquidated and more likely to de acquired. There is a strong significant negative pattern for Tobin's q for both acquisitions and bankruptcies, which also accords with intuition. Firms with high market value relative to replacement cost of capital, expressed here in terms of the Tobin's q, are less likely to go bankrupt/liquidated or be acquired.

4.3 Duration models of attrition.

An alternative way to utilize the information in the data is to estimate duration models for firms in the sample. Meghir (1988) proposes such a model and provides some non-parametric statistics using U.K data.

Duration here is defined as the number of years a firm stays in the sample until it exits for any of the following reasons: bankruptcy, liquidation and reorganization. In the latter case, firms never re-appear in the sample after their exit for reorganization.

Duration models are implied by the model in (23) or (30). For the univariate model (23), in particular, we may relate the time until firm i exits to all that is known for that firm and the environment within which it operates up until the time it exits. In practice, [19] estimation with duration data requires that we restrict attention to a fairly well-defined class of parametric models of duration. The estimations discussed here have

[19] See Lancaster(1990) for a comprehensive analysis of duration models

been performed with the subsample consisting only of firms that exit from 1977 to 1987.

Parametric models of duration are obtained from specifying the probability density function for the time of occurrence of an underlying discrete event [20]. The survival function is defined as the probability that the event has not occurred as of time t: $S(t) = Prob\{\tau \geq t\}$; the hazard function at t is the conditional probability of exit at time t, $h(t) = \frac{f(t)}{S(t)}$, where f(t) is the probability density function of the underlying discrete event. For the parametric distributions we consider here the survival and hazard functions are given in the following table:

Distribution	Survival Function	Hazard Function
Weibull	$exp(-(\lambda t)^p)$	$\lambda p(\lambda t)^{p-1}$
Normal	$N(-plog(\lambda t))$	n/N
logistic	$\frac{1}{1+(\lambda t)^p}$	$\frac{\lambda p(\lambda t)^{p-1}}{1+(\lambda t)^p}$

where λ and p are parameters of the models, and N and n have the standard definitions of the normal distribution integrals. The effect of external covariates, $\mathbf{x_i}$, on the duration can be specified by defining the parameter λ to be:

$$\lambda = e^{-\beta' \mathbf{x_i}}.$$

We include in $\mathbf{x_i}$ a number of firm characteristics and macroeconomic variables describing the state of the economy. Firm characteristics, including a number of ad hoc ratios measuring liquidity, profitability and leverage which have also been used by others before

[20] For excellent surveys see Cox and Oakes (1984) and Kiefer (1988).

us did not give significant results. Some others, like Tobin's q, gave results with signs opposite to what intuition would suggest. Variables like the state of the economy (GNP growth) and interest rates, measured by the Treasury bill rate at the time of entry or exit of the firm in the panel give results which accord with intuition. It is those results that we report here.

Table 6 provides a summary of the main results for different specifications of duration models. We consider a number of parametric loglinear models of duration. We obtain our best results with the Weibull, the normal and the logistic distributions. The coefficient of the GNP growth rate of the year the firm enters the panel is positive and significant. It may be interpreted as implying that shorter durations are associated with firms which appear in the market during recession periods. Finally the coefficient of λ is significant and positive, which implies that the conditional probability for a firm to exit increases with duration (positive duration dependence of the hazard function).

We note a significant negative coefficient for the Treasury Bill rate at the year the firm exits from the sample. There is a simple intuition behind this result: High interest rates at the time the firm exits from the panel are associated with shorter duration of firms.

We note that duration models hardly utilize the full dynamics of the panel data structure. Yet, they do provide empirical support for the importance of market conditions at the time a firm exits upon the length of firms' lives in the panel. Dynamics are related to firm characteristics at the time of the firm entry or exit from the panel and cyclical characteristics.

This conclusion is drawn from estimations with a sample consisting of firms that exit between 1977 and 1987. A complete analysis should include all firms. We think the above conclusion would be bolstered by doing so. In any case, our results with duration models should be interpreted with caution because they are based on treating incomplete spells as complete.

4.4 Poisson Estimations with Aggregated Data on Exits

The data suggest that while exits are in general quite frequent, bankruptcies as such are relatively infrequent. For this reason we have carried out an analysis under the assumption of a Poisson model for exits for each of the different reasons for exit. Let $\mathcal{X}_t$ be the number of firms recorded as exiting under a particular category above in year t. We assume for the purpose of estimation that $\mathcal{X}_t$ has a Poisson distribution,

$$Prob\{\mathcal{X}_t = v\} = e^{-m_t}\frac{(m_t)^v}{v!},$$

with a (possibly time-varying) mean given by $m_t = e^{b\mathbf{X}_t}$, where b is a constant vector of parameters and $\mathbf{X}_t$ a vector of regressors. The attractiveness of the Poisson model on theoretical grounds lies in its ability to handle infrequent events. On practical grounds, the ability of the Poisson model to handle zeros in a simple way is also useful.

For each of the categories of exits defined above we associate the number of the respective exits in a given year with a number of explanatory variables in that year and treat this as an independent draw over the years of the panel. We estimate the respective Poisson model by maximum likelihood.

The results with Poisson regressions for the various categories of exits, reported in Table 3 below, do provide support for the notion that market conditions help induce exits. Specifically the rate of interest, the U.S. Treasury Bill rate in our case, appears to be an important explanatory variable in the regressions for bankruptcies, liquidations and reorganizations. Our results have rejected a negative binomial specification for the number of exits. All regressions reported in Table 2 are highly significant in terms of the likelihood ratio test. Estimations with Poisson models for exits yield excellent fits with respect to the estimated mean.

5 Conclusions

Estimations of dynamic probit models with the full panel data show that cyclical effects and observable firm characteristics are significant in explaining firms' propensity to exit. Unobserved firm heterogeneity, however, is found not to be important in explaining exit decisions. This finding implies that conditionally on observable characteristics of firms and macroeconomic conditions, especially interest rates, exits are more likely to result from random events at the time of exit.

Poisson regressions with aggregated data on exits provide additional evidence in favor of macroeconomic factors. Repeated cross section estimation of exits by means of a multinomial probit model that distinguishes mergers and acquisitions from bankruptcies confirm the importance of observable characteristics of firms.

TABLE 1

VARIABLES

I2K	Investment to capital
OPY2K	Operating Income to Capital
GRATE	Gross Cash Flow to Capital
NCF2K	Net Cash Flow to Capital
SALES2K	Sales to Capital
q	Tobin's q
DIV2K	Dividends to Capital
DIVR2K	Dividends plus Repurchases to Capital
DEBT2K	Total Debt Stock to Capital
NCF2SALE	Net Cash Flow to Sales
NCF2TANG	Net Cash Flow to Total Tangible Assets
OPY2TANG	Operating Income to Total Tangible Assets
NCF2LIAB	Net Cash Flow to Total Liabilities
B2TANG	Total Debt to Total Tangible Assets
RE2TANG	Retained Earnings to Total Tangible Assets

TABLE 2

DESCRIPTIVE STATISTICS: The Whole Sample

Variable	N	Mean	Std Dev	Minimum	Maximum
FINDEX	43409	1078.68	623.6353209	1.0000000	2161.00
YEAR	43409	74.7673063	7.1744150	60.0000000	87.0000000
BANKRUPT	43409	0.0028566	0.0533709	0	1.0000000
DGNP	43409	2.9959870	2.4242907	-2.5000000	6.8000000
TBILL	43409	6.7684617	2.7936635	2.3780000	14.0200000
NETCAP	41621	608.6339348	2652.65	0.0723749	80707.81
NRATE	41621	0.6623216	9.2926861	-94.4505768	946.5126953
NCF	41621	80.3904333	380.8334698	-2863.49	11515.53
TANGIBLE	42947	914.6858297	3260.17	0.2100000	81907.85
I2K	40046	0.1767575	0.1679412	0	2.4211005
OPY2K	41614	0.4216613	0.5021680	-6.7108238	18.7017073
GRATE	41621	1.1779146	18.2104279	-12.6138391	1523.73
NCF2K	41621	0.7310173	9.2926354	-94.0005768	946.5344990
SALES2K	41598	3.9617436	4.8273296	2.4146441E-8	255.3450015
q	34836	5.1467641	65.4146812	-15.9063216	3075.82
DIV2K	41273	0.2870757	5.0070556	0	283.5819304
DIVR2K	37845	0.2547895	4.1928679	-0.1041461	257.0584497
DEBT2K	41616	0.4134180	0.5987289	0	71.4891029
NCF2SALE	41598	-2176.47	798125.81	-152609395	56489695.60
NCF2TANG	41620	0.2638726	3.5029984	-24.5216356	355.6228661
OPY2TANG	42764	0.1562754	0.1154510	-2.9734359	3.2533328
NCF2LIAB	41574	1514.99	218348.24	-177.5181725	32504091.14
B2TANG	42940	0.1783274	0.1531897	0	3.9889552
RE2TANG	39313	0.2870149	0.5168375	-24.0047616	2.7933324

DESCRIPTIVE STATISTICS: Bankruptcies

Variable	N	Mean	Std Dev	Minimum	Maximum
FINDEX	2079	1118.62	630.7662625	14.0000000	2159.00
YEAR	2079	73.4324194	6.1159889	60.0000000	87.0000000
BANKRUPT	2079	0.0596441	0.2368832	0	1.0000000
DGNP	2079	2.9928331	2.4612026	-2.5000000	6.8000000
TBILL	2079	6.6321217	2.7769781	2.3780000	14.0200000
NETCAP	1955	113.9513828	637.8278309	0.0968446	12077.67
NRATE	1955	0.9846872	13.4397797	-21.4695892	559.8303223
NCF	1955	10.6505594	35.3201936	-53.5162763	552.9247305
TANGIBLE	2040	296.0788360	1459.98	0.6537283	23686.74
I2K	1813	0.1597077	0.1883301	0.000054920	1.8899731
OPY2K	1955	0.3342126	0.8169724	-6.7108238	17.8177115
GRATE	1955	2.0943213	34.6655401	-3.8209915	1471.75
NCF2K	1955	1.0468453	13.4422237	-21.2036317	560.0274448
SALES2K	1955	5.4406430	13.8515404	0.0244367	255.3450015
q	1529	5.5454326	53.5394614	0.0092535	1532.01
DIV2K	1933	0.2004287	2.1835328	0	63.2628676
DIVR2K	1866	0.1974430	2.2047954	-0.0041746	63.2628676
DEBT2K	1955	0.5486080	0.6852042	0	17.4685203
NCF2SALE	1955	0.0402334	5.1333276	-205.7268580	40.4636123
NCF2TANG	1955	0.2056242	1.0947285	-7.2732260	17.2359931
OPY2TANG	2003	0.0930886	0.1727933	-2.9734359	0.7086915
NCF2LIAB	1945	1.1722754	6.7097851	-6.8759255	163.2247085
B2TANG	2038	0.2188696	0.2353374	0	3.5241295
RE2TANG	1853	0.0839882	0.9920483	-21.0015629	0.8941133

TABLE 3

POISSON REGRESSIONS WITH AGGREGATED DATA ON EXITS

Variable	Mean	St. Dev.	% of panel	Const. Term (T-Stat.)	T-Bill Rate (T-Stat.)	GNP Growth Rt (T-Stat)	Estimated Mean
M (merger)	41.66	14.79	18.42	3.31676 (16.999)	0.0182861 (1.842)	0.0351675 (2.176)	41.4358
P (private)	12.58	7.65	5.56	1.02976 (2.879)	.138922 (4.416)	0.0774079 (2.651)	11.8358
PL (private-l)	6.66	5.64	2.94	0.795671 (1.649)	.116266 (2.657)	0.022899	6.3876
F (foreign)	7.91	5.45	3.50	3.01244 (6.369)	-0.107967 (-2.270)	-0.0195745 (-0.492)	7.6543
C (contrl)	0.25	0.45	0.11	-1.38629 (-2.401)			0.25
B (bankrpt)	8.16	5.21	3.61	0.139481 (.314)	0.195758 (5.099)	0.0550382 (1.614)	4.2434
L (liquid.)	2:91	2.61	1.29	-1.54973 (-1.976)	0.237182 (3.685)	0.125668 (1.977)	2.4308
R (reorgan)	1.16	1.52	0.51	-3.41503 (-2.324)	0.268868 (2.466)	0.273439 (2.069)	0.8271
NC (change)	11.0	23.863	4.86	8.29444 (10.761)	-.654529 (-7.521)	-0.333136 (-5.281)	5.0263
NO (unknown)	2.58	2.06	1.14	0.949081 (5.284)			2.5833
D (delisted)	2.41	2.81	1.06	-1.023529 (-1.241)	.178265 (2.513)	0.0871262 (1.311)	2.1881

TABLE 4a

PROBIT ESTIMATION of

$\mathcal{Y}_t$ = 1(Bankruptcy or Liquidation occurs at time t)

(sample of exited firms)

Variable	no random effects	with random effects
constant	-130.7259417	-118.3674927
	(-3.849936126)*	(-108.9392565)
i2k	-528.1266809	-469.2724609
	(-3.499154026)	(-58.40192282)
opy2k	-0.1573060189	-0.1143025756
	(-0.3539743699)	(-6.686179282)
grate	0.6233982646	0.6194911003
	(2.592714180)	(10.20187540)
ncf2k	-0.2515271856	-0.2841100693
	(-0.6888969655)	(-7.135441960)
sales2k	-4.0385049731E-02	-4.5607507229E-02
	(-0.3597838869)	(-6.654258017)
div2k	6.5019329811E-02	6.6109716892E-02
	(0.7286180906)	(6.780961188)
debt2k	-0.3008790702	-0.3199727535
	(-1.321410576)	(-7.284844579)
q	-0.1986817685	-0.2013744116
	(-0.8446889494)	(-6.827836255)
ncf2tang	4.6937788301E-02	8.3880364895E-02
	(0.1515531603)	(6.706821423)
opy2tang	-0.2808663391	-0.3125824928
	(-0.8870315753)	(-7.682586769)
b2tang	7.8990137188E-02	8.3837509155E-02
	(0.7246453387)	(6.836640395)
re2tang	-50.37717981	-52.62408447
	(-1.905747574)	(-3.680323175)
tbill	0.5325914488	0.5309872627
	(7.037755856)	(11.23959144)
dgnp	0.3121484202	0.3115646839
	(4.453734591)	(8.608255868)
$\log(\sigma_\eta)$	________	-164.6063232
	________	(-7.084836058)
L.L.F.	-2.9308254638D+02	-2.9317588488D+02

* Numbers in parentheses are t-statistics.

TABLE 4b
PROBIT ESTIMATION of
$\mathcal{Y}_t = \mathbf{1}$(Bankruptcy or Liquidation occurs at time t)
(full sample)

	no random effects		*random effects*	
Variable	Coefficient	T-Statistic	Coefficient	T-Statistic
constant	-69.30543112	(-5.768143224)	-69.22066615	(-6.250137889)
i2k	-391.2211913	(-4.188952829)	-390.7144646	(-3.526339180)
opy2k	5.377203159	(1.290280265)	5.346729165	(0.4825565157)
grate	0.3717615792	(4.005613489)	0.3724185172	(3.365356174)
ncf2k	-0.2163123950	(-2.299389665)	-0.2161910370	(-1.953845020)
sales2k	0.1074002928	(0.4086775823)	0.1084909982	(0.9791809220)
div2k	7.2522937974E-03	(0.3172037837)	7.2689304436E-03	(0.6568120083)
debt2k	-0.1936578288	(-1.843937913)	-0.1937238036	(-1.748882462)
q	-2.4279411537E-02	(-0.3474337364)	-2.4282405138E-02	(-0.2191828087)
ncf2tang	9.3491658194E-02	(1.189113153)	9.3291505692E-02	(0.8442334598)
opy2tang	-43.92026771	(-5.533839512)	-43.93918629	(-3.965625602)
b2tang	0.1464277235	(2.960818275)	0.1466180809	(1.324697344)
re2tang	-9.875326926	(-1.183019723)	-9.859158937	(-0.8898408384)
tbill	0.3246383345	(7.480014707)	0.3251944910	(2.937368159)
dgnp	0.1403485881	(3.671953234)	0.1405715666	(12.69369159)
food	7.1154828543E-02	(1.333739376)	7.1166431877E-02	(0.6425872404)
tobacco	3.9783347547E-02	(1.277997211)	3.9880104892E-02	(0.3601832743)
textile	8.9899611482E-02	(2.459084733)	9.0044030064E-02	(0.8133939023)
appareil	8.9119867949E-02	(2.521260805)	8.9361841440E-02	(0.8073827525)
lumber	8.5267365226E-02	(3.017309291)	8.5439885555E-02	(0.7722536354)
furnitur	5.3626472650E-02	(1.561849166)	5.3701691474E-02	(0.4850290308)
paper	3.9287429323E-02	(0.8485019457)	3.9265781546E-02	(0.3545285368)
printing	1.3820625036E-02	(0.2584235162)	1.3839430901E-02	(1.249404286)
chemical	-4.2003387341E-02	(-0.6120136932)	-4.2072373802E-02	(-0.3797939944)
petroleu	4.3912235553E-02	(0.8553123405)	4.3904258091E-02	(0.3963681008)
rubber	4.7425541729E-02	(1.026529957)	4.7432014883E-02	(0.4282657257)
leather	3.0876720597E-02	(0.9349935818)	3.0902340372E-02	(0.2790865266)
stonglas	-1.556284821	(-0.00220084799)	-1.529260529	(-1.380214401)
metal	7.7694845802E-02	(1.898849896)	7.7866933679E-02	(0.7033239942)
fabric	1.0954660551E-02	(0.2030200522)	1.0916552032E-02	(0.9855851793)
machiner	5.1801549093E-02	(0.9340841805)	5.1813338766E-02	(0.4678464415)
electric	2.5133278866E-02	(0.3826152643)	2.4983474409E-02	(0.2255679329)
transpeq	7.5849896304E-02	(1.585019030)	7.5930865076E-02	(0.6856945910)
mediopti	-0.1152200024	(-1.359204866)	-0.1152529472	(-1.040306812)
jewerly	7.9323439634E-03	(0.1801208330)	7.9002240386E-03	(0.7133099606)
sigetta			-2.916617858	(-0.2632322608)
L.L.F.	-5.7396549065D+02		-5.7399140571D+02	

TABLE 5a

Probit Results for Cross Sections of the Years 1978–1982

	1978	1979	1980	1981	1982
I2K1	-17.901 (-1.72)	-1.124 (-1.08)	-18.331 (-0.55)	-3.545 (-2.80)	-35.886 (-0.61)
I2K2	-4.496 (-2.33)	-1.181 (-1.42)	-2.006 (-0.57)	-3.494 (-2.76)	1.011 (0.51)
OPY2K1	-14.971 (-2.17)	0.073 (0.03)	-5.768 (-0.75)	-2.234 (-0.90)	-411.074 (-1.06)
OPY2K2	-5.744 (-2.11)	-3.720 (-2.13)	-6.567 (-1.78)	-2.319 (-0.93)	-5.449 (-1.05)
GRATE1	12.362 (1.07)	0.195 (0.05)	24.774 (1.61)	-1.085 (-0.20)	173.166 (1.23)
GRATE2	-3.093 (-0.47)	-1.735 (-0.37)	1.641 (0.17)	-1.000 (-0.18)	-7.425 (-1.02)
NCF2K1	25.980 (1.59)	-0.077 (-0.02)	-0.234 (-0.01)	4.585 (1.05)	343.229 (0.83)
NCF2K2	11.981 (1.37)	6.336 (1.36)	7.229 (0.59)	4.563 (1.03)	16.575 (1.68)
SALES2K1	-0.041 (-0.32)	-0.023 (-0.44)	0.518 (1.29)	0.150 (2.76)	13.225 (2.14)
SALES2K2	0.003 (0.06)	0.046 (3.81)	0.302 (3.25)	0.150 (2.75)	-0.213 (-1.33)
q1	0.002 (1.43)	-0.211 (-0.97)	-0.194 (-0.38)	-0.202 (-1.55)	-72.432 (-1.73)
q2	-0.009 (-2.21)	-0.038 (-0.25)	-0.000 (-0.38)	-0.200 (-1.52)	-0.910 (-3.98)
DIV2K1	14.045 (2.82)	-6.535 (-2.23)	-0.058 (-0.00)	-14.406 (-1.95)	139.242 (0.64)
DIV2K2	1.381 (0.62)	0.611 (4.32)	-2.124 (-0.54)	-14.241 (-1.94)	-15.531 (-1.52)
DIVR2K1	-14.023 (-2.82)	0.085 (0.07)	2.772 (0.27)	2.560 (1.68)	-98.474 (-0.56)
DIVR2K2	-1.357 (-0.61)	-0.283 (-0.22)	2.302 (0.59)	2.533 (1.66)	0.788 (0.41)
DEBT2K1	-6.862 (-2.73)	2.316 (2.07)	-4.305 (-0.77)	-0.226 (-0.18)	245.673 (2.28)
DEBT2K2	1.309 (2.20)	3.108 (3.83)	-0.789 (-0.40)	-0.189 (-0.15)	2.289 (1.61)
NCF2SAL1	0.606 (0.19)	-0.306 (-0.61)	0.124 (0.02)	1.269 (0.81)	-25.400 (-2.37)
NCF2SAL2	0.834 (0.38)	1.483 (1.20)	0.556 (0.44)	1.057 (0.67)	-2.262 (-1.17)
NCF2TAN1	-42.407 (-2.15)	-4.336 (-1.21)	-27.157 (-0.84)	-8.682 (-1.43)	300.202 (0.86)
NCF2TAN2	-14.773 (-1.52)	-10.106 (-2.08)	-20.862 (-1.24)	-8.670 (-1.42)	-12.680 (-1.51)
OPY2TAN1	10.793 (1.09)	-0.181 (-0.05)	2.690 (0.21)	4.446 (1.16)	-277.122 (-0.85)
OPY2TAN2	9.009 (2.38)	4.863 (1.48)	13.959 (1.73)	4.594 (1.19)	7.592 (1.38)
NCF2LIA1	1.195 (0.72)	0.539 (1.24)	1.709 (0.67)	0.140 (0.36)	-71.677 (-2.12)
NCF2LIA2	-0.321 (-0.38)	0.392 (2.21)	0.419 (0.39)	0.163 (0.43)	0.892 (2.87)
B2TANG1	9.387 (2.55)	-4.665 (-2.82)	8.181 (0.96)	-0.253 (-0.15)	-111.934 (-1.60)
B2TANG2	-2.913 (-2.23)	-5.413 (-4.40)	2.393 (0.95)	-0.323 (-0.19)	-1.680 (-0.88)
RE2TANG1	0.146 (0.75)	-0.028 (-0.08)	-0.170 (-0.27)	-0.524 (-2.82)	-6.404 (-0.48)
RE2TANG2	0.173 (0.56)	0.362 (0.98)	0.013 (0.02)	-0.525 (-2.83)	0.374 (0.66)
constant1	-2.357 (-2.61)	-1.971 (-6.30)	-5.203 (-2.58)	-1.725 (-8.80)	-135.987 (-2.26)
constant2	-2.278 (-7.85)	-2.354 (-10.64)	-4.377 (-6.59)	-1.725 (-8.77)	-2.133 (-3.98)
sd–nul	1.000 (0.00)	1.004 (0.90)	1.000 (0.00)	1.000 (0.05)	28.549 (6.41)
co–nul	0.000 (0.00)	0.999 (5.38)	0.000 (0.00)	0.999 77.26	0.478 (1.41)
L.L.F.	-179.0959	-239.8549	-318.6671	-334.0581	-176.6

TABLE 5b

Probit Results for Cross Sections of the Years 1983–1987

	1983	1984	1985	1986	1987
I2K1	-0.137 (-0.12)	-0.133 (-0.09)	-0.475 (-0.28)	-80.165 (-0.39)	-0.185 (-0.16)
I2K2	-0.152 (-0.12)	-0.156 (-0.10)	0.315 (0.32)	-1.116 (-1.00)	0.142 (0.08)
OPY2K1	-1.533 (-0.18)	-1.572 (-0.72)	5.186 (2.42)	4.013 (0.12)	-0.472 (-0.15)
OPY2K2	-1.297 (-0.16)	-1.258 (-0.61)	3.582 (1.26)	3.108 (1.36)	0.031 (0.01)
GRATE1	-2.372 (-0.52)	-2.385 (-0.74)	-6.492 (-1.69)	32.101 (0.27)	-0.248 (-0.03)
GRATE2	-4.544 (-1.01)	-4.531 (-1.40)	-7.392 (-1.38)	-6.215 (-1.59)	0.211 (0.03)
NCF2K1	4.445 (0.56)	4.428 (1.14)	2.901 (0.93)	-46.747 (-0.29)	-0.268 (-0.05)
NCF2K2	5.307 (0.74)	5.324 (1.41)	5.530 (0.90)	0.829 (0.21)	0.432 (0.07)
SALES2K1	0.225 (2.27)	0.234 (2.97)	0.002 (0.02)	2.005 (0.61)	0.341 (4.06)
SALES2K2	0.182 (1.82)	0.190 (2.39)	0.027 (0.36)	0.074 (0.85)	0.161 (2.12)
q1	-0.362 (-5.35)	-0.471 (-2.76)	-0.726 (-3.76)	-12.518 (-0.63)	-0.524 (-2.00)
q2	-0.337 (-10.12)	-0.319 (-1.71)	-0.671 (-4.20)	-0.011 (-0.73)	-0.377 (-1.44)
DIV2K1	15.628 (4.89)	15.627 (4.26)	-1.971 (-0.48)	-34.108 (-0.06)	-0.024 (-0.01)
DIV2K2	8.937 (3.09)	8.941 (3.15)	-5.118 (-1.17)	1.856 (1.06)	-0.100 (-0.06)
DIVR2K1	-6.048 (-1.59)	-6.049 (-1.87)	0.067 (0.04)	-210.833 (-0.25)	-0.072 (-0.03)
DIVR2K2	0.055 (0.01)	0.059 (0.06)	0.274 (0.19)	-1.139 (-0.74)	-0.267 (-0.33)
DEBT2K1	-0.843 (-0.65)	-0.811 (-1.05)	-0.799 (-0.79)	2.830 (0.26)	-0.655 (-0.76)
DEBT2K2	-0.703 (-0.57)	-0.732 (-0.94)	-1.002 (-1.01)	-0.564 (-0.91)	-0.188 (-0.24)
NCF2SAL1	1.846 (1.44)	1.859 (1.99)	-3.001 (-3.36)	-22.301 (-0.90)	-0.000 (-0.00)
NCF2SAL2	1.246 (0.83)	1.234 (1.15)	-2.126 (-1.57)	0.616 (1.01)	-0.193 (-0.21)
NCF2TAN1	-5.710 (-0.76)	-5.717 (-1.22)	4.018 (1.20)	-4.507 (-0.06)	-0.282 (-0.07)
NCF2TAN2	-5.301 (-0.75)	-5.293 (-1.13)	1.286 (0.27)	2.886 (0.53)	0.263 (0.04)
OPY2TAN1	0.864 (0.10)	0.845 (0.27)	-6.822 (-2.24)	-31.148 (-0.40)	-0.397 (-0.07)
OPY2TAN2	1.033 (0.12)	1.052 (0.37)	-4.118 (-1.05)	-4.820 (-1.26)	0.059 (0.01)
NCF2LIA1	0.207 (0.44)	0.179 (0.53)	0.172 (0.53)	10.297 (0.81)	-0.040 (-0.28)
NCF2LIA2	0.437 (0.89)	0.465 (1.44)	-0.007 (-0.02)	0.157 (0.44)	0.263 (0.54)
B2TANG1	1.935 (1.28)	1.984 (1.83)	2.241 (1.61)	18.670 (0.48)	-0.551 (-0.43)
B2TANG2	1.648 (1.12)	1.601 (1.51)	2.422 (1.78)	2.022 (2.05)	-0.298 (-0.22)
RE2TANG1	-0.327 (-2.45)	-0.332 (-1.98)	-0.062 (-0.28)	15.231 (0.72)	-0.544 (-3.68)
RE2TANG2	-0.293 (-2.18)	-0.295 (-1.75)	0.101 (0.42)	0.377 (1.22)	-0.489 (-1.61)
constant1	-2.469 (-8.60)	-2.397 (-7.78)	-1.409 (-3.66)	-7.070 (-1.20)	-3.350 (-8.63)
constant2	-2.311 (-8.33)	-2.385 (-8.10)	-1.534 (-5.34)	-2.844 (-9.82)	-2.677 (-8.84)
sd–nu1	1.058 (2.89)	1.000 (0.02)	0.914 (-0.49)	1.000 (0.00)	0.694 (-3.07)
co–nu1	0.998 (12.37)	0.998 (5.40)	0.997 (1.68)	0.000 (0.00)	0.021 (0.06)
L.L.F	-1261.6624	-334.8818	-361.9924	-179.0427	-112.4634

TABLE 6

Estimations with Duration Models on Exits (ML–Estimates)
(Logarithms of durations)

Model	Constant (T-Stat)	1st Year's GNP Growth (T-Stat)	Last Year's GNP Growth (T-Stat)	1st Year's t-bill rate (T-Stat)	Last Year's t-bill rate (T-Stat)	1st Year's Tobin's-q (T-Stat)	sigma (T-Stat)	lambda (T-Stat)	Log-Likel.
Weibull	3.7778	0.096096	-0.13365	0.0021761	-0.078110	-0.075716	0.28448	0.04997	-14.709
	(16.558)	(3.002)	(-4.240)	(0.117)	(-4.704)	(-3.998)	(8.527)	(20.64)	
Normal	3.2266	0.10206	-0.13226	0.020936	-0.043871	-0.12898	0.34888	0.05877	-17.199
	(11.465)	(2.878)	(-3.301)	(0.721)	(-2.257)	(-4.657)	(8.778)	(16.46)	
Logistic	3.3864	0.11038	-0.12618	0.009116	-0.059287	-0.11396)	0.18312	0.05759	-15.345
	(15.856)	(4.131)	(-4.481)	(0.457)	(-3.674)	(-4.725)	(8.463)	(19.92)	
Weibull	3.1300	0.080591	-0.024703	0.0041859	-0.038930		0.30158	0.04947	-47.370
	(18.037)	(4.062)	(-1.947)	(0.417)	(-3.015)		(14.041)	(32.76)	
Normal	3.1486	0.082113	-0.058198	-0.010769	-0.040350		0.38431	0.05868	-59.679
	(29.148)	(2.995)	(-3.730)	(-0.760)	(-4.829)		(21.747)	(22.65)	
Logistic	3.2121	0.078541	-0.045683	-0.021385	-0.041587		0.19039	0.05724	-47.360
	(22.240)	(4.288)	(-3.311)	(-2.005)	(-4.014)		(15.987)	(31.62)	
Weibull	2.9941	0.088914			-0.033778		0.30667	0.04910	-49.480
	(21.134)	(7.542)			(-3.126)		(14.782)	(30.88)	
Normal	2.7306	0.081177			-0.021281		0.40147	0.05868	-65.402
	(30.251)	(5.122)			(-3.441)		(25.414)	(23.37)	
Logistic	2.7533	0.073719			-0.017541		0.20092	0.05724	-52.850
	(24.095)	(5.575)			(-1.835)		(15.935	(31.45)	

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APPENDIX

A Definitions of variables

We describe here the variables used from the COMPUSTAT data, from the R&D Master File and the new variables we created.

A.1 Net Investment

We measure investment by using the variable INVEST, which accounts for capital expenditures (gross investment). GRATE is the gross rate of return to capital defined as the ratio of gross cash flows to gross capital stock adjusted for inflation (GROCAP). The market value of the firm (VAL) is defined as the sum of common and preferred stock (VCOMS, PREFST), the long term debt adjusted for its age structure (LTDEBT), and the short term debt (STDEBT), less the net short term assets (ADJ). We use this definition of the value of the firm to calculate Tobin's q, which is defined as the ratio of the value of the firm divided by the replacement value of capital. For the replacement value of capital we use the inflation adjusted net capital stock (NETCAP).

To examine the discrete event of investing or not we need to model net (new) investment. In the literature there is a distinction between replacement investment[21] and net investment, defined as the difference between gross investment and replacement investment. There are no data about the two separately. We construct net investment implicitly from other information of the data and by making some additional assumptions.

The data provide information on the gross capital stock, K^G, and the net capital stock, K^N, which is similar but depreciated, assuming straight line depreciation. So, it must be the case:

$$K_t^N = K_t^G - \sum_{i=0}^{t} DE_{t-i},$$

where DE_t is the total depreciation at time t. We also have that gross investment at time t, I_t, is

$$I_t = I_t^N + I_t^R,$$

where I_t^N is net investment and I_t^R replacement investment. It is pretty obvious that replacement investment is at most equal to depreciation, but here we assume that equality holds, that is replacement investment is always equal to depreciated capital. This assump-

[21]For an interesting review see Feldstein and Rothschild (1974)

tion allows net investment to become negative which is an implication of disinvesting by the firm. Substituting for $DE_t = I_t^R = I_t - I_t^N$ in the first equation and taking differences with its lagged we get an explicit form for net investment at t:

$$I_t^N = I_t - K_t^N + K_{t-1}^N + K_t^G - K_{t-1}^G$$

A.2 New Debt – New Shares

The data distinguish between long term debt (due after one year), BKDEBT, and debt due in one year from now, DEBT1YR. We derive a NEWDEBT variable with a simple transformation of the two above variables as follows:

$$\text{NEWDEBT}_t = \text{BKDEBT}_t - \text{BKDEBT}_{t-1} + \text{DEBT1YR}_t$$

Similar is the case for new shares. We define the issue of new shares as:

$$\text{NEWSHARES}_t = \text{NOSHARES}_t - \text{NOSHARES}_{t-1}$$

where NOSHARES_t is the number of common shares outstanding at time t. We have corrected this variable on account of common stock splits etc.

A.3 Dividends

We consider the variable DIV, dividends per share, which we multiplied by the number of shares outstanding in order to find the amount of dividends the firm paid out at a specific year.

A.4 Other Variables

To account for the industry structure we considered the Compustat 4-digit Industry Code (SIC). This variable takes values between 2000 and 3999 for the manufacturing industries.

We define 20 broad industry categories falling in this range as follows: 2000: Food and Kindred Products, 2100: Tobacco Products, 2200: Textile Mill Products, 2300: Apparel and other finished products, 2400: Lumber and wood products, 2500: Furniture and fixtures, 2600: Paper and allied products, 2700: Printing and publishing, 2800: Chemicals, 2900: Petroleum refining and related, 3000: Rubber and miscellaneous plastic products, 3100: Leather products, 3200: Stone, clay, glass, concrete products, 3300: Primary metal industries, 3400: Fabricated metals, 3500: Engines, Computers etc., 3600: Electronic equipment, 3700: Transportation Equipment, 3800: Measuring Instruments, photographic equipment, watches, 3900: Jewelry, sports, art equipment. All values outside this range were considered as OTHER.

All macroeconomic variables, including deflators for nonresidential investment and the consumer price index, as well as the growth rate of GNP and the Treasury Bill rates are taken from the 1992 *Economic Report of the President.*

A.5 Sources of the List of Exited Firms

The sources of the reasons for exits of the firms which disappeared from the sample are the *Directory of Obsolete Securities* (1983, 1987, 1989), the *Capital Changes Reporter* (through 1989) and the *Directory of Corporate* Affiliations.

B The U.S. Bankruptcy Law: Economic Aspects.

The Bankruptcy Reform Act of 1978, as amended by the Bankruptcy Amendments and Federal Judgeships Act of 1984 contains eight odd-numbered chapters. Chapters 1, 3, 5, 9, 13 and 15 include general provisions about creditors and debtors for different kinds of bankruptcy. Chapters 7 and 11 consider the cases of liquidation and reorganizations which are more interesting from an economic point of view. Chapter 7 does not cover railroads, insurance companies, banks, savings and loans associations and credit unions.[22]

B.1 Liquidations: CHAPTER 7

A bankruptcy liquidation begins by filing a voluntary or involuntary petition. The debtor who files for bankruptcy voluntarily states the following 'schedules' to the petition: (i) All secured and unsecured creditors and the amount of debt owed to each; (ii) a statement of financial affairs; (iii) a list of all his property, including the property to be exempt; and, (iv) a list of current income and expenses. On the other side, an involuntary bankruptcy occurs when a debtor's creditors force (in 'good faith') the debtor into bankruptcy.

After the firm - debtor - files for liquidation under Chapter 7, the bankruptcy court

[22]This appendix follows a Law Vocabulary, the term debtors stands for the equity holders or shareholders, and the term creditors for the bondholders.

appoints a trustee who shuts the firm down and sell its assets. A trustee's duty is to collect and reduce to money the "property of the estate" for which he serves. Within a reasonable time (10–30 days) a meeting of all creditors is called, where the debtor submits examination under oath by the creditor and the trustee. Then the trustee turns the proceeds for payment to the creditors.

Creditors can be either secured or unsecured. A secured creditor has a security interest in collateral that ensures the debt. According to the Code the secured party has priority over unsecured parties to the proceeds from the disposition of the secured collateral. Any excess over this amount is used to pay unsecured creditors in the order of their priority. Each class of creditors must be paid in full before the next class is entitled to any of the proceeds. If there are not sufficient funds to pay the entire class, the proceeds are distributed proportionately to each creditor in a class, and the lower priority classes receive nothing. The Code provides the following order of priority, which is called the "absolute priority rule:" 1. Administrative expenses including items like court costs and trustee and attorney fees and costs incurred by the trustee, as rental and appraisal fees. 2. Unsecured claims arising in the ordinary cost of the debtor's business occurred after the Chapter 7 filing but before the appointment of the trustee. 3. Claims for wages, salaries, and commissions up to $ 2,000 per claimant. Higher amount claims are treated as the "claims of general creditors." 4. Unsecured claims for contributions to employee benefit plans. 5. Farm producers and fishermen, up to $ 2,000 against debtors who own or operate storage or processing facilities. 6. Unsecured claims for money, up to $ 900, deposited with the debtor just before the petition for services that were not delivered or provided. 7. Taxes and penalties legally due to various governmental units. 8. Unsecured creditors claims, such as trade creditors, utilities, long term bondholders, and claims exceeding the amounts specified in earlier classes. These debts are paid on a pro rata basis, unless there are subordination agreements between particular creditors and the firm specifying priority orderings within a class. 9. Any remaining balance is returned to the equity holders (debtor), but usually this amount is zero. The law on bankruptcies has other provisions as well, like pertaining to claims that can or cannot be discharged, revocations of discharges and reaffirmation of the debt, the case where a debtor may voluntarily wish to pay off a discharged debt.

B.2 Reorganizations: CHAPTER 11

A Chapter 11 reorganization is the most commonly used type of bankruptcy proceeding by firms (corporate debtors). In a reorganization the creditors and the debtor formulate a plan under which the debtor pays a portion of his debts and is discharged of the remainder. The debtor is allowed to continue in business. All principles that govern the filing and the entry of the order of a Chapter 7 petition apply to Chapter 11 proceedings. Note that in some circumstances, creditors may prefer private negotiated adjustments of credit company relations, known as "workouts." Such out-of-court workouts are more flexible and conducive to a speedy settlement which is very important because delay is a very costly element in a bankruptcy proceeding. Another advantage is that they avoid various administrative costs of the bankruptcy proceeding.

Upon entry to the reorganization proceedings the debtor generally continues to operate the business as a debtor-in-possession. However the court may appoint a trustee to operate the business if mismanagement of the business is shown. Then a creditors' committee of unsecured creditors is appointed. This committee may consult with the trustee or the debtor-in-possession concerning the administration of the case or the formulation of the plan. Only the debtor may file a plan within the first 120 days after the date of the filing. After that day any party may propose a plan. In corporations with large number of shareholders only the manager can propose a plan. From an economic point of view the strong position of the management is very interesting because of its ability to impose a credible threat to transfer bankruptcy from Chapter 11 to Chapter 7.

According to the Code the plan must be "fair and equitable", designate classes of claims and interests, specify the treatment for each class and provide an adequate means for the plan's execution. Acceptance of the plan is required by each class by a majority vote of the number of creditors, representing two thirds of the amount of the total claim. Then the plan must be confirmed by a court to be "in the best interests of the creditors." This procedure is called "unanimous consent procedure." However, even if only one class of claimants has accepted the plan, the court may still confirm it or a modified version of it under the Code's "cramdown" provision. Cramdown plans involve higher transaction costs, since the court may require appraisals by outside experts and more court hearings before approving the plan. If no reorganization plan is adopted then the court may shift the bankruptcy filing to Chapter 7 liquidation.

Chapter 2

AN EMPIRICAL INVESTIGATION ON THE DYNAMICS OF QUALITATIVE DECISIONS OF FIRMS[1]

[1]This chapter is coauthored with Yannis M. Ioannides. This research has been supported by grants SES9000-200 and SES9211-913 from the National Science Foundation. We are grateful for this assistance. We are also grateful to Bronwyn Hall for giving us access to the Manufacturing Sector Master File. All data used in this paper have been archived at the Survey Research Center, University of Michigan.

1 Introduction

The present chapter explores dynamic aspects of qualitative decisions of firms by means of econometric techniques which utilize dynamic limited dependent variable models. One principal aspect of firms' behavior for which limited dependent variable models are indispensable modelling devices is that firms typically make qualitative decisions, such as whether or not to pay dividends and whether to finance investment by borrowing (i.e., by means of issuing debt), or by issuing new shares, or such as whether to repurchase outstanding shares or not.

The prototype model that we present below integrates the several pertinent strands in the literature. Noteworthy contributions in modes of finance and investment behavior are papers by Blundell *et al.* (1989), Bond and Meghir (1989), Carpenter (1991), Devereux and Sciantarelli (1989), Fazzari *et al.* (1988), Gertler *et al.* (1990), Gilchrist (1990), Hayashi and Inoue (1991), Himmelberg(1990), Sakellaris (1990), Hubbard and Kashyap (1990), Morck *et al.* (1990), and Whited (1988). This literature has relied upon estimating Euler-type equations by identifying different subsamples describing investment behavior that may be qualitatively different. Many of these papers have employed careful comparisons of estimates derived from these subsamples and have drawn interesting conclusions about the investment behavior of firms. Nonetheless, many of these approaches have fallen short of delivering models of quantitative and qualitative decisions, such as investment behavior and choice of mode of finance, as *joint* decisions.

The present chapter begins in Section 2 with a partial equilibrium stochastic dynamic programming problem for a firm's financing and investment decisions. The necessary optimization conditions under financing constraints (binding or not) are analyzed next. Section 3 discusses the econometric aspects of the problem and models the qualitative decisions to be estimated. A discussion and preliminary observations on the COMPUSTAT data are presented in Section 4, while the empirical results appear in Section 5. Main conclusions and extensions can be found in Section 6. Descriptions of data construction, descriptive statistics and an extension on the model using taxes are given in the Appendix.

We find that firm heterogeneity is always very significant when modeling discrete decisions of firms. Modeling the dynamic pattern of discrete decisions shows that there is always significant persistence in the propensity in all of them. A large part of the variation of such decisions can be explained by individual firm characteristics.

We feel that the present study of of qualitative decisions of firms in dynamic settings is the first step towards a more general theory which would combine quantitative and qualitative aspects of firms' investment and financing decisions.

2 A Prototype Model of Investment, Output and Financing Decisions of Firms

The analytical core of the modern literature on investment behavior may be traced back to models of firms' behavior introduced by Abel (1979; 1980) and Hayashi (1982). Those models assume that firms maximize the expected value to its shareholders, that is the present value of dividend payments after tax, subject to a cash flow constraint and to stock accumulation constraints. These authors have provided a useful link with the earlier literature on Tobin's q. [Tobin(1969)]

2.1 The Standard Model

We follow a standard formulation of a firm's decision problem, such as Abel and Blanchard (1986), and adapt it to the case of uncertainty. First, we introduce notation to describe the model of firms' behavior. Let V_t be a firm's value, as of the beginning of time period

t, defined in the standard fashion as the expected value of a firm's stream of cash flows. Let K_t be its stock of the single capital good used in production in period t; I_t, its corresponding period t investment which augments capital in the following period. Let a_t be the firm's age, and let w_t be a vector of parameters some of which may be deterministic or stochastic, whose evolution over time is determined exogenously, for simplicity, by a family of distribution functions $P_w = \{P(\cdot \mid \mathbf{w}), \mathbf{w} \in \mathbf{W}\}$. Let ω_t be the vector of prices, with the price of the investment good being the numeraire; $\pi_t(K_t, a_t; \omega_t; w_t)$, the restricted profit function, which gives current period profits as a function of the vector of state variables and satisfies the usual properties [McFadden (1978)]; $c_t(I_t, K_t; w_t)$, the cost of current investment, a convex increasing function of I_t and K_t. Finally, let β be the firm's discount factor.

This problem may be treated analytically by means of the theory of dynamic programming. We can define the Bellman equation in terms of the value function, which in this case coincides with the value function for an incumbent firm, formally defined as $V_t \equiv V_t(K_t, a_t; \omega_t; w_t, r_t \mid \mathcal{N}_t)$, where $\mathcal{N}_t$ is the information state at time t. The Bellman equation is:

$$V_t(K_t, a_t; \omega_t; w_t, r_t \mid \cdot) =$$

$$\max_{\{I_t, K_{t+1}\}} : \pi_t(K_t, a_t; \omega_t; w_t) - c_t(I_t, K_t; w_t) - I_t + \beta E_t \{V_{t+1}(K_{t+1}, a_{t+1}; \omega_{t+1}; w_{t+1}, r_{t+1} \mid \cdot)\}, \tag{1}$$

subject to the equations of motion for aging

$$a_{t+1} = a_t + 1, \tag{2}$$

and for capital accumulation

$$K_{t+1} = (1 - \delta)K_t + I_t, \tag{3}$$

Existence and uniqueness of the optimal solution and thus the value function may be established by means of standard conditions. [2]

A key element of this theory is the assumed quasi-fixed nature of capital, with adjustment costs being a function of investment undertaken. In fact, this is the only way in which this model differs from the textbook case, where capital may be adjusted costlessly.

It is straightforward to show in this model that if the underlying production function is linear in K_t and all other variable inputs and the adjustment cost function for investment is linearly homogeneous in K_t and I_t, then the value of the firm, which is equal to the value function of problem (1), is proportional to K_t. [3] The factor of proportionality, which is equal to $(V_t(K_t, \cdot)/K_t)$, is known as the average q. Furthermore, this theory becomes operational under some additional assumptions which ensure that average q becomes equal to Tobin's q, defined as the market value of the firm over the replacement cost of its capital. These assumptions are that stock markets are efficient and managers rely upon the stock market to make investment decisions.

In a formal treatment of this problem, we would be adjoining the sequence of capital accumulation constraints (3) by means of Lagrange multipliers q_t, $t = 0, 1, \ldots$. According to the marginal interpretation of Lagrange multipliers, we have that q_t, known as the marginal q, can be described by the following necessary condition:

$$\frac{\partial V_t}{\partial K_t} = \frac{\partial \pi_t}{\partial K_t} - \frac{\partial c_t}{\partial K_t} + q_t(1 - \delta) - \beta q_{t+1}$$

[2] See Bertsekas (1987) or Stokey, Lucas, and Prescott (1989), 112-114.

[3] See Hayashi (1982) for a proof of this important proposition under certainty and Hayashi and Inoue (1991) for its latest statement under uncertainty. The earliest statement of this proposition, though without proof, is attributed by them to Lucas and Prescott (1971).

which has a solution of the form:

$$q_t = \frac{\partial V_t}{\partial K_t} = E_t \left\{ \sum_{\tau=1}^{\infty} (\beta(1-\delta))^{\tau} \left[\frac{\partial \pi_t}{\partial K_{t+\tau}} - \frac{\partial c_t}{\partial K_{t+\tau}} \right] \right\}. \tag{4}$$

Equation (4) implies that the marginal value of capital equals the sum of expected discounted present value of future net cash flows of the firm.

The attractiveness of this simple theory lies in its ability to explain investment. To see this, note that the first order conditions for the firm's optimization problem imply:

$$\tilde{C}_t(\frac{I_t}{K_t}) = q_t, \tag{5}$$

where $\tilde{C}_t(\cdot)$ is defined in terms of the adjustment costs for investment as follows:

$$c_t(I, K; W) \equiv I\bar{C}_t(\frac{I}{K})$$

and

$$\tilde{C}_t(x) \equiv 1 + \bar{C}_t(x) + x\bar{C}_t'(x).$$

The economic interpretation of this condition is straightforward. The firm computes the marginal value of an additional unit of capital and sets investment so as to equate the marginal cost of investment to it. If the adjustment costs for investment are assumed to be quadratic, then (5) implies that (I_t/K_t) is a linear function of q_t. It is for this reason that the assumption of quadratic adjustment costs is so popular in the literature [Bond and Meghir(1989), Carpenter (1991), Devereux and Sciantarelli (1989), Gertler *et al.* (1990), Gilchrist (1990), Himmelberg(1990), Hubbard and Kashyap (1990), and Whited (1988).]

Under the above assumptions about production and cost conditions, average Tobin's q, which may be computed as the ratio of a firm's value over the value of its capital, is equal to marginal q, which appears in the RHS of (4).

The theory may be tested by means of equation (5). This implies that investment is determined only by a firm's costs for adjusting investment and a firm's market value. By suitably parameterizing $\tilde{C}_t(.)$, the adjustment cost function in (5), researchers have used it with both aggregate as well as micro (panel) data, [Bond and Meghir(1989), Carpenter (1991), Devereux and Sciantarelli (1989), Gertler *et al.* (1990), Gilchrist (1990), Himmelberg(1990), and Whited (1988).] Of course, a number of underlying assumptions are crucial for the validity of such a test.

A key weakness of this theory, at this level of generality, is is that it says nothing specific about how a particular investment plan may be financed. Investment is determined so as to maximize the expected present value of a firm's cash flow over its lifetime. In general, when a firm's borrowing is unconstrained, we can demonstrate that the value of the firm at any point in time is equal to the value of its debt plus the expectation of the present value of its stream of dividend payments to its owners. This is a statement of the Modigliani-Miller(1959) theorem.[4]

2.2 Borrowing and Equity Issue Constraints

We have so far assumed that firms are not concerned with how they may finance their investments. Matters are less straightforward, however, if a firm may be constrained in its borrowing behavior. Constraints on borrowing by a firm affect investment and cash flows. A firm's value may still be defined as above, by introducing borrowing constraints explicitly. It should still be possible to show that the Modigliani-Miller theorem applies to the case when the firm is subject to constraints.

We proceed further by following Himmelberg, *op. cit.*, to describe a model of a firm's investment and dividend behavior under the assumption that internally generated funds

[4] One may easily demonstrate this by assuming an arbitrary financial plan, such as that adopted by Abel and Blanchard (1986).

enjoy a cost advantage over external sources of finance. Thus external finance is ignored and an external quantity constraint is imposed on the level of debt. This is done for two reasons. One is in order to express the existence of credit rationing. The second is as a device to disentangle the role of cash as liquidity from that of an input to the formation of expectations by the firm about its future profitability. We follow Himmelberg and impose two important restrictions on the firm's optimization problem. One is that dividends must be nonnegative, and the second is that debt may not exceed an exogenously given amount. Clearly, borrowing constraints would be irrelevant if firms could pay negative dividends, in effect borrowing from stockholders.

In addition, following Fazzari *et al.* (1988), Gilchrist (1990) and Gilchrist and Himmelberg (1991) we introduce equity financing, and constraints on it. The value of the new shares should be deducted from the dividend payments assuming that current shareholders would have to buy additional shares proportionally in order to maintain their current claim on the firm's equity. By doing so we also account for the asymmetric information problem generated by the fact that new shareholders demand some risk premium payment when purchasing new shares in order to offset possible losses from funding lemons. The motivation of this additional cost is primarily due to the famous "lemons" problem first considered by Akerlof (1970).

We now introduce additional notation to describe the model of firms' behavior. Let V_t be the expected present value, as of the beginning of time period t, of the stream of dividend payments to the firm's owners. We explicitly introduce the constraints that bind the firm's behavior. We introduce additional notation as follows. Let: D_t be the period t net dividend payment to the firm's shareholders; S_t the amount of new shares the firm issues at time t; $\bar{S}_t$ the minimum amount of (negative) new stock the firm can issue at time t; Ψ_t a measure of the asymmetry of information, accounting for the risk premium or overvaluation of the new stock; X_t, net borrowing by the firm during t; B_t, the principal of the outstanding stock of debt as of the beginning of period t; $(1+r_{t-1})B_t$, the principal plus interest due in the beginning of period t, assuming r_t to be fixed and independent of B_t; $\bar{B}_t$, the maximum stock of debt the firm may hold as of the end of period t; [5] a_t, the firm's age; ω_t, a vector of prices, whose evolution over time is determined exogenously, for simplicity, by a family of distribution functions $P_\omega = \{P(\cdot \mid \omega), \omega \in \mathbf{\Omega}\}$; $\pi_t(K_t, a_t; \omega_t; w_t)$, the restricted profit function, giving current period profits as a function of the vector of state variables; $c_t(I_t, K_t; w_t)$, the cost of current investment; β, $0 \leq \beta < 1$, the firm's discount factor.

Analytically now, the Bellman equation for an incumbent firm can be written in terms of the firm's value function, $V_t \equiv V_t(K_t, B_t, a_t; \omega_t; w_t, r_t \mid \mathcal{N}_t)$, $\mathcal{N}_t$ being the information state at time t, as follows:

$$V_t(K_t, B_t, a_t; \omega_t; w_t, r_t \mid \cdot) =$$

$$\sup_{\{I_t, X_t, K_{t+1}, B_{t+1}, S_t, D_t\}} : [D_t - (1+\Psi_t)S_t] + \beta E_t \{V_{t+1}(K_{t+1}, B_{t+1}, a_{t+1}; \omega_{t+1}, w_{t+1}; r_{t+1} \mid \cdot)\}, \tag{6}$$

subject to the following constraints. First, dividends, investment and borrowing in each period are related through the cash flow constraint:

$$D_t = \pi_t(K_t, a_t; \omega_t; w_t) - c_t(I_t, K_t; w_t) - I_t + X_t + S_t. \tag{7}$$

Second, dividends [6] are constrained to be nonnegative:

[5] There exist several alternative specifications of a firm's borrowing constraints. It would be interesting to consider the case where the firm may borrow unlimited amounts at a borrowing rate that increases with the stock of debt outstanding.

[6] Tax considerations are in practice extremely important and should be reflected in the definition of the dividend payments and of the various entries in the cash flow constraint. We derive the Bellman equation with tax considerations in Appendix B.

$$D_t \geq 0. \tag{8}$$

Third, borrowing in period t is constrained by:

$$X_t \leq \bar{B}_t - (1 + r_{t-1})B_t. \tag{9}$$

Fourth, the accumulation equation for debt, [7]

$$B_{t+1} = (1 + r_{t-1})B_t + X_t. \tag{10}$$

Finally, the new equity issue is exogenously restricted as follows:

$$S_t \geq \bar{S}_t. \tag{11}$$

that is, new shares issues are bounded below by some minimum (negative) level.

The accumulation equations for age and capital (2)-(3) above still hold. Some remarks are in order. The sup operator inside the large brackets in the RHS of (6) defines the investment dividend and financing decisions.

The following transversality condition ensures that the problem is well defined:

$$\Pr\left\{\lim_{t\to\infty} \beta^t B_t \leq 0\right\} = 1$$

This requires that the firm should pay all its debts as time goes to infinity, or, in other words, that the accumulation of debt cannot increase *too* fast.

Existence and uniqueness of an optimal solution in the presence of constraints is more complicated than the unconstrained case. However, we may extend the methods developed by Hajivassiliou and Ioannides (1992) in order to demonstrate existence and uniqueness.

[7]Note that in effect the debt accumulation equation may also stand for accumulation of liquid assets which may earn the same rate of return as that paid on debt.

2.3 The Algebra of the Extended Problem and Implications of the Necessary Conditions.

Let q_t, λ_t, d_t, b_t, μ_t and ς_t be the Lagrange multipliers corresponding to equations (3), (7), (8), (9), (10) and (11), respectively. The first order (necessary) conditions for the maximization of the firm's problem are the following:

For optimal investment, I_t, the firm equates the marginal value of investment, the marginal q, to the corresponding marginal cost, which is equal to the marginal resource cost, the shadow price of the net cash flow, plus the marginal adjustment cost;

$$q_t = \lambda_t \left(1 + \frac{\partial c_t(I_t, K_t)}{\partial I_t}\right) \tag{12}$$

This condition relates marginal q as the marginal cost of investment in terms of the shadow price of the net cash flow, λ_t. The first order condition for optimal capital, K_{t+1}, requires that:

$$q_t = E_t \left[\beta(1-\delta)q_{t+1} + \beta\lambda_{t+1}\left(\frac{\partial \pi_{t+1}(K_{t+1}, \omega_{t+1})}{\partial K_{t+1}} - \frac{\partial c_{t+1}(K_{t+1}, I_{t+1})}{\partial K_{t+1}}\right)\right] \tag{13}$$

This may be interpreted as follows: The firm should be indifferent, on the margin, between investing today and tomorrow; the marginal value of an additional unit of capital today should equal to the expected discounted marginal value of an additional unit of capital tomorrow accounting for depreciation plus the expected discounted foregone increase in the firm's value due to investment costs.

The first order condition for the dividend payments, D_t, gives:

$$\lambda_t = 1 + d_t, \quad d_t \geq 0. \tag{14}$$

It implies that when the firm pays positive dividends ($d_t = 0$) then the shadow value of an additional dollar of net cash flow equals to 1, $\lambda_t = 1$. That is, every additional dollar in the cash flow can become dividend payment. If the firm is constrained it has to pay zero dividends, the shadow value of the net cash flow exceeds one by the marginal value of an additional dollar of dividends.

The necessary condition for new debt, X_t, is:

$$\lambda_t = \mu_t + b_t, \;\; b_t \geq 0. \tag{15}$$

It requires that the value of an additional unit of net cash flow equals the shadow value of the new debt, $\lambda_t = \mu_t$, when the firm is unconstrained with respect to debt, $b_t = 0$. If the firm is constrained, it is the case that $\lambda_t > \mu_t$, that is the firm would be better off by borrowing more, since the value of an additional dollar in net cash flow exceeds the value of an additional dollar of debt. Concerning the optimal stock of debt, we have:

$$\mu_t = \beta E_t \left\{ (1 + r_t)(\mu_{t+1} + b_{t+1}) \right\}. \tag{16}$$

Note that for a firm which does not expect to be debt-constrained at time t+1, that is $b_{t+1} = 0$, the condition implies that the shadow value of the debt today should equal to the expected discounted value tomorrow including the interest payment. In other words, borrowing an additional dollar today is equivalent to borrowing $\beta(1 + r_t)$ dollars tomorrow. For a debt-constrained firm, condition (16) implies that the firm must be indifferent between transferring funds from tomorrow to today, but it cannot, due to the constraint. It is interesting to observe that a debt-constrained firm for which the value of the debt is smaller than the value of the net cash flow, debt does not contribute much to the net cash flow. In such an increase a firm will never use debt to finance dividend payments. Given, however, that marginal q is always greater than λ_t (since $q_t = \lambda_t(1 + \partial c_t(.)/\partial I_t)$), the firm will demand as much debt as possible to finance investment.

An interesting result implied by the above necessary conditions and obtained by Himmelberg, *op. cit.*, is that a constrained firm pays zero dividends until the probability of being debt-constrained in the future becomes zero. Once it starts paying positive dividends, it expects to continue doing so in all subsequent periods. For a constrained firm the shadow price of investment is higher than the shadow value of the net cash flow, which is higher than the shadow value of debt. This implies that a constrained firm will use any funds from borrowing to finance investment projects rather than dividend payments.

It is also evident that the firm may not want to borrow up to its limit even though the shadow value of internally generated funds is positive. That is because the firm by keeping unused borrowing capacity, in effect liquidity, may be able to better handle future contingencies. In terms of the necessary conditions this can be explained as follows: The firm is assumed to be constrained in both periods t and $t+1$, that is $b_t \neq 0$ and $b_{t+1} \neq 0$. However it may be the case that each additional dollar of debt today is worth less than $\beta(1+r_{t-1})$ tomorrow, due to expected investment opportunities at these periods. In this case the firm will not exhaust its debt limit at the current period, transferring credit funds to the next period.

Finally, the first order condition for the new stock issue should satisfy:

$$\lambda_t = (1+\Omega_t) - \varsigma_t \tag{17}$$

This condition implies that the benefit of issuing new stock to raise more net cash flows, should equal to the its cost, as appears from the risk premium payment.

Interdependence between the two different nodes of external financing (borrowing – new equity issue) are also interesting. Depending on the size of the risk premium, the interest rate and the constraints on debt and equity, combinations between using one of the two types of financing, or a mixing of the two are possible.

3 Empirical Applications

In principle both qualitative and quantitative aspects of the above theory for the behavior of firms may be tested econometrically. The literature, to date, has emphasized quantitative aspects pertaining to investment decisions. Below we review first the work on quantitative aspects of investment decisions in greater detail than earlier in this paper. We then turn to qualitative aspects, and to our own work.

3.1 Empirical Studies of Investment

Theoretical predictions about the behavior of investment have been tested econometrically in the literature by means of Euler-type dynamic optimization conditions as in (12) and (13) of the above model. The estimated parameters obtained by Himmelberg, *op. cit.*, are plausible but Hansen's test of the overidentifying restrictions barely fails to reject the perfect capital market model at the one percent significance level. Himmelberg provides additional evidence in favor of borrowing constraints by assuming that an auxiliary function of the Lagrange multiplier corresponding to borrowing constraints is related to observables in some arbitrary fashion, such as being a function of lags of cash flow and sales to capital ratio.[8] The theory predicts that the cash flow coefficients of the reduced form equation are economically large and statistically significant. This implies that an increase in cash flow relaxes the borrowing constraint and an increase in sales tightens it by causing an increase in investment demand.

Whited (1988) [9] and Gilchrist (1990), [10] who use COMPUSTAT data, and Bond

[8]This is similar to a procedure proposed first by Altonji *et al.*(1986).

[9]Whited also provides an interesting defense of the use of the GMM method with panel data. She notes that the Garber-King criticism of the GMM method with aggregate data is mitigated when panel data are used. Using error components that account for individual effects as well as for time-effects removes possible sources of dependence between unobservable shocks and available instruments.

[10]Several authors emphasize that observing a strong correlation between cash flow and investment, both of which are endogenous variables, may simply capture the fact that firms with good investment

and Meghir (1989), who use a company panel from the U.K., all employ models which are generally quite similar to Himmelberg's and obtain results clearly supporting the conclusion that borrowing constraints have an impact on investment. When these authors split their samples, by means of a variety of very different variables, [11] they find the unconstrained Euler equation being violated for the sample of firms that are likely to be constrained. For constrained firms, cash flow does affect investment. Such sample splits are reminiscent of what Zeldes (1989) and Runkle (1991) have done with data from the Panel Study of Income Dynamics. As Hajivassiliou and Ioannides (1991b) have argued, the endogeneity of the variables used to split the sample should be accounted for.

Overall the models employed by Gilchrist, by Himmelberg and by Whited are quite similar. Whited puts greater emphasis in her empirical work on the impact of a firm's access to the corporate debt market, rather than on implications of not paying dividends, which Himmelberg emphasizes.

An obvious extension of Himmelberg's framework is to estimate Euler equations while correcting for sample selection bias associated with restricting oneself to observations for firms which do or do not pay dividends. This estimation problem may be handled by a switching regression model with endogenous switching. [Hajivassiliou and Ioannides (1992)].

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opportunities tend to have high cash flows. Reduced-form investment equations (such as q-type models) are likely to be mispecified so that q is no longer a sufficient statistic for investment. This point is made particularly clearly by Blundell *et al.* (1989).

[11] Noteworthy are the variables Whited uses to split the sample. One is the ratio of a firm's debt to the market value of its total assets. A second is the ratio of a firm's interest expenses to the sum of interest expense and cash flow. The former may be considered as a measure of a firm's effective discount rate. The latter may be considered as a measure of a firm's need to borrow. A third variable involves the availability of a rating for a firm's bond in the beginning of the sample. She argues that if firm has undergone the extensive investigation that precedes the rating of its bonds, it would be less likely to suffer from the informational asymetries that may restrict its access to borrowing.

3.2 Empirical Approaches to Qualitative Decisions of Firms

Equally important from the point of view of empirical applications is using qualitative aspects of firms' behavior to test the basic theory of firms' decisions presented in Section 2. In general, we would expect that as market conditions vary over time a firm may switch from being constrained in its borrowing to be unconstrained, or it may decide to start paying positive dividends. Switching from one to another regime may depend on individual characteristics. Gilchrist (1990), Himmelberg (1990) and Whited (1988) are noteworthy in that they have emphasized such qualitative aspects. Yet Himmelberg (1990) is the only one that tests, though rather informally, his qualitative predictions about the dynamics of dividend payments.

The use of focusing on qualitative decisions models suffers from the loss of information relative to quantitative decision models. The use of quantitative models, however, raises serious misspecification problems, since the actual decision of the firm is not the result of an optimization problem, but rather the effect of a constraint the analyst has no information on. Problems like the firm's model developed earlier typically produce corner solutions due to the linearity of the objective function and the (unknown) constraints from borrowing and new equity limits the firm faces. The role of the adjustment cost function is crucial here: Although the standard literature assumes that the adjustment cost function is convex, several authors have investigated concave adjustment costs [Jørgensen and Kort (1990), Söderström (1976)]. The implication for the model in Section 2 is rather obvious: A convex adjustment cost function implies generally a smooth solution as a result of the concave programming problem. A concave adjustment cost, however, leads to corner solutions which are characterized by "jumps" in the firm behavior. In the latter case the empirical investigation of the dynamics of the firm decisions with use of discrete choice models is strongly recommended. Our work takes a first step in a direction opposite to the standard literature. We develop models of qualitative decisions which avoid misspecification problems at the cost of losing quantitative information.

We consider a number of different specifications with respect to discrete characteristics of the firm especially on financing behavior as well as for dividend and investment behavior. The techniques we use allow for the inter-dependence of the different alternatives while accounting for the dynamic structure of such models.

3.2.1 Univariate discrete events

It is interesting that an analysis for firms' propensity to issue new debt, and new equity as reported in Tables 3a and 3b,[12] provides strong support for a rich pattern of transitions and for a role for unobserved heterogeneity. However, cyclical characteristics are now much more important.

Simple parametrization of the optimization problem yields expressions for the following endogenous variables: X_t, S_t, D_t and I_t. These depend upon the exogenous and endogenous state variables of the problem, that is prices and other market variables and the capital stock, including characteristics of individual firms which may be observable, as a number of different behavioral ratios or the industry the firm operates, or unobservable but persistent characteristics.

For the purpose of our empirical investigation we may define a number of discrete-valued endogenous variables that correspond to the above endogenous variables. The discrete aspects of the financing decisions of the firms are captured by the following discrete events:

$$\mathcal{B}_t \equiv \mathbf{1}(X_t > 0), \tag{18}$$

[12] We discuss these results in Section 4.2

and

$$\mathcal{S}_t \equiv \mathbf{1}(S_t > 0), \tag{19}$$

where the indicator function $\mathbf{1}(\mathcal{A})$ is equal to 1, if $\mathcal{A}$ is true, and equal to 0, otherwise.

We define in addition, the discrete events $\mathcal{I}_t$ for whether or not a firm undertakes net investment and $\mathcal{D}_t$ for whether or not a firm pays positive dividends:

$$\mathcal{I}_t \equiv \mathbf{1}(I_t > 0), \tag{20}$$

$$\mathcal{D}_t \equiv \mathbf{1}(D_t > 0), \tag{21}$$

These events are observable in the COMPUSTAT data. Furthermore, the above definitions are amenable to refinements. For example, there exist several categories of dividends.

We isolate the questions we focus on by considering ("marginal") value functions associated with each of the discrete decisions in

$$\varpi_t = \{\mathcal{B}_t, \mathcal{S}_t, \mathcal{D}_t, \mathcal{I}_t\},$$

which are conditional on all observable information but are "marginal" with respect to one another. Such a formulation allows us to examine the determinants and dynamics of each of these decisions on its own at a first pass. In other words, for now, we do not allow for interdependence between these decisions.

Let $\mathcal{A}_t \in \varpi_t$ denote each of these decisions. The marginal value function is defined as:

$$U_{\mathcal{A}_t} = \beta_{\mathcal{A}} Y_{it} + \epsilon_{\mathcal{A}_t}, \tag{22}$$

where β_t is a vector of parameters to be estimated, Y_{it} a vector of observable variables which include a number of firm i's characteristics and ratios, and $\epsilon_{\mathcal{A}_t}$ the stochastic (unobservable) part of the value function of the firm. The probability of choosing $\mathcal{A}_t = 1$, is thus given by:

$$Prob\{\mathcal{A}_t = 1\} = Prob\{\beta_1 Y_{it} - \beta_0 Y_{it} > \epsilon_{0,t} - \epsilon_{1,t}\}. \tag{23}$$

We assume that the optimal choice delivers maximum (marginal) value for the firm, which implies that we are not interested in the value of the maximal choice but in the difference in value levels between the best choice and the alternative choice.

Additionally, we account for individual heterogeneity by means of individual random effects. That is, we assume that the stochastic error $\epsilon_{\mathcal{A}_t}$ consists of a random individual effect for each firm i, $\eta_{i,\mathcal{A}}$, and an unobserved value component for firm i at period t, $\nu_{i,\mathcal{A}_t}$:

$$\epsilon_{\mathcal{A}_t} = \eta_{i,\mathcal{A}} + \nu_{i,\mathcal{A}_t}. \tag{24}$$

The two error components are assumed to be uncorrelated and have a joint normal cumulative distribution function. Failure to account for the random individual effect may result in serious bias in the estimation.

For all specifications we are bound by available econometric techniques. For the case of univariate discrete events we can use univariate probit estimation methods for non-balanced panel data with random effects. For the estimation we use a numerical quadrature method (with and without random effects) based on an algorithm developed by Butler an Moffitt (1982).

Additional discrete events corresponding to other qualitative aspects of firms' behavior may also be defined. Whether or not they are observable depends very much on the data.[13]

[13]The methods proposed by Hajivassiliou and Ioannides (1991) allow us to handle with panel data

The availability of data in COMPUSTAT on bond ratings, ingeniously used by Whited (1988), is a classic example of an imperfect indicator of $\mathcal{S}(t)$. The event of whether a firm is constrained in its borrowing may be defined as follows:

$$\mathcal{C}(t) \equiv \mathbf{1}(X_t < \bar{B}_t - (1 + r_{t-1})B_t).$$

3.2.2 Multivariate discrete events

We extend the above models to account for possible inter-dependence among the discrete financing decisions. Our assumptions for the marginal value functions allow us to consider multivariate events by means of a multinomial probit model. That is an observation for which financing is in the form of new debt only, $\{\mathcal{B}_t = 1\} \cap .\{\mathcal{S}_t = 0\}$ is associated with a probability equal to:

$$Prob\left\{(\beta_{1,\mathcal{B}} - \beta_{0,\mathcal{B}})Y_{it} \geq \epsilon_{0,\mathcal{B}_t} - \epsilon_{1,\mathcal{B}_t}, (\beta_{0,\mathcal{S}} - \beta_{1,\mathcal{S}})Y_{it} \geq \epsilon_{1,\mathcal{S}_t} - \epsilon_{0,\mathcal{S}_t}\right\}. \tag{25}$$

In a similar fashion we can define observation for which the firm uses new equity financing only, $\{\mathcal{B}_t = 0\} \cap \{\mathcal{S}_t = 1\}$,

$$Prob\left\{(\beta_{0,\mathcal{B}} - \beta_{1,\mathcal{B}})Y_{it} \geq \epsilon_{1,\mathcal{B}_t} - \epsilon_{0,\mathcal{B}_t}, (\beta_{1,\mathcal{S}} - \beta_{0,\mathcal{S}})Y_{it} \geq \epsilon_{0,\mathcal{S}_t} - \epsilon_{1,\mathcal{S}_t}\right\}, \tag{26}$$

or a mix of new debt and new equity financing, $\{\mathcal{B}_t = 1\} \cap \{\mathcal{S}_t = 1\}$,

$$Prob\left\{(\beta_{1,\mathcal{B}} - \beta_{0,\mathcal{B}})Y_{it} \geq \epsilon_{0,\mathcal{B}_t} - \epsilon_{1,\mathcal{B}_t}, (\beta_{1,\mathcal{S}} - \beta_{0,\mathcal{S}})Y_{it} \geq \epsilon_{0,\mathcal{S}_t} - \epsilon_{1,\mathcal{S}_t}\right\}, \tag{27}$$

or no external financing at all, $\{\mathcal{B}_t = 0\} \cap \{\mathcal{S}_t = 1\}$,

$$Prob\left\{(\beta_{0,\mathcal{B}} - \beta_{1,\mathcal{B}})Y_{it} \geq \epsilon_{1,\mathcal{B}_t} - \epsilon_{0,\mathcal{B}_t}, (\beta_{0,\mathcal{S}} - \beta_{1,\mathcal{S}})Y_{it} \geq \epsilon_{1,\mathcal{S}_t} - \epsilon_{0,\mathcal{S}_t}\right\}. \tag{28}$$

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imperfect indicators for discrete events.

We propose to explain the probability of the observable financing event in terms of the differences of the unobserved value components.

$$w_{\mathcal{A}_t} = \epsilon_{j,\mathcal{A}_t} - \epsilon_{i,\mathcal{A}_t}, i, j \in \{0, 1\}, i \neq j. \tag{29}$$

This implies that regressions for the estimation of (25) – (28) would be identified by means of the differences only. As for the errors, the above assumptions on the stochastic structure of ϵ' s, implies a well defined stochastic structure for (29) which may be obtained from (24) by means of tedious but elementary manipulations.

In this setup we are also able to allow for interdependence of the alternative choices. In such a case, we relax the independence of irrelevant alternatives hypothesis. The smooth simulated maximum likelihood algorithm used produces unbiased estimates of the choice probabilities of the above models. Our estimation according to the Simulated Maximum Likelihood Algorithm follows the approach proposed by Börch-Supan and Hajivassiliou (1991), and Börch-Supan et. al (1992) which allows for random effects for panel data models as described in (24).

4 Description of the COMPUSTAT Data

The data used in this work are based on the "Manufacturing Sector Master File: 1959–1987" created initially by Bronwyn H. Hall [Hall (1988)] under the auspices of a National Bureau of Economic Research project. The Manufacturing Sector Master File consists of a non-balanced panel of 2726 publicly traded firms with 90 variables during the period 1959–1987. There are 49,225 observations in all. The original data are obtained from the Annual COMPUSTAT Industrial and Over-the-Counter Files for 1978 through 1987. Data items come from a variety of sources such as income statements, balance sheets, flow of funds statements, etc. A detailed description of the construction of the data is presented by Bronwyn Hall in Hall (1990), pp. 26–30.

The COMPUSTAT panel data set contains all firms traded on the New York and American Stock Exchanges and a number of firms traded on over–the–counter markets. Minimum requirement for the inclusion of a firm in the current panel is the existence of data for at least three consecutive years between 1976 and 1985.

We consider a number of individual characteristics including a number of firm statistics and different ratios used in the finance literature. The following variables from the COMPUSTAT data are included: Investment, operating income, net and gross cash flow, sales, dividends, dividends and common stock repurchases and total debt. All of these variables have been normalized by dividing by the net capital stock. In addition we use Tobin's q[14] and a number of ratios used in standard corporate finance theory.[15]

We consider profitability, liquidity and leverage ratios. Profitability ratios include cash flow to sales, which measures the operating efficiency and the rate of internal cash generation The ratio of cash flow to total tangible assets accounts for the ability of the firm to generate cash flows from resources and the ratio operating income to total tangible assets which measures the management ability to generate operating income from the firm's assets, are also considered. The liquidity ratio used is defined as cash flow over total liabilities; it measures the cash generation out of total liabilities. Finally, ratios intended to measure leverage include the total debt to total tangible assets, which measures the degree to which the firm's assets are financed by debt and retained earnings to total tangible assets, which indicates long term profitability, i.e. the degree to which existing assets have been financed by reinvested profits. A list of the variable definitions is given on Table 1. Descriptive statistics of all variables and ratios are given in Tables 2a and 2b and in Appendix C .

[14] For a detailed description of the construction of Tobin's q see Appendix A

[15] For example see Brealey and Myers (1991).

4.1 Analysis of the Data

Tables A and B of the Appendix gives descriptive statistics for the whole panel after a number of corrections have been made. All variables have been made comparable using an adjustment factor for the common stock splits and have been deflated with respect to 1970 as the base year. We define dummy variables in order to consider qualitative phenomena associated with a number of key observable variables as well as auxiliary ones that we have constructed.

In an attempt to illuminate qualitative aspects of the data we have defined a number of distinct regimes for a specific firm behavior (investment financing – dividend behavior). Particularly, firms may stay in a specific regime for a number of periods or they may switch between regimes. We examine some basic characteristics of these regimes towards obtaining a better understanding of the dynamics of regime changes.

We distinguish six regimes defined in terms of the discrete events $\mathcal{D}_t = 0$ or 1, positive versus zero dividends, $\mathcal{B}_t = 0$ or 1, positive versus negative net debt (if the firm pays back debt), and $\mathcal{S}_t = 0$ or 1, new shares issues positive or negative (if the firms buys back its own shares). A picture of the average pattern of transitions is given in Tables 3a and 3b. We have left out the investment decision primarily because it exhibits, according to Tables 2a and 2b, relatively very little variation, at least when compared to the other variables.

However Tables C to R in the appendix provide descriptive statistics for each of the subsamples that correspond to sixteen distinct regimes after the inclusion of the discrete event $\mathcal{I}_t = 0$ or 1, positive versus negative net investment.

Regime 1 includes firms which at a specific time utilize all kinds of external finance, that is, they borrow and issue new shares, and pay dividends. Firms which belong to this regime are younger and stronger with high leverage and high profits. 28.7% of all firm observations belong to Regime 1. Regime 2 is similarly defined except that dividend payments are zero. This 13.06% of the sample consists of younger small firms with low debt and profits. Regime 3 consists of observations from the sample where firms use debt for finance purposes and they do not issue new shares or buy back shares from the market. The descriptive statistics show that these firms (11.8%) are mostly larger than average, with high debt and high earnings, and such observations come mostly from recent years. Regime 4 has a similar definition but without dividend payments. It includes small firms with low debt and earnings, especially the latest years of the sample. [16] Regime 5 is a rather "abnormal" but nonetheless includes a substantial number of firms (17.5 %) which pay dividends and issue new equity but do not issue new debt. [17] Regime 6, comprises a small portion of the sample (5.5%), and is similar to regime 5, but no dividends are paid. Small firms with low leverage and profits is the case here. Regime 7 consists of firms using internal finance only to pay dividends. This group comprises 9.8% of the panel and include average firms typically with low debt and high income for dividends. Finally, regime 8, pertains to a relatively infrequent occurrence (5.5%) of smaller firms with low debt and no income to distribute, which do not use any external finance and do not pay dividends. Descriptive statistics on the whole sample and on these regimes are given in Tables A–R of the Appendix.

4.2 Analysis of Patterns of Transitions across Regimes.

Tables 3a and 3b consider cross tabulations on transitions for 8 regimes concerning dividend payments, borrowing and equity issue behavior. Table 3a refers to the whole sample (46,513 observations) while Table 3b refers to the balance panel of 301 firms for the years 1959-1987. A comparison between those two tables suggests the following observations:

[16] This is possibly a case of constrained firms with high risk premia which explain the fact that they do not issue new equity.

[17] This behavior of mostly average firms with high profits is questionable: They seem to worry mostly about their signals for bankruptcy risks (debt–equity ratio) and less about the cost of financing.

From Regime 1 (positive dividend payments and positive borrowing and new shares issue) which is the most frequent regime in both samples, most of the firms (60 %) seem to remain in the same regime from period to period. Another 20% of the firms change their behavior towards not issuing more debt and 13% do not issue new equity in the next period.

From Regime 2 (same as Regime 1 but no dividend payments) most firms remain in the same regime for the next period (50% and 40% for the whole and the balanced sample respectively) where the only other interesting move is to a regime where no new debt is issued.

From Regime 3 (firms which do not issue new shares, but they increase net borrowing while paying positive dividends) most firms remain in the same regime. However we have stronger than earlier moves to regimes where the financing pattern changes, either by starting issuing shares or (fewer) by stopping borrowing. Similar is the case for Regime 4 (same as 3, but with zero dividends).

From Regimes 5 and 6 (no debt issue, positive share issue and positive and zero dividends respectively) while most firms remain in the same regime for the next period, some start issuing debt and a smaller number of them stop issuing shares too.

For the firms which do not use any kind of financing the most common switch (if any) is starting issuing new shares, while issuing new debt is less strong.

A most interesting conclusion obtained by comparing Tables 3a and 3b is that the transitions of regimes on the unbalanced panel of the whole sample of 46,513 observations are very similar to the transitions for the smaller balanced panel of 301 firms for the years 1959–1987 (8,428 observations). This enables us to use the balanced and smaller panel for the multinomial probit estimation as described on Section 3.2.2 rather than the full sample, since the smooth simulated probit algorithm requires a balanced panel.

Summarizing the above discussion we can see that there is no dramatic switching across regimes over time (around 50 % of the firms prefer to remain in the same regime). Whenever firms do switch from one regime to another, it is hardly ever the case that firms change their dividend behavior. When firms change their financing pattern, it is more likely that they do so by issuing new shares. If they did not issue new shares in the last period, it is possible to start issuing in the current period. A similar but weaker result holds for issuing new debt. The above results are reversed when firms use a specific type of financing and then they stop using it. They also seem to be more likely to stop borrowing than to stop issuing new shares.

5 Estimation Results

Tables 4, 5, 6 and 7 summarize the results of the probit estimations for the discrete events of issuing new debt, issuing new shares, dividend payments and net investment respectively for a unbalanced panel of 1875 firms between the years 1958 and 1987, totaling 46,498 observations. In all tables the first column of results reports to estimations for a homogeneous probit model (no individual heterogeneity is assumed), while the second column contains the probit results for the same model with individual heterogeneity modeled by means of random effects.

5.1 New Debt

Estimation results for the discrete event of issuing new (net) debt as described on equation (18) and modeled in terms of the specification in (23) and (24) are given on Table 4. Comparing the two columns of results we can observe that the use of the random effects model significantly increases the explanatory power of the model. This follows from the fact that the likelihood ratio test gives strong support for the hypothesis that the model in the second column (which includes random effects) significantly improves the performance of the homogeneous model. In support to this argument comes the significance of the variance of the random effect, $\log(\sigma_\eta)$. The logarithm, rather than the variance σ_η^2 itself, is used because it is convenient for the quadrature procedure used for the estimation of the univariate probit model. It is clear then that the unobserved "value" component includes a time-invariant random term. The estimated results on the first column of the table then could well be biased. Yet they show considerable stability after the introduction of the random effects.

Most of the explanatory variables used for modelling this discrete event are significant and their signs are consistent with simple economic intuition. The lagged dependent variable gives a positive estimate, which implies that firms exhibit strong persistence when it comes to decisions about issuing new debt. In other words, given that the firm was issuing new debt last period, it is very possible that it will continue issuing debt the current period. The coefficient of variation is quite high. Switching is rather rare. The effect of investment is positive. Firms which invest with higher rates are more likely to issue debt in order to finance investment. On the other hand, firms which are not involved in major investment projects are expected to pay back their debt.

Firms with high operating income prefer to pay back their debt while firms with low operating income decide to issue more debt; this result is also consistent with the theory. There is a significant negative sign for the gross rate of return coefficient. Firms with high rate of return from their investment seem to issue more debt. Also, firms with high net cash flows and large sales pay back their debt or do not issue more. Tobin's q has a significant and positive estimated coefficient, which implies that firms with higher value to replacement cost of capital decide to borrow more often. This is a direct implication of the first order conditions for borrowing discussed in section 3.2 and by using equations (12) and (15). When the shadow value of investment, the marginal q, which is approximated here by the Tobin's q, is high enough to exceed the shadow value of borrowing, the firm is more willing to borrow transferring funds from tomorrow to today.

The ratio of net cash flow to tangible assets, which provides a measure of a firm's ability to generate funds from its own resources, has a significant positive relation to the firm's decision to issue new debt. Higher long term profitability, measured by the retained earnings to tangible assets ratio, also has a positive impact on the firm's decision to issue debt.

5.2 New Stock Issues

The probit estimations on Table 5 for the discrete event of issuing new stock are very interesting. The first noteworthy observation is that the panel structure is strongly significant. Comparing the two models on the two columns of Table 5 which represent estimations without and with random effects respectively and by using a likelihood ratio test, it is easy to see that the model with the random effects significantly improves the explanatory power of the model. The same conclusion can be demonstrated by the t-statistic of the variance of the random effect.

Many of the explanatory variables are very significant and provide useful insights on the firm's decision to issue new stock. First, the inclusion of the last period's decision shows very significant dynamics. Its positive sign implies high persistence in the firm's propensity to issue new shares. Firms which invest more are more likely to issue new stock. So is the case for firms with high operating income. On the other hand, firms with higher net cash flows and higher sales seem to be less likely to issue new stock. One explanation may be that they do not need cash as much and are thus unwilling to assume the risk associated with issuing new shares. Surprisingly, dividend payments seem to be completely irrelevant to the decision of issuing new stock.

5.3 Dividends

The discrete event of whether or not to pay dividends is the most interesting since modelling dividends is one of the most controversial topics in the finance literature. Our estimations on Table 6 show a number of interesting aspects of the dividend decision. Here, again, individual heterogeneity seems to be important since the variance of the random effects turns out to be significant and the likelihood ratio test for the homogeneous versus the random effects model supports the explanatory power of the model which accounts for the panel structure.

Accounting for the dynamics, last year's decision has a significant positive sign coefficient, which implies that there is high persistence in the propensity to pay or not pay dividends. This results accords with Himmelberg's *op. cit.*, predictions that conditional on the event that positive dividends are paid in a given year, the probability that no dividends are paid in the following year is small. Similarly, here, the probability that no dividends are paid in a subsequent year is very high, conditional on the event that no dividends are paid in a given year. Our own results provide strong support for Himmelberg's predictions with respect to the discrete event of whether positive dividends are paid, even after we have accounted for individual effects (which he does not).

A number of other explanatory variables show a significant effect on the decision to pay dividends. We find that firms which invest a lot are less likely to pay dividends, as is also the case for firms with high gross rate of return. The intuition is rather simple: At the time firms use their cash flow to fund investment projects they have no funds for dividends. This may well be the case for young firms, while it seems natural to observe that firms with no new investment opportunities cash their flows to their shareholders as dividends. This is also connected with our next finding, that firms with higher operating income are more willing to pay dividends. Debt is negatively related to dividend payments: Firms with high debt to capital ratio are less likely to pay dividends. Assuming that firms with higher debt levels are more likely to be debt-constrained, this finding comes in partial support of Himmelberg (1990) and White's (1988) argument that constrained firms do pay zero dividends. Finally, the result that long-term profitability, as approximated by the retained earnings to tangibles ratio, is positively associated with paying positive dividends, accords with simple economic intuition.

5.4 Net Investment

Table 7 describes the probit results for the model of equation (23) applied to the case of the discrete event defined in terms of net investment being positive as given in (20). Appendix A provides details on the construction of net investment and the endogenous variables. Our findings here give interesting insights on the investment behavior of firms. Again, here, the explanatory power of the model increases with the inclusion of a random effect. Both the variance of the random effect, $\log(\sigma_\eta)$, and the likelihood ratio test between the models in columns I and II of Table 7 shows that the model with the random effect is significantly stronger than the homogeneous model.

Concentrating on the second column of Table 7, we make a number of interesting observations concerning the determinants of net investment being positive. The lagged dependent variable, $\mathcal{I}_{t-1}$, has a positive and significant coefficient, which implies that firms' propensity to invest exhibits strong persistent. That is, when a firm decided to increase net investment in the last period, then the probability that it will continue this behavior is very high, while so is the case for firms which dis-invest.

The coefficient of Tobin's q is positive and significant, implying that the higher a firm's valuation of investment as measured by Tobin's q the more attractive is new investment. This result is interesting, because it accords with prediction with the theoretical prediction developed in Section 2, and with previous work in the investment literature for quantitative models.

Additional significant coefficients include the debt to capital ratio (DEBT2K) which gives a positive effect on the discrete event of net investment. This implies that firms with higher debt are the ones which invest in new projects. This finding provides a support to the borrowing – investment link established by our previous results on the discrete event of issuing new debt.

5.5 Inter-Dependence of Financing Modes

Table 8 describes the multinomial probit results for the models (25) – (28), which combine models (18) and (19) but allow for possible inter-dependence between the discrete financing modes. This estimation uses a balanced panel of firms, which appear in the sample during the period 1959 to 1987 The reliance on a balanced panel is problematic but is dictated by the availability of software for the Simulated Maximum Likelihood Algorithm. As we discussed in Section 4.2 the pattern of transitions among the various modes for this sample and the full sample are very similar. It is for this reason that we are not too concerned about using the smaller balanced panel.

The estimation results provide support for the univariate results for new debt and new equity, as described in Sections 5.1 and 5.2 but they are not as strong. The results reported in Table 8 are without random effects. We do not know why but the random effects estimation failed to converge. The model allows for estimation of three out of the four discrete events and we choose to estimate choice among three financing modes where only borrowing is used (variables with 1 in Table 8), only new equity is used (variables with 2) and a combination of new debt and new equity is used (variables with 3).

Similarly to the results for new debt and new equity the lagged dependent variables (LDB1, LDB2, LDB3) are associated positive estimates which imply strong persistence when it comes to such financing decisions. This is not the case however with the combination of the two types of external financing, that is issue new debt and new equity at the same time. It is hardly significant and gives a negative sign. Firms seem to avoid using both types of external finance when they used both of them in the last period. This is consistent with an earlier observation in the cross-tabulation Table 3b.

For the rest of the results we observe that the sales to capital ratio (SALES2K) gives a negative coefficient, implying the negative relationship of high sales to external financing generally. The positive sign of the Tobin's q coefficients seems to support the same argument as in Section 5.1 which relates the marginal q (approximated here by the Tobin's q) with the shadow price of external financing. Also the long term profitability, as measured by the retained earnings to tangibles ratio, has a positive impact on external financing.

Another interesting characteristic of the result is its improvement due to the inclusion of an autoregressive error in the specification in the form:

$$\epsilon_{i,t} = \rho_i \epsilon_{i,t-1} + \nu_{i,t}$$

with $\nu_{i,t}$ being an i.i.d. process. This specification gives a block diagonal structure of the variance–covariance matrix with each block having an AR1 process structure.[18] Our model strongly supports the autoregressive error structure implying rich dynamics of the financing decisions.

[18] See Börch-Supan et. al (1992), p.83.

6 Concluding Remarks

Models of qualitative aspects of the firm's investment and finance decisions give new perspectives on some of the classic problems in the theory of the firm. Our results show interesting patterns in explaining firms' behavior, which have not been investigated before.

Concerning simple decisions such as whether to pay dividends or not, issue new debt and/or new equity or not, and increase net investment or not we find that firm heterogeneity is always very significant, and should be considered seriously before conclusions are drawn. This is also the case for the dynamic characteristics of the qualitative aspects of firms' investment and financing decisions. Our results show that there is always high persistence in the propensity of a specific decision. Firms seem to be very carefully follow smooth patterns of decisions in a repetitive fashion.

Our model may be seen as a first step towards a more general theory which would combine quantitative and qualitative aspects of firms' behavior as joint decisions. This task still lies ahead.

TABLE 1

VARIABLES and RATIOS USED
as FIRM CHARACTERISTICS

I2K	Investment to capital
OPY2K	Operating Income to Capital
GRATE	Gross Cash Flow to Capital
NCF2K	Net Cash Flow to Capital
SALES2K	Sales to Capital
q	Tobin's q
DIV2K	Dividends to Capital
DIVR2K	Dividends plus Repurchases to Capital
DEBT2K	Total Debt Stock to Capital
NCF2SALE	Net Cash Flow to Sales
NCF2TANG	Net Cash Flow to Total Tangible Assets
OPY2TANG	Operating Income to Total Tangible Assets
NCF2LIAB	Net Cash Flow to Total Liabilities
B2TANG	Total Debt to Total Tangible Assets
RE2TANG	Retained Earnings to Total Tangible Assets

Table 2a

Descriptive Statistics
Full Sample

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
$\mathbf{1}(NEWDEBT > 0)$	46471	0.4222418	0.4939220	0	1.0000000
$\mathbf{1}(NEWSHARES > 0)$	46471	0.6059048	0.4886607	0	1.0000000
$\mathbf{1}(DIVIDENDS > 0)$	46471	0.6697725	0.4702999	0	1.0000000
$\mathbf{1}(NETINVEST > 0)$	46471	0.9437499	0.2304066	0	1.0000000
I2K	42891	0.1777658	0.1676876	0	2.3346705
OPY2K	44560	0.4159968	0.5116916	-7.4400785	18.7017073
GRATE	44568	1.2768296	18.7769207	-12.6138391	1523.73
NCF2K	44568	0.7727858	9.5685606	-94.0005768	946.5344990
SALES2K	44544	3.9405346	4.8034437	0.000220911	255.3450015
q	37296	5.1457523	65.0279018	-15.9063216	3075.82
DIV2K	44198	0.2767623	4.8942466	0	283.5819304
DEBT2K	44561	0.4120752	0.5941614	0	71.4891029
NCF2SALE	44544	0.2274687	22.9523600	-4161.38	2059.34
NCF2TANG	44567	0.2726277	3.4667908	-24.5216356	355.6228661
OPY2TANG	45817	0.1542847	0.1235678	-3.6675017	3.2533328
NCF2LIAB	44520	1.4290837	18.5477593	-177.5181725	1762.64
B2TANG	45999	0.1779327	0.1547900	0	3.9889552
RE2TANG	42122	0.2770584	0.5237479	-24.0047616	2.7933324

Table 2b

Descriptive Statistics
Balanced Panel Subsample 1959–1987

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
$\mathbf{1}(NEWDEBT > 0)$	8439	0.3732670	0.4837008	0	1.0000000
$\mathbf{1}(NEWSHARES > 0)$	8439	0.7068373	0.4552394	0	1.0000000
$\mathbf{1}(DIVIDENDS > 0)$	8439	0.9082830	0.2886432	0	1.0000000
$\mathbf{1}(NETINVEST > 0)$	8439	0.9840028	0.1254716	0	1.0000000
I2K	8179	0.1936675	0.1595023	0	1.5947460
OPY2K	8298	0.4795413	0.4572764	-1.7762903	4.6764499
GRATE	8299	0.2222445	1.5598848	-0.7198718	70.4608917
NCF2K	8299	0.2084666	0.9332855	-1.3067890	36.1275845
SALES2K	8290	3.6780945	3.1262598	0.0427295	44.5979670
q	7321	0.7906973	0.7364028	-0.3894575	15.4823851
DIV2K	8287	0.0842973	0.1241639	0	1.7739578
DEBT2K	8299	0.4041610	0.4294232	0	9.1535827
NCF2SALE	8290	0.0740164	0.2984768	-0.9288598	19.7768275
NCF2TANG	8299	0.0858174	0.2774273	-0.7643613	16.6228396
OPY2TANG	8413	0.1708566	0.0862727	-0.4176803	0.6712404
NCF2LIAB	8288	0.4448659	2.2826108	-3.4419560	163.0225741
B2TANG	8436	0.1692053	0.1227820	0	1.4936618
RE2TANG	7114	0.3671882	0.1926993	-1.6795466	1.1030691

TABLE 3a

CROSS TAB ON THE TRANSITIONS OF 8 REGIMES BASED ON DIVIDEND AND FINANCING PATTERNS (full sample)

$t+1$ \ t	Regime 1 $\Delta B > 0$ $\Delta S > 0$ $D > 0$	Regime 2 $\Delta B > 0$ $\Delta S > 0$ $D = 0$	Regime 3 $\Delta B > 0$ $\Delta S \leq 0$ $D > 0$	Regime 4 $\Delta B > 0$ $\Delta S \leq 0$ $D = 0$	Regime 5 $\Delta B \leq 0$ $\Delta S > 0$ $D > 0$	Regime 6 $\Delta B \leq 0$ $\Delta S > 0$ $D = 0$	Regime 7 $\Delta B \leq 0$ $\Delta S \leq 0$ $D > 0$	Regime 8 $\Delta B \leq 0$ $\Delta S \leq 0$ $D = 0$	Total
Regime 1 $\Delta B > 0$ $\Delta S > 0$ $D > 0$	6000 (58.07)	166 (3.31)	1407 (29.04)	66 (2.11)	641 (22.59)	5 (1.71)	119 (9.06)	2 (1.10)	2632
Regime 2 $\Delta B > 0$ $\Delta S > 0$ $D = 0$	127 (1.23)	2625 (52.41)	48 (0.99)	744 (23.84)	5 (0.18)	66 (22.60)	1 (0.08)	18 (9.89)	204
Regime 3 $\Delta B > 0$ $\Delta S \leq 0$ $D > 0$	1443 (13.96)	47 (0.94)	1785 (36.84)	107 (3.43)	143 (5.04)	0 (0.00)	174 (13.24)	5 (2.75)	1022
Regime 4 $\Delta B > 0$ $\Delta S \leq 0$ $D = 0$	70 (0.68)	689 (13.76)	108 (2.23)	1183 (37.9)	0 (0.00)	11 (3.77)	2 (0.15)	30 (16.48)	113
Regime 5 $\Delta B \leq 0$ $\Delta S > 0$ $D > 0$	2040 (19.74)	62 (1.24)	571 (11.79)	40 (1.28)	1673 (58.95)	14 (4.79)	475 (36.15)	6 (3.30)	2819
Regime 6 $\Delta B \leq 0$ $\Delta S > 0$ $D = 0$	81 (0.78)	1071 (21.38)	30 (0.62)	319 (10.22)	13 (0.46)	161 (55.14)	7 (0.53)	47 (25.82)	304
Regime 7 $\Delta B \leq 0$ $\Delta S \leq 0$ $D > 0$	539 (5.22)	26 (0.52)	828 (17.09)	59 (1.89)	361 (12.72)	4 (1.37)	530 (40.33)	14 (7.69)	1184
Regime 8 $\Delta B \leq 0$ $\Delta S \leq 0$ $D = 0$	33 (0.32)	323 (6.45)	68 (1.4)	603 (19.32)	2 (0.07)	31 (10.62)	6 (0.46)	60 (32.97)	150
Total	2556	187	953	106	2838	292	1314	182	8428

TABLE 3b

CROSS TAB ON THE TRANSITIONS OF 8 REGIMES BASED ON DIVIDEND AND FINANCING PATTERNS (balanced panel subsample 1959-1987)

t / $t+1$	Regime 1 $\Delta B > 0$ $\Delta S > 0$ $D > 0$	Regime 2 $\Delta B > 0$ $\Delta S > 0$ $D = 0$	Regime 3 $\Delta B > 0$ $\Delta S \leq 0$ $D > 0$	Regime 4 $\Delta B > 0$ $\Delta S \leq 0$ $D = 0$	Regime 5 $\Delta B \leq 0$ $\Delta S > 0$ $D > 0$	Regime 6 $\Delta B \leq 0$ $\Delta S > 0$ $D = 0$	Regime 7 $\Delta B \leq 0$ $\Delta S \leq 0$ $D > 0$	Regime 8 $\Delta B \leq 0$ $\Delta S \leq 0$ $D = 0$	Total
Regime 1 $\Delta B > 0$ $\Delta S > 0$ $D > 0$	1546 (60.49)	4 (2.67)	308 (32.32)	6 (5.66)	392 (25.09)	80 (2.06)	667 (11.07)	62 (1.65)	10840
Regime 2 $\Delta B > 0$ $\Delta S > 0$ $D = 0$	13 (0.51)	76 (40.46)	4 (0.42)	21 (19.81)	50 (0.52)	1139 (29.33)	28 (0.46)	564 (15.00)	5325
Regime 3 $\Delta B > 0$ $\Delta S \leq 0$ $D > 0$	329 (12.87)	3 (1.60)	363 (38.09)	5 (4.72)	645 (6.76)	29 (0.75)	961 (15.95)	105 (2.79)	5122
Regime 4 $\Delta B > 0$ $\Delta S \leq 0$ $D = 0$	5 (0.20)	27 (14.44)	5 (0.52)	33 (31.13)	22 (0.23)	348 (8.96)	41 (0.68)	764 (20.32)	3225
Regime 5 $\Delta B \leq 0$ $\Delta S > 0$ $D > 0$	516 (20.19)	11 (5.88)	121 (12.70)	3 (2.83)	5002 (52.46)	149 (3.84)	1788 (29.67)	99 (2.63)	9751
Regime 6 $\Delta B \leq 0$ $\Delta S > 0$ $D = 0$	10 (0.39)	49 (26.20)	3 (0.31)	14 (13.21)	78 (0.82)	1632 (42.02)	43 (0.71)	817 (21.73)	4071
Regime 7 $\Delta B \leq 0$ $\Delta S \leq 0$ $D > 0$	134 (5.24)	1 (0.53)	139 (14.59)	1 (0.94)	1294 (13.57)	63 (1.62)	2402 (39.86)	217 (5.77)	5428
Regime 8 $\Delta B \leq 0$ $\Delta S \leq 0$ $D = 0$	3 (0.12)	15 (8.02)	10 (1.05)	23 (21.70)	52 (0.55)	444 (11.43)	96 (1.59)	1132 (30.11)	2751
Total	10333	5009	4845	3121	9535	3884	6026	3760	46513

TABLE 4

Probit Estimation of $\mathcal{B}_t = \mathbf{1}(B_t > 0)$

Variable	no random effects	with random effects
constant	0.051177661524	0.051598856421
	(7.291795089)*	(5.602160669)
$\mathcal{B}_{t-1}$	0.1404642540	0.1396823645
	(19.72138031)	(18.05188470)
i2k	0.2925936145	0.2915183118
	(34.11189535)	(31.62560213)
opy2k	-0.2074047072	-0.2130227674
	(-15.96345411)	(-9.422087795)
grate	0.4255806876	0.4213081325
	(15.56835510)	(10.52524399)
ncf2k	-0.3277625940	-0.3323055648
	(-8.981876191)	(-7.513923678)
sales2k	-0.090368605164	-0.091780629273
	(-9.085427874)	(-7.878287575)
div2k	-0.050428812021	-0.0051541492345
	(-5.511638309)	(-0.6065213973)
debt2k	-0.1338497766	-0.1323983999
	(-9.759506184)	(-9.176919985)
Tobin's q	0.016353233108	0.015876451992
	(2.066601774)	(1.906655018)
ncf2tang	0.070738192351	0.065405101290
	(11.35671524)	(3.053341070)
opy2tang	-0.3550239145	-0.036288373716
	(-28.92878310)	(-1.825731522)
b2tang	0.2258989043	0.2279822190
	(19.14812081)	(17.73524285)
re2tang	0.023866628434	0.020536572430
	(2.608798114)	(2.242048585)
$\log(\sigma_\eta)$	———	-1.320290336
	———	(-28.06508570)
L.L.F.	-2329.6026910	-2217.7232472

* Numbers in parentheses are t-statistics.

TABLE 5

Probit Estimation of $\mathcal{S}_t = 1(S_t > 0)$

Variable	no random effects	with random effects
constant	0.3833186696	0.3981954140
	(52.14258015)*	(33.24419311)
$\mathcal{S}_{t-1}$	0.4854837918	0.3728896112
	(67.50765732)	(44.28430597)
i2k	0.1451993090	0.1565073657
	(16.36020501)	(15.69911507)
opy2k	0.1330031803	0.1353364464
	(6.247619230)	(5.754972785)
grate	0.1765292194	0.1567543046
	(5.149400057)	(4.048809876)
ncf2k	-0.2450572971	-0.2217132124
	(-5.794234693)	(-4.712597777)
sales2k	-7.0799832069E-02	-8.0519842259E-02
	(-7.651185331)	(-6.649846292)
div2k	-1.1798536425E-02	-2.6938297404E-04
	(-1.526666375)	(-0.0305295294)
debt2k	8.1555735054E-05	-3.8642229164E-03
	(0.0055953874)	(-0.2432618922)
q	-4.9852006557E-03	4.4968819518E-03
	(-0.6390940272)	(0.5119232348)
ncf2tang	0.1134909879	0.1197253449
	(5.674907054)	(5.494983697)
opy2tang	-2.5801936557E-02	-2.2548772246E-02
	(-1.324762517)	(-1.041853242)
b2tang	1.0308992525E-02	3.4253218493E-03
	(0.8519754720)	(0.2477371750)
re2tang	-7.4728039932E-02	-7.8716378159E-02
	(-8.698213302)	(-7.841615927)
$\log(\sigma_\eta)$	———	-0.8263214828
	———	(-25.10367050)
L.L.F.	-1.9670439298D+04	-1.9315966474D+04

* Numbers in parentheses are t-statistics.

TABLE 6

Probit Estimation of $\mathcal{D}_t = \mathbf{1}(D_t > 0)$

Variable	no random effects	with random effects
constant	0.7994247496	0.8056634842
	(73.15715194)	(65.53016328)
$\mathcal{D}_{t-1}$	1.515477034	1.501845380
	(153.9623001)	(122.3912806)
i2k	-4.1190478530E-02	-4.0257072110E-02
	(-3.850320142)	(-3.280756859)
opy2k	5.685600435	5.692269404
	(17.74384413)	(46.26416417)
grate	-6.6041037854E-02	-6.6908020185E-02
	(-1.712081825)	(-5.422400867)
ncf2k	1.7612743749E-02	1.8430891632E-02
	(0.5295027640)	(0.1495686169)
sales2k	-1.9826639760E-02	-1.9557155208E-02
	(-2.063538961)	(-1.594669569)
div2k	-3.2358594915E-03	-4.7356126045E-03
	(-0.3654256635)	(-0.3870750158)
debt2k	-2.733657160	-2.834054136
	(-7.806287345)	(-23.16904549)
ncf2tang	5.9885398377E-03	5.4037233942E-03
	(0.1447442320)	(0.4373594905)
opy2tang	-6.024323936	-6.031389099
	(-17.73795937)	(-48.99077062)
b2tang	2.912690327	3.019891867
	(7.786046540)	(24.65363684)
re2tang	4.6535635210E-02	4.5725761972E-02
	(3.697454754)	(3.717848122)
$\log(\sigma_\eta)$	————	-1.754709787
	————	(-14.18506128)
L.L.F.	-8.3187723871D+03	-8.3165390224D+03

* Numbers in parentheses are t-statistics.

TABLE 7

Probit Estimation of $\mathcal{I}_t = \mathbf{1}(I_t > 0)$

Variable	no random effects	with random effects
constant	2.479130561	31.70863165
	(0.8611163950)	(8.795519929)
$\mathcal{I}_{t-1}$	0.2158909964	0.2377648373
	(4.995935286)	(6.600528150)
i2k	-11.99697020	-14.76964820
	(-0.5583352981)	(-4.096408900)
opy2k	-1.092260451	-11.07817900
	(-0.2057329500)	(-0.3072641429)
grate	3.9363142281E-02	1.9347140721E-02
	(0.3175033701)	(0.5372711692)
ncf2k	2.6610430029E-02	0.3874883517
	(0.1928676170)	(1.075630516)
sales2k	-5.3218822766E-02	-0.8801223154
	(-0.2231723927)	(-0.2441085439)
div2k	2.896136246	1.598612830
	(0.2235333248)	(0.4433794264)
debt2k	-0.1076390121	1.0603530681E-02
	(-2.012399883)	(2.942274832)
q	9.998865656	2.945115629
	(1.029824824)	(8.168345822)
ncf2tang	1.7270057160E-02	-3.3266857440E-02
	(0.2358526308)	(-0.9231399999)
opy2tang	1.888741814	11.37923206
	(0.3074783043)	(0.3156141923)
b2tang	-6.9128026282E-02	-0.3169213799
	(-0.8618907150)	(-0.8792765982)
re2tang	5.7964036537E-03	-9.0414391816E-02
	(0.7101148667E-01)	(-0.2508528400)
$\log(\sigma_\eta)$	————	2.404633295
	————	(7.659328572)
L.L.F.	-7.4883862193D+01	-6.8086936178D+01

* Numbers in parentheses are t-statistics.

Table 8
Probit Estimation of the Multivariate Inter-Dependent Discrete Events of Alternative Financing Nodes.

Variable	Coefficient	T-Statistic
LDB1	0.128286092	(2.836947959)
LDB2	0.313903830	(6.827176134)
LDB3	-0.047227624	(-1.357966516)
I2K1	0.315487018	(0.246542313)
I2K2	0.147851508	(0.166527140)
I2K3	1.066935235	(1.482681564)
OPY2K1	-0.238055391	(-0.142123950)
OPY2K2	0.087370562	(0.062373304)
OPY2K3	-0.978118287	(-0.928016614)
GRATE1	0.427811112	(0.059142894)
GRATE2	0.153074050	(0.032549171)
GRATE3	1.175227594	(0.272235954)
NCF2K1	-0.326746472	(-0.052812662)
NCF2K2	-0.228279970	(-0.057620946)
NCF2K3	-1.233417248	(-0.366428181)
SALES2K1	-0.566632208	(-3.495552956)
SALES2K2	-0.589700180	(-5.004866234)
SALES2K3	-0.374827282	(-4.890583230)
Q1	0.186829988	(0.863945000)
Q2	0.046282410	(0.316170403)
Q3	0.548461844	(4.913115150)
DIV2K1	-0.004381436	(-0.000974578)
DIV2K2	-0.005465970	(-0.001525633)
DIV2K3	0.998056274	(0.368027149)
DEBT2K1	-0.103760724	(-0.095359470)
DEBT2K2	-0.019546739	(-0.026678628)
DEBT2K3	0.950764966	(1.718956510)
NCF2TAN1	0.081820079	(0.024189243)
NCF2TAN2	0.123587973	(0.039988785)
NCF2TAN3	1.009348851	(0.328981931)
OPY2TAN1	-0.030588882	(-0.011837792)
OPY2TAN2	-0.034161229	(-0.016955919)
OPY2TAN3	-1.057137570	(-0.537545563)
B2TANG1	0.279276175	(0.138215227)
B2TANG2	0.011313111	(0.009433276)
B2TANG3	0.939036513	(1.041133251)
RE2TANG1	0.042369802	(0.067259576)
RE2TANG2	0.072758037	(0.179797328)
RE2TANG3	0.882573619	(1.998593031)
one1	0.138380052	(0.251369761)
one2	0.342277491	(0.962450531)
one3	0.705534933	(2.275519702)
σ_1	1.877559974	(127.401166323)
σ_2	1.672989452	(1664.494839423)
$\sigma_1 2$	0.057680908	(68.183902082)
$\sigma_1 3$	-0.134186104	(-133.964100089)
$\sigma_2 3$	-0.024339196	(-62.887993886)
ρ_1	0.534541995	(522.699342666)
ρ_2	0.549608136	(5357.787495835)
ρ_3	0.482587295	(851.140138408)
L.L.F.	-4603.1173	

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APPENDIX

A Definitions and Constructions of Variables

We describe here the variables used from the COMPUSTAT data, from the R&D Master File and the new variables we created.

A.1 Net Investment

We measure investment by using the variable INVEST, which accounts for capital expenditures (gross investment). GRATE is the gross rate of return to capital defined as the ratio of gross cash flows to gross capital stock adjusted for inflation (GROCAP). The market value of the firm (VAL) is defined as the sum of common and preferred stock (VCOMS, PREFST), the long term debt adjusted for its age structure (LTDEBT), and the short term debt (STDEBT), less the net short term assets (ADJ). We use this definition of the value of the firm to calculate Tobin's q, which is defined as the ratio of the value of the firm divided by the replacement value of capital. For the replacement value of capital we use the inflation adjusted net capital stock (NETCAP).

To examine the discrete event of investing or not we need to model net (new) investment. In the literature there is a distinction between replacement investment[19] and net investment, defined as the difference between gross investment and replacement investment. There are no data that separates the two. We construct net investment implicitly from other information of the data and by making some additional assumptions.

The data provide information on the gross capital stock, K^G, and the net capital stock, K^N, which is similar but depreciated, assuming straight line depreciation. So, it must be the case:

$$K_t^N = K_t^G - \sum_{i=0}^{t} DE_{t-i},$$

where DE_t is the total depreciation at time t. We also have that gross investment at time t, I_t, is

[19] For an interesting review see Feldstein and Rothschild (1974)

$$I_t = I_t^N + I_t^R,$$

where I_t^N is net investment and I_t^R replacement investment. It is pretty obvious that replacement investment is at most equal to depreciation, but here we assume that equality holds, that is replacement investment is always equal to depreciated capital. This assumption allows net investment to become negative which is an implication of disinvesting by the firm. Substituting for

$$DE_t = I_t^R = I_t - I_t^N$$

in the first equation and taking differences with its lagged we get an explicit form for net investment at t:

$$I_t^N = I_t - K_t^N + K_{t-1}^N + K_t^G - K_{t-1}^G$$

A.2 New Debt – New Shares

The data distinguish between long term debt (due after one year), BKDEBT, and debt due in one year from now, DEBT1YR. We derive a NEWDEBT variable with a simple transformation of the two above variables as follows:

$$\text{NEWDEBT}_t = \text{BKDEBT}_t - \text{BKDEBT}_{t-1} + \text{DEBT1YR}_t$$

Similar is the case for new shares. We define the issue of new shares as:

$$\text{NEWSHARES}_t = \text{NOSHARES}_t - \text{NOSHARES}_{t-1}$$

where NOSHARES_t is the number of common shares outstanding at time t. We have corrected this variable on account of common stock splits etc.

A.3 Dividends

We consider the variable DIV, dividends per share, which we multiplied by the number of shares outstanding in order to find the amount of dividends the firm paid out at a specific year.

A.4 Other Variables

All macroeconomic variables, including deflators for nonresidential investment and the consumer price index, as well as the growth rate of GNP and the Treasury Bill rates are taken from the 1992 *Economic Report of the President.*

B Derivation of the Bellman Equation with Tax Considerations.

Let V_t be the value of the firm at time t. Then, the following equation describes the evolution of the value of the firm:

$$E_t \ V_{t+1} = E_t \ {}_tV_{t+1} - (1 + \Psi_t)S_t, \tag{1}$$

where V_{t+1} is the value at time $t+1$ of shares outstanding at the same period $t+1$, ${}_tV_{t+1}$ is the value at time $t+1$ of shares outstanding at time t, S_t is the value of new shares issued in the end of period t, and Ψ_t a neasure of the asymmetry of information, accounting for the risk premium of new stock.

Let R_t be the equilibrium after tax rate of return for the current equity holders. Then the standard finance arbitrage condition in the stock market is:[20]

$$R(t) = \frac{(1-\theta)D_t + (1-c)\left[E_t \ {}_tV_{t+1} - V_t\right]}{V_t}, \tag{2}$$

where θ is the tax rate on dividends and c is the tax rate on capital gains. It is generally the case, under the U.S. Tax Code that the tax rate on dividends exceeds the tax rate on capital gains, or

$$\theta > c$$

Now, by substituting (1) into (2) and rewriting we get

$$R_tV_t = (1-\theta)D_t + (1-c)(E_t \ V_{t+1} - (1+\Psi_t)S_t - V_t)$$

which implies that:

$$V_t = \frac{1}{1+\frac{R}{1-c}}\left[E_tV_{t+1} + \frac{1-\theta}{1-c}D_t - (1+\Psi_t)S_t\right]$$

Solving forward after normalizing for the initial period $t=0$ and considering uncertainty for random variables as assumed in Section 2.2 we get:

[20]See for example Fama, Eugene, R. and Merton H. Miller, *The Theory of Finance*, 1972.

$$V_0 = E_0 \sum_{t=0}^{\infty} \prod_{j=0}^{t} \beta_j \left[\frac{1-\theta}{1-c} D_t - (1+\Psi_t) S_t\right]$$

where

$$\beta_j = \left(1 + \frac{R_j}{1-c}\right)^{-1}$$

The term $1/(1+\frac{R_t}{1-c})$ is thus the discount factor, β_t, and so the *value of the firm* turns out to be the discounted present value of all future earnings in the form of dividends corrected for the tax rates and the new shares valuation. Notice also that the value of an additional unit of capital – i.e. the marginal q – is $(1-\theta)/(1-c)$ because shareholders at this point are indifferent between reinvesting one dollar in the firm taxed at rate c and a dollar of dividends taxed at rate θ.

It seems interesting to consider the relationship between the value of the firm over time with the dividend payments D_t. From the value of the firm equation (3) it follows that:

$$V_t = E_t \sum_{i=t}^{\infty} [\prod_{j=t}^{i-t} \beta(j)] \left(\frac{1-\theta}{1-c} D_i - (1+\Psi_i) S_i\right)$$

or

$$V_t = \frac{1-\theta}{1-c} D_t - (1+\Psi_t) S_t + E_t \sum_{i=t+1}^{\infty} [\prod_{j=t+1}^{i-(t+1)} \beta(j)] \left(\frac{1-\theta}{1-c} D_i - (1+\Psi_t) S_i\right)$$

or

$$V_t = \left(\frac{1-\theta}{1-c} D_t - (1+\Psi_t) S_t\right) + E_t V_{t+1}$$

which, after rewritten as

$$E_t V_{t+1} - V_t = -(1+\Psi_t) S_t - \frac{1-\theta}{1-c} D_t$$

implies that the *increase* in the firm value equals to the market value of its new shares after dividends are subtracted. Also, using equation (1) we get the condition

$$E_t \left[{}_t V_{t+1}\right] = V_{t+1} - \frac{1-\theta}{1-c} D_t$$

that is, the expected value of the currently existing stock tomorrow equals to their value today after the dividend payments.

C Descriptive Statistics

Table A
THE WHOLE SAMPLE

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
YEAR	46499	74.9715263	7.2734724	60.0000000	87.0000000
BKDEBT	46475	104.4238500	420.2414834	0	18294.40
DEBT1YR	39579	7.5394903	43.5326810	0	3252.00
NEWDEBT	39566	17.4086516	162.5094970	-5271.00	11348.00
$1(NEWDEBT > 0)$	46499	0.5271511	0.4992676	0	1.0000000
GROCAP	44576	883.9716698	4068.17	0.1056103	125899.38
NETCAP	44576	587.8215500	2691.88	0.0723749	80707.81
INVEST	44011	84.3319005	377.3571535	0	11688.23
NETI	42659	109.1856470	494.5074581	-3525.82	17814.79
$1(NETINVEST > 0)$	46499	0.8864922	0.3172159	0	1.0000000
NRATE	44576	0.7046411	9.5688806	-94.4505768	946.5126953
GRATE	44576	1.2791807	18.7774209	-12.6138391	1523.73
NOSHARES	46056	36.1496111	235.4204095	0	17896.11
NEWSHAR	45639	0.1686569	192.0075152	-17878.07	17878.59
$1(NEWSHARES > 0)$	46499	0.6057980	0.4886839	0	1.0000000
DIV	46456	0.3667625	0.9812817	0	72.0000060
DIVIDEND	46025	15.5667704	84.8882267	0	2707.84
$1(DIVIDENDS > 0)$	46499	0.6651111	0.4719567	0	1.0000000
VAL	38403	1088.07	3988.06	-353.8623047	137127.28
q	37297	17.0426057	232.7750606	-26.2791047	17055.59

Table B
BANKRUPCIES, LIQUIDATIONS, REORGANIZATIONS

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
YEAR	2225	73.4844944	6.1219514	60.0000000	87.0000000
BKDEBT	2223	26.6014989	105.2628068	0	1877.00
DEBT1YR	1853	3.0914604	16.3117600	0	434.8969727
NEWDEBT	1853	4.9729765	29.8388198	-205.5049896	537.3929596
$1(NEWDEBT > 0)$	2225	0.5146067	0.4998989	0	1.0000000
GROCAP	2100	137.2783685	677.0705790	0.2780483	13299.00
NETCAP	2100	109.3509242	615.8859001	0.0968446	12077.67
INVEST	1985	10.2085674	30.5764121	0	630.1928540
NETI	1925	13.8525902	48.0787255	-135.1849126	992.0541279
$1(NETINVEST > 0)$	2225	0.8152809	0.3881568	0	1.0000000
NRATE	2100	0.9746250	13.0068459	-21.4695892	559.8303223
GRATE	2100	2.0387692	33.4783674	-4.1873264	1471.75
NOSHARES	2189	9.4228423	53.3312116	0.0034638	1230.00
NEWSHAR	2165	0.3713698	48.5251057	-1228.56	1228.77
$1(NEWSHARES > 0)$	2225	0.5078652	0.5000505	0	1.0000000
DIV	2225	0.2207239	0.7944928	0	18.8519495
DIVIDEND	2189	2.7525258	22.4183502	0	399.9995117
$1(DIVIDENDS > 0)$	2225	0.4323596	0.4955150	0	1.0000000
VAL	1703	248.4186705	1086.65	0.1248739	24775.84
q	1639	18.4606430	251.8829522	0.0096547	8521.78

Table C

REGIME #1, $\Delta B > 0, D > 0, \Delta S > 0, \Delta I > 0$

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
YEAR	9837	76.9448002	5.6208219	60.0000000	87.0000000
BKDEBT	9837	211.2425226	544.2027291	0	11492.00
DEBT1YR	9837	13.4195877	55.2634525	0	3252.00
NEWDEBT	9837	48.2794671	196.7229443	3.7252903E-9	7059.49
$1(NEWDEBT > 0)$	9837	1.0000000	0	1.0000000	1.0000000
GROCAP	9837	1634.97	4843.97	0.7307848	102735.19
NETCAP	9837	1098.24	3185.11	0.3704693	72737.06
INVEST	9837	160.6471192	529.8742030	0	11688.23
NETI	9837	209.5612976	654.9073867	0.0321727	12635.73
$1(NETINVEST > 0)$	9837	1.0000000	0	1.0000000	1.0000000
NRATE	9837	0.1043671	2.2656729	-35.2112732	189.5123749
GRATE	9837	0.1739706	4.0703958	-0.7065853	330.8264160
NOSHARES	9837	46.9694822	204.6734509	0.0046839	7702.83
NEWSHAR	9837	6.1506012	130.9383466	5.9604645E-8	7499.98
$1(NEWSHARES > 0)$	9837	1.0000000	0	1.0000000	1.0000000
DIV	9837	0.5727951	1.1636246	0.0013169	66.0000104
DIVIDEND	9837	28.2737357	109.4775803	0.0097500	2707.84
$1(DIVIDENDS > 0)$	9837	1.0000000	0	1.0000000	1.0000000
VAL	9597	1597.57	4544.69	0.2476886	116662.81
q	9597	14.3615400	261.3658685	0.0543396	17055.59

Table D

REGIME #2, $\Delta B > 0, D = 0, \Delta S > 0, \Delta I > 0$

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
YEAR	4556	77.8516242	6.0515477	60.0000000	87.0000000
BKDEBT	4556	34.6245914	129.9455796	0	2868.00
DEBT1YR	4556	3.4555598	18.2684391	0	918.0000000
NEWDEBT	4556	12.6727075	68.4391049	3.7252903E-9	1689.00
$1(NEWDEBT > 0)$	4556	1.0000000	0	1.0000000	1.0000000
GROCAP	4556	140.2258727	541.2806595	0.1056103	11229.29
NETCAP	4556	100.4711809	367.4337754	0.0953737	8439.31
INVEST	4556	16.1970988	49.0198610	0	980.7286694
NETI	4556	21.3960089	66.2493729	0.0046619	1702.42
$1(NETINVEST > 0)$	4556	1.0000000	0	1.0000000	1.0000000
NRATE	4556	0.5976313	8.8141121	-76.7096558	298.9086914
GRATE	4556	1.0317601	12.1137146	-4.9682655	352.5517578
NOSHARES	4556	27.5026138	263.8380064	0.0040367	7976.21
NEWSHAR	4556	10.4116839	168.2479463	5.9604645E-8	6689.28
$1(NEWSHARES > 0)$	4556	1.0000000	0	1.0000000	1.0000000
DIV	4556	0	0	0	0
DIVIDEND	4556	0	0	0	0
$1(DIVIDENDS > 0)$	4556	0	0	0	0
VAL	4203	285.9005564	1333.41	-119.2901830	45192.28
q	4203	25.4233905	318.9372399	-0.2741668	8841.24

Table E

REGIME #3, $\Delta B > 0, D > 0, \Delta S = 0, \Delta I > 0$

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
YEAR	5394	76.9430849	5.4849646	60.0000000	87.0000000
BKDEBT	5394	171.5348944	654.4906262	0	18294.40
DEBT1YR	5394	12.8060759	74.8806837	0	3229.00
NEWDEBT	5394	44.0268974	300.8315269	1.1641532E-9	11348.00
$1(NEWDEBT > 0)$	5394	1.0000000	0	1.0000000	1.0000000
GROCAP	5394	1607.02	6987.99	0.4875709	125899.38
NETCAP	5394	1074.04	4672.11	0.3350248	80707.81
INVEST	5394	136.5284051	572.2157118	0	9052.68
NETI	5394	182.9369972	795.0196889	0.0140926	17814.79
$1(NETINVEST > 0)$	5394	1.0000000	0	1.0000000	1.0000000
NRATE	5394	0.1296799	1.9961682	-1.2036276	116.9448700
GRATE	5394	0.2179408	4.1690307	-0.6656837	273.4074707
NOSHARES	5394	41.1427382	170.6066533	0.1046850	5844.00
NEWSHAR	5347	-12.2075263	290.4198931	-17878.07	0
$1(NEWSHARES > 0)$	5394	0	0	0	0
DIV	5394	0.5469364	1.7085503	0.000307688	72.0000060
DIVIDEND	5394	31.1550453	149.3446687	0.0073200	2666.06
$1(DIVIDENDS > 0)$	5394	1.0000000	0	1.0000000	1.0000000
VAL	5151	1327.71	4516.55	-12.8736439	84418.40
q	5151	13.6828630	163.4768539	-0.9786142	7237.79

Table F

REGIME #4, $\Delta B > 0, D = 0, \Delta S = 0, \Delta I > 0$

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
YEAR	2994	77.1867067	5.2636671	62.0000000	87.0000000
BKDEBT	2994	19.6313889	69.4211398	0	1470.20
DEBT1YR	2994	2.1715469	12.1386621	0	434.8969727
NEWDEBT	2994	5.7772893	26.9638741	1.1641532E-9	530.8848867
$1(NEWDEBT > 0)$	2994	1.0000000	0	1.0000000	1.0000000
GROCAP	2994	92.2103608	307.2372256	0.4446527	4688.60
NETCAP	2994	65.4146899	230.1134901	0.3406105	3851.23
INVEST	2994	7.6677207	31.0549498	0	948.4194548
NETI	2994	10.8336084	38.2086227	0.0090715	974.3430083
$1(NETINVEST > 0)$	2994	1.0000000	0	1.0000000	1.0000000
NRATE	2994	1.1895290	16.4153888	-19.6860199	526.3706055
GRATE	2994	2.5445240	37.8453058	-8.9860659	1057.63
NOSHARES	2994	37.9436486	346.5793768	0.0034638	6669.00
NEWSHAR	2942	-19.3208227	271.0911360	-7968.24	0
$1(NEWSHARES > 0)$	2994	0	0	0	0
DIV	2994	0	0	0	0
DIVIDEND	2994	0	0	0	0
$1(DIVIDENDS > 0)$	2994	0	0	0	0
VAL	2646	181.4120423	869.9258413	-15.9110490	16485.34
q	2646	21.9961234	215.3215689	-1.6022557	6444.17

Table G

REGIME #5: $\Delta B \leq 0, \Delta S > 0, DIV > 0, \Delta I > 0$

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
YEAR	4944	75.7754854	7.0398534	60.0000000	87.0000000
BKDEBT	4944	111.0048911	460.3664122	0	9745.00
DEBT1YR	4944	5.6989581	25.9944523	0	735.5000000
NEWDEBT	4944	-14.0676021	104.1008685	-4986.48	0
$1(NEWDEBT > 0)$	4944	0	0	0	0
GROCAP	4944	1026.82	3879.65	0.3719027	69705.69
NETCAP	4944	664.1823809	2423.61	0.1461723	45268.97
INVEST	4944	71.3394267	259.0460507	0	6176.87
NETI	4944	100.6529384	366.2005719	0.0092716	6662.34
$1(NETINVEST > 0)$	4944	1.0000000	0	1.0000000	1.0000000
NRATE	4944	0.6179106	5.5578609	-5.9197454	193.0252838
GRATE	4944	1.0738818	10.5389040	-4.6259108	386.3371582
NOSHARES	4944	38.5403639	322.4486406	0.4140000	17896.11
NEWSHAR	4944	7.9861783	277.8147322	1.4901161E-8	17878.59
$1(NEWSHARES > 0)$	4944	1.0000000	0	1.0000000	1.0000000
DIV	4944	0.5114357	0.5143752	0.0010720	6.4879999
DIVIDEND	4944	17.8968468	63.7142558	0.0062712	1498.48
$1(DIVIDENDS > 0)$	4944	1.0000000	0	1.0000000	1.0000000
VAL	3604	1214.24	3754.86	-15.4336195	137127.28
q	3604	10.4729018	136.0218047	-0.4500686	4410.32

Table H

REGIME #6, $\Delta B \leq 0, D = 0, \Delta S > 0, \Delta I > 0$

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
YEAR	2350	78.2727660	6.2824858	60.0000000	87.0000000
BKDEBT	2350	29.8131587	131.9056473	0	2353.30
DEBT1YR	2350	2.2123005	11.8093894	0	315.8999023
NEWDEBT	2350	-7.8200787	57.8719450	-2019.90	0
$1(NEWDEBT > 0)$	2350	0	0	0	0
GROCAP	2350	193.5762208	1130.99	0.1333162	37124.23
NETCAP	2350	124.8787574	688.2413228	0.1300346	23634.38
INVEST	2350	11.7766993	72.6250801	0	2967.40
NETI	2350	17.0700122	101.7224912	0.0011053	4139.91
$1(NETINVEST > 0)$	2350	1.0000000	0	1.0000000	1.0000000
NRATE	2350	1.8958585	18.6979814	-17.7273712	559.8303223
GRATE	2350	3.8030965	40.9872959	-9.0107775	1471.75
NOSHARES	2350	30.2588038	275.1797220	0.0064550	6723.00
NEWSHAR	2350	10.4640395	180.6650210	9.0144532E-9	5784.62
$1(NEWSHARES > 0)$	2350	1.0000000	0	1.0000000	1.0000000
DIV	2350	0	0	0	0
DIVIDEND	2350	0	0	0	0
$1(DIVIDENDS > 0)$	2350	0	0	0	0
VAL	1656	325.6053113	1346.18	-39.1270109	29949.39
q	1656	38.9634637	469.9389107	-0.2944843	15314.92

Table I

REGIME #7, $\Delta B \leq 0, D > 0, \Delta S = 0, \Delta I > 0$

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
YEAR	4003	75.5348489	6.4844775	60.0000000	87.0000000
BKDEBT	4003	64.2612264	399.8619819	0	9897.00
DEBT1YR	4003	4.3752712	34.7979474	0	1218.00
NEWDEBT	4003	-7.4966047	92.0307505	-5271.00	0
$1(NEWDEBT > 0)$	4003	0	0	0	0
GROCAP	4003	755.0757263	4847.83	0.3238057	116656.44
NETCAP	4003	496.9080337	3272.58	0.1152944	77574.38
INVEST	4003	50.0677770	330.4707645	0	9039.87
NETI	4003	66.8822794	414.0952548	0.000675975	9896.93
$1(NETINVEST > 0)$	4003	1.0000000	0	1.0000000	1.0000000
NRATE	4003	0.7687662	5.4173020	-21.4695892	202.3753510
GRATE	4003	1.2886798	9.6402664	-4.2860098	355.2663574
NOSHARES	4003	30.2466137	186.8782889	0.001000000	6277.50
NEWSHAR	3957	-9.6871273	176.5805882	-7283.70	0
$1(NEWSHARES > 0)$	4003	0	0	0	0
DIV	4003	0.5446166	0.8728909	0.0032000	18.1589966
DIVIDEND	4003	15.9040652	92.7609886	0.0025200	2598.02
$1(DIVIDENDS > 0)$	4003	1.0000000	0	1.0000000	1.0000000
VAL	2412	908.1138071	3435.32	-10.5034252	58950.99
q	2412	22.7111690	222.8749147	-0.6111759	4853.72

Table J

REGIME #8: $\Delta B < 0, \Delta S = 0, DIV = 0, \Delta I > 0$

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
YEAR	1808	76.9076327	5.3702729	60.0000000	87.0000000
BKDEBT	1808	12.1029283	60.3888112	0	1408.55
DEBT1YR	1808	1.4493425	12.2899712	0	364.1879883
NEWDEBT	1808	-2.9875277	23.5758541	-540.2128906	0
$1(NEWDEBT > 0)$	1808	0	0	0	0
GROCAP	1808	78.9226529	299.2724750	0.2338077	5319.95
NETCAP	1808	52.8396653	203.9155852	0.0873393	3584.47
INVEST	1808	4.4892857	22.5772142	0	745.3773772
NETI	1808	6.8282156	31.5515060	0.000141972	1021.02
$1(NETINVEST > 0)$	1808	1.0000000	0	1.0000000	1.0000000
NRATE	1808	2.4553267	15.5961622	-68.7368774	323.1340332
GRATE	1808	4.6338628	31.8009229	-12.6138391	883.9785156
NOSHARES	1808	56.5368168	419.3328465	0.0048840	6669.00
NEWSHAR	1773	-11.9916115	210.8959362	-5784.61	0
$1(NEWSHARES > 0)$	1808	0	0	0	0
DIV	1808	0	0	0	0
DIVIDEND	1808	0	0	0	0
$1(DIVIDENDS > 0)$	1808	0	0	0	0
VAL	1202	272.1748585	1389.31	-353.8623047	20981.58
q	1202	37.0441052	249.7486198	-1.7489456	4159.73

Table K

REGIME #9, $\Delta B > 0, D > 0, \Delta S > 0, \Delta I \leq 0$

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
YEAR	121	82.6115702	4.3615210	63.0000000	87.0000000
BKDEBT	121	370.0517400	863.3192047	0.0490000	7769.00
DEBT1YR	121	22.3656015	49.2818512	0	364.0000000
NEWDEBT	121	85.3132481	212.7676031	1.1175871E-8	1320.80
$1(NEWDEBT > 0)$	121	1.0000000	0	1.0000000	1.0000000
GROCAP	121	2056.72	5073.42	5.9744301	43165.64
NETCAP	121	1394.33	3158.62	4.6504459	23751.70
INVEST	121	77.3141093	151.6216048	0.0489510	1027.89
NETI	121	-85.6717115	239.7923189	-2026.40	-0.0596930
$1(NETINVEST > 0)$	121	0	0	0	0
NRATE	121	0.0334253	0.0978554	-0.5375810	0.2387629
GRATE	121	0.0708499	0.0591913	-0.2498707	0.2230090
NOSHARES	121	28.6355824	45.1427655	0.5740070	264.7009277
NEWSHAR	121	2.2353873	9.4262323	6.8426971E-8	92.1649933
$1(NEWSHARES > 0)$	121	1.0000000	0	1.0000000	1.0000000
DIV	121	0.6416218	0.5895837	0.0166667	3.0000000
DIVIDEND	121	22.4804905	47.4718141	0.0758000	317.6410628
$1(DIVIDENDS > 0)$	121	1.0000000	0	1.0000000	1.0000000
VAL	118	1262.12	2602.31	1.3118238	19705.82
q	118	1.2026813	0.9355571	0.1549525	7.6228318

Table L

REGIME #10, $\Delta B > 0, D = 0, \Delta S > 0, \Delta I \leq 0$

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
YEAR	188	81.9680851	5.3457007	66.0000000	87.0000000
BKDEBT	188	71.2691814	175.1609362	0	1559.50
DEBT1YR	188	12.0329508	56.2565415	0	698.2419434
NEWDEBT	188	30.9810929	98.0294819	4.4703484E-8	730.0509796
$1(NEWDEBT > 0)$	188	1.0000000	0	1.0000000	1.0000000
GROCAP	188	382.9303795	1583.67	1.0372620	19237.77
NETCAP	188	223.4062675	748.9532825	0.7532287	8555.56
INVEST	188	10.2918234	29.4542304	0	228.8423032
NETI	188	-32.1670885	127.2801610	-1445.64	-0.0098498
$1(NETINVEST > 0)$	188	0	0	0	0
NRATE	188	-0.0048712	1.5328787	-8.3770370	11.1030569
GRATE	188	0.2564514	2.8225133	-6.9946852	35.3358307
NOSHARES	188	11.5994653	22.0274995	0.4301994	174.0999908
NEWSHAR	188	2.4158289	12.5074619	4.4703484E-7	160.1349916
$1(NEWSHARES > 0)$	188	1.0000000	0	1.0000000	1.0000000
DIV	188	0	0	0	0
DIVIDEND	188	0	0	0	0
$1(DIVIDENDS > 0)$	188	0	0	0	0
VAL	172	203.5909501	394.9419132	2.3014363	2722.50
q	172	2.1352183	3.1639074	0.2924823	22.4146502

Table M

REGIME #11, $\Delta B > 0, D > 0, \Delta S = 0, \Delta I \leq 0$

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
YEAR	123	81.8373984	4.7189433	64.0000000	87.0000000
BKDEBT	123	178.5962028	414.1578825	0.0460000	3057.00
DEBT1YR	123	14.1394545	39.0641076	0	227.0000000
NEWDEBT	123	42.0836182	143.5420710	3.7252903E-9	1378.00
$1(NEWDEBT > 0)$	123	1.0000000	0	1.0000000	1.0000000
GROCAP	123	1145.49	2435.66	6.5778236	15355.57
NETCAP	123	761.1490623	1631.29	3.9824038	8759.64
INVEST	123	51.2787348	132.3662613	0.0130000	830.4392237
NETI	123	-68.7347927	207.2048350	-1519.10	-0.0054226
$1(NETINVEST > 0)$	123	0	0	0	0
NRATE	123	0.0106125	0.1373863	-0.9297651	0.1609970
GRATE	123	0.0569694	0.1002992	-0.7136714	0.2152312
NOSHARES	123	58.2579733	332.7728938	0.3830000	3600.00
NEWSHAR	123	-2.6070608	9.2038004	-75.1259918	0
$1(NEWSHARES > 0)$	123	0	0	0	0
DIV	123	0.6060743	0.7469550	0.0250000	6.2999992
DIVIDEND	123	30.4240100	134.2241096	0.0429600	1395.00
$1(DIVIDENDS > 0)$	123	1.0000000	0	1.0000000	1.0000000
VAL	122	1698.80	10476.87	-2.0548530	115032.89
q	122	33.3617884	328.3904370	-0.1943482	3616.48

Table N

REGIME #12, $\Delta B > 0, D = 0, \Delta S = 0, \Delta I \leq 0$

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
YEAR	168	80.4047619	4.8166852	64.0000000	87.0000000
BKDEBT	168	38.2490291	179.6891675	0	2015.34
DEBT1YR	168	2.9146603	6.1895489	0	47.2749939
NEWDEBT	168	9.1329385	45.9907976	1.2805685E-8	580.0297632
$1(NEWDEBT > 0)$	168	1.0000000	0	1.0000000	1.0000000
GROCAP	168	172.8477937	628.2582127	1.4300184	5609.57
NETCAP	168	110.3527306	424.6956084	0.7569601	4083.40
INVEST	168	5.0834299	15.8534396	0.0030364	111.2930572
NETI	168	-14.7297260	64.7776470	-616.1203709	-0.0014355
$1(NETINVEST > 0)$	168	0	0	0	0
NRATE	168	1.2844049	7.5421874	-1.3692932	67.7039948
GRATE	168	1.9252510	10.5029546	-0.7486436	89.9770660
NOSHARES	168	19.0533334	110.0756214	0.4487587	847.9995117
NEWSHAR	166	-5.8887912	72.7383203	-936.9975117	0
$1(NEWSHARES > 0)$	168	0	0	0	0
DIV	168	0	0	0	0
DIVIDEND	168	0	0	0	0
$1(DIVIDENDS > 0)$	168	0	0	0	0
VAL	145	161.1932415	664.2273250	-1.1404371	6888.27
q	145	20.4118186	161.1598719	-0.2478914	1837.61

Table O

REGIME #13: $\Delta B \leq 0, \Delta S > 0, DIV > 0, \Delta I \leq 0$

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
YEAR	161	81.7142857	5.4399317	60.0000000	87.0000000
BKDEBT	161	197.6604412	451.0810125	0	2747.00
DEBT1YR	161	16.0433958	39.3897749	0	239.6999969
NEWDEBT	161	-36.3653635	79.2535559	-610.1048555	0
$1(NEWDEBT > 0)$	161	0	0	0	0
GROCAP	161	1562.86	3784.13	1.7920017	21899.50
NETCAP	161	1029.92	2436.38	1.3173914	15922.86
INVEST	161	61.1086609	128.1373819	0	705.5963316
NETI	161	-72.0883266	162.5289313	-937.1386432	-0.0777623
$1(NETINVEST > 0)$	161	0	0	0	0
NRATE	161	0.1370015	0.7625935	-0.5627093	7.9496078
GRATE	161	0.2281407	0.9556459	-0.1503205	8.2571306
NOSHARES	161	39.4086699	189.3681124	0.5082693	2350.00
NEWSHAR	161	18.7088660	188.8222211	0.000269353	2347.31
$1(NEWSHARES > 0)$	161	1.0000000	0	1.0000000	1.0000000
DIV	161	0.7954021	1.5598347	0.0125000	15.8999996
DIVIDEND	161	24.0430572	55.6341852	0.0895000	363.1513455
$1(DIVIDENDS > 0)$	161	1.0000000	0	1.0000000	1.0000000
VAL	141	1202.63	3098.13	-306.9781882	25475.69
q	141	22.5371794	182.2096039	-0.8158947	1775.65

Table P

REGIME #14, $\Delta B \leq 0, D = 0, \Delta S > 0, \Delta I \leq 0$

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
YEAR	210	81.7047619	4.8121135	68.0000000	87.0000000
BKDEBT	210	56.2111327	201.8996643	0	2146.40
DEBT1YR	210	6.1260612	22.6348356	0	206.6219940
NEWDEBT	210	-22.8629212	70.4082878	-563.1960144	0
$1(NEWDEBT > 0)$	210	0	0	0	0
GROCAP	210	277.6275628	820.0965984	0.2339562	6439.39
NETCAP	210	190.1316461	603.6494185	0.0723749	5545.18
INVEST	210	7.0217213	18.2364500	0.0089820	174.4114574
NETI	210	-33.0636451	143.2946204	-1635.14	-0.0134756
$1(NETINVEST > 0)$	210	0	0	0	0
NRATE	210	1.0283458	6.6075228	-11.6519403	68.4626770
GRATE	210	1.7357405	9.9143381	-5.8019447	112.6928711
NOSHARES	210	35.6487703	326.0370948	0.0059800	4651.16
NEWSHAR	210	1.6543209	6.4767616	1.1920929E-7	56.6450043
$1(NEWSHARES > 0)$	210	1.0000000	0	1.0000000	1.0000000
DIV	210	0	0	0	0
DIVIDEND	210	0	0	0	0
$1(DIVIDENDS > 0)$	210	0	0	0	0
VAL	173	236.9794788	752.7870897	-0.9183825	6684.08
q	173	21.9186273	189.7647790	-0.5179578	1892.24

Table Q

REGIME #15, $\Delta B \leq 0, D > 0, \Delta S = 0, \Delta I \leq 0$

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
YEAR	175	80.2342857	6.4449010	60.0000000	87.0000000
BKDEBT	175	83.1543740	233.2118342	0	1750.00
DEBT1YR	175	5.5261936	21.3214809	0	220.0000000
NEWDEBT	175	-30.5230845	87.2150826	-560.9568939	0
$1(NEWDEBT > 0)$	175	0	0	0	0
GROCAP	175	683.2704817	2059.92	1.0020447	20810.61
NETCAP	175	439.8838368	1283.85	0.7847025	12535.61
INVEST	175	32.4156163	93.1766374	0	664.2784033
NETI	175	-63.2457445	292.9686768	-3525.82	-0.0261254
$1(NETINVEST > 0)$	175	0	0	0	0
NRATE	175	0.6530923	3.4001104	-6.1632185	33.0193329
GRATE	175	1.4411425	7.9270504	-3.5782986	89.5627136
NOSHARES	175	33.0125998	208.8409118	0.5080000	2717.55
NEWSHAR	175	-20.7565865	250.0431880	-3308.63	0
$1(NEWSHARES > 0)$	175	0	0	0	0
DIV	175	0.7491376	1.7337731	0.0053760	20.5000000
DIVIDEND	175	17.7597938	58.2754689	0.0139700	401.2851843
$1(DIVIDENDS > 0)$	175	1.0000000	0	1.0000000	1.0000000
VAL	127	747.8614864	1735.53	-64.7829112	9280.74
q	127	19.9284318	178.0626840	-0.2170644	1969.76

Table R

REGIME #16: $\Delta B < 0, \Delta S = 0, DIV = 0, \Delta I \leq 0$

Variable	# of Observ.	Mean	Std Dev	Minimum	Maximum
YEAR	233	80.0300429	5.0688321	65.0000000	87.0000000
BKDEBT	233	13.1135562	46.7855040	0	572.6999512
DEBT1YR	233	6.7364630	58.8084172	0	860.0109863
NEWDEBT	233	-7.8202689	40.9103160	-541.4119720	0
$1(NEWDEBT > 0)$	233	0	0	0	0
GROCAP	233	131.0750241	492.3288160	0.5622219	4632.17
NETCAP	233	83.1837340	308.7251815	0.0919999	2968.29
INVEST	233	4.9947937	22.0491068	0.0010121	248.5359955
NETI	233	-11.9116414	47.5141826	-581.6351471	-0.0037318
$1(NETINVEST > 0)$	233	0	0	0	0
NRATE	233	0.0903762	9.8065139	-94.4505768	62.5895691
GRATE	233	1.6776403	8.5567790	-2.1719170	82.6613159
NOSHARES	233	14.0687395	78.0323933	0.3601061	797.9995117
NEWSHAR	232	-0.1207036	0.8785726	-12.6596176	0
$1(NEWSHARES > 0)$	233	0	0	0	0
DIV	233	0	0	0	0
DIVIDEND	233	0	0	0	0
$1(DIVIDENDS > 0)$	233	0	0	0	0
VAL	160	136.0077562	470.3537655	-83.9969686	4172.07
q	160	16.7462245	100.2036647	-0.4063447	899.3246651

VITA

Stelios Corres was born in Athens, Greece, on May 19, 1963. His received his Bachelor and M.A. Degree from the Athens School of Economics and Business Science. He entered the Virginia Polytechnic Institute and State University on August 1988 and received his Master's of Arts in Economics on December 1991 and his Doctor of Philosophy in Economics on August 1993.

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